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## Medicinal Bioactives as Antimicrobial Agents: An Overview

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### ABSTRACT

Ethnopharmacologists, botanists, microbiologists, and natural-products chemists are combing the Earth for phytochemicals and "leads" which could be developed for treatment of infectious diseases. While 25 to 50% of current pharmaceuticals are derived from plants, none are used as antimicrobials. Traditional healers have long used plants to prevent or cure infectious conditions; Western medicine is trying to duplicate their successes. Plants are rich in a wide variety of secondary metabolites, such as tannins, terpenoids, alkaloids, and flavonoids, which have been found in vitro to have antimicrobial properties. Scientists from divergent fields are investigating plants anew with an eye to their antimicrobial usefulness. A sense of urgency accompanies the search as the pace of species extinction continues. Laboratories of the world have found literally thousands of phytochemicals which have inhibitory effects on all types of microorganisms in vitro. Plant produced a diverse array of secondary metabolites, many of which have antimicrobial activity. Some of these compounds are constitutive, existing in healthy plants in their biologically active forms. Others such as cyanogenic glycoside and glucosinolates, occur as inactive precursor and are activated in response to tissue damage or pathogen attack. In the present paper, a summarize picture of how Indian Medicinal Plants are working as antimicrobial agents and their past, present and future prospects, both as potential antimicrobial crude drugs as well as a source for natural compounds that act as new anti-infection agents. In the past few decades, the search for new anti-infection agents has occupied many research groups in the field of ethnopharmacology. Further, this review deals with the correlations with the structure activity relationship between bioactives and Indian Medicinal Plants potentials in terms of biopotentials.

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### Key Words

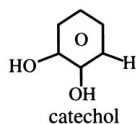
*Antimicrobial activity; Medicinal plants; Antibacterial; Antifungal, Bioactives*

## INTRODUCTION

Plants are the chemical factories. These chemical reservoirs are the source of various natural products having therapeutic potentials. The use of and search of drugs and dietary supplements derived from plants have studied in recent years. These plants possess various secondary metabolites viz. tannins, terpenoids, alkaloids and flavonoids, which possess antimicrobial potentials. The present review is attempt to summarize various bioactives isolated from plants as antimicrobial agents. The structure and antimicrobial properties of phytochemicals are also taken into account which showed a relationship between structure and its potent activity. This review aimed to accumulate the structures with therapeutic potentials.

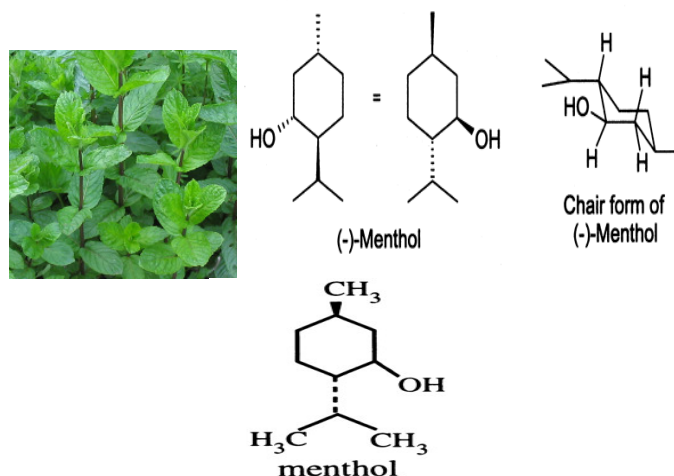
Plants have almost limitless ability to synthesize aromatic substances, most of which are phenols or oxygen substituted derivatives. As per literature 12,000 metabolomes were isolated from the plants. Secondary metabolites are the plants product now a day's known as natural product these chemicals forms the defense system which fight against predators like microorganisms, insects and herbivores. Some are terpenoids are the essential oils like menthol used in various nasal infections, some oil jasmine used for fragrance for food and toilitary industry. Even compound possessed flavor

### ***Croton urucurana* Baillon (Euphorbiaceae).**

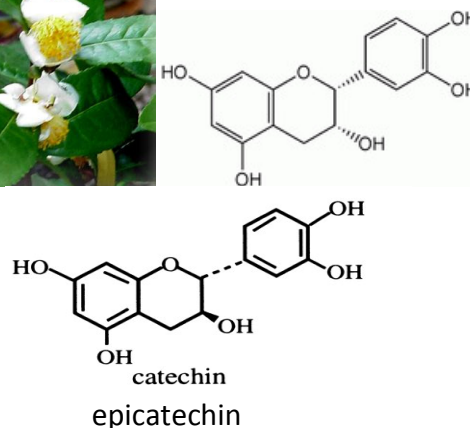


In the methanolic extract of *Croton urucurana* Baillon (Euphorbiaceae) a number of known compounds, such as acetyl aleuritic acid, stigmasterol, beta-sitosterol, campesterol, beta-sitosterol-O-glucoside, sonderianin, catechin and galocatechin were isolated and identified by MS and NMR spectroscopy, HRGC and data from literature. The antibacterial activity of the aqueous-EtOH extract, some fractions of the methanolic extract

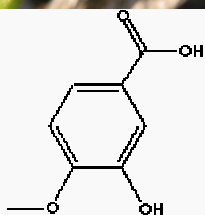
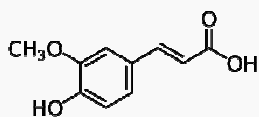
and some of the isolated compounds, were tested against *Staphylococcus aureus* and *Salmonella typhimurium*. Acetyl aleuritic acid exhibits the best minimum inhibitory concentration (MIC) against both *Staphylococcus aureus* and *Salmonella typhimurium* (Peres et al., 1997).



Menthol isolated from *Mentha piperita* also possess antimicrobial activity (Mathur et al., 2011)

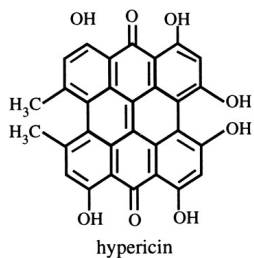


Tea catechins inhibited the fluid accumulation induced by cholera toxin in sealed adult mice. The catechins also reduced fluid accumulation by *Vibrio cholerae* O1 in ligated intestinal loops of rabbits. These findings suggest that tea catechins may possess protective activity against *V. cholerae* O1. (Toda et al., 1992)

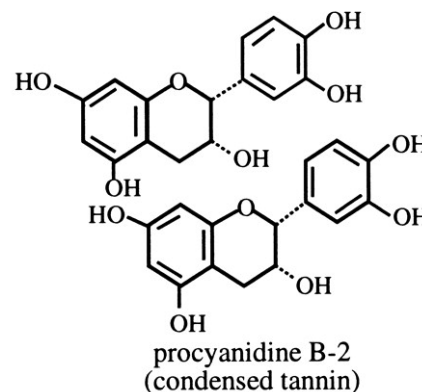
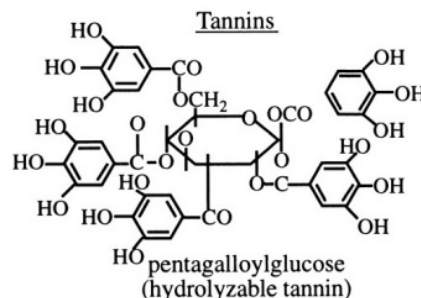


*Scrophularia frutescens* ferulic acid  
isovanillic acid

The phenolic fractions of aerial part of *Scrophularia frutescens* and *S. sambucifolia* (Scrophulariaceae) showed a potent antibacterial activity. Ferulic, isovanillic, p-hydroxycinnamic, p-hydroxybenzoic, syringic, caffeic, gentisic and protocatechuic acids were isolated from *S. frutescens* and ferulic, p-coumaric, vanillic, p-hydroxybenzoic and syringic acids were isolated from *S. sambucifolia*. Since phenolic acids have been shown in the literature to exert an antibacterial effect, the presence of these compounds in the two plants explains their antibacterial activity (Fernandez et al., 1996).

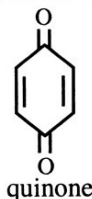


An anthraquinone from *Cassia italica*, a Pakistani tree, which was bacteriostatic for *Bacillus anthracis*, *Corynebacterium pseudodiphthericum*, and *Pseudomonas aeruginosa* and bactericidal for *Pseudomonas pseudomalliae*. Hypericin, an anthraquinone from St. John's wort (*Hypericum perforatum*), has received much attention in the popular press lately as an antidepressant (Kazmi et al., 1994) and it had general antimicrobial properties (Duke, 1985).



The antimicrobial significance of this particular activity has not been explored. There is also evidence for direct inactivation of microorganisms: low tannin concentrations modify the morphology of germ tubes of *Crinipellis pernicioso*. Tannins in plants inhibit insect growth (Schultz, 1988) and disrupt digestive events in ruminal animals. These tannins have a lot of methods to perform structure activity relationship by bind to proteins, adhesions, even enzyme inhibition and substrate deprivation, complex with cell wall (Scalbert, 1991; Haslam, 1996).

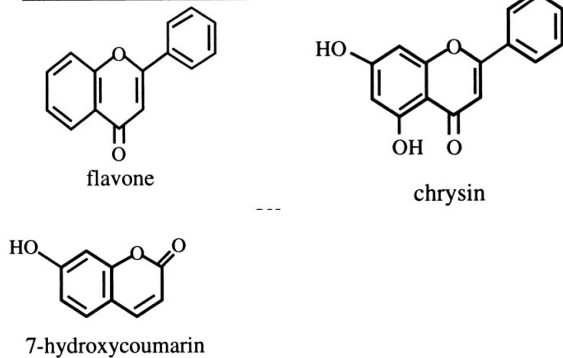
#### Quinones



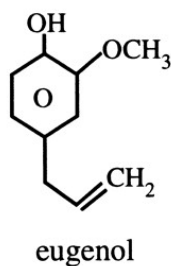
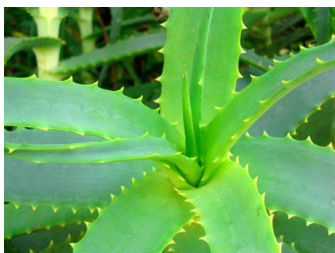
Quinones are aromatic bioactives though belongs to largest group of secondary metabolites phenol, they are highly reactive, often leading to inactivation of the protein and loss of function. The potential range of antimicrobial effects is great. Probable targets in the microbial cell are surface exposed adhesions, cell wall

polypeptides and membrane bound enzymes. Quinones may also render substrate unavailable to the microorganisms. Still the toxicity must be screened (Harris, 1963).

#### Flavones and flavonoids

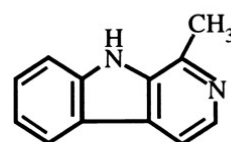
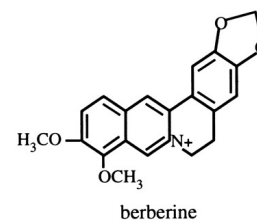


Flavones are phenolic structures containing one carbonyl group (as opposed to the two carbonyls in quinones) it is noteworthy that they have been found in vitro to be effective antimicrobial substances against a wide array of microorganisms. Their activity is probably due to their ability to complex with extracellular and soluble proteins and to complex with bacterial cell walls, as described above for quinones. More lipophilic flavonoids may also disrupt microbial membranes (Tsuchiya et al., 1996).



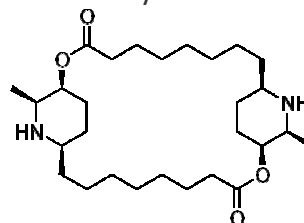
The antimicrobial activities of 23 extracts of 12 Cuban plant species reported in traditional medicine were tested. The agar diffusion method was used to assess the activity against four bacteria and one yeast: *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans*. The results, evaluated as the diameter of the inhibition zone of microbial growth, showed that nine extracts were active against Gram-positive bacteria but only two of these proved to be also active against Gram-negative bacteria. None of the extracts inhibited the growth of the yeast. The most susceptible bacterium was

*Staphylococcus aureus* and the best antibacterial activity was shown by *Schinus terebenthifolius*. *Aloe barbadensis* and *Aloe vera* latex possessed antibacterial activity against *S. aureus*, *Corynebacterium* and *Salmonella* spp (Martinez et al., 1996)

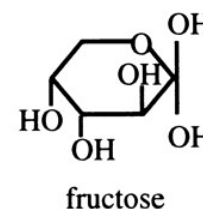


harmaline

The mechanism of action of highly aromatic planar quaternary alkaloids such as berberine (McDevitt et al., 1996) and harmaline (Hopp et al., 1976) is attributed to their ability to intercalate with DNA.

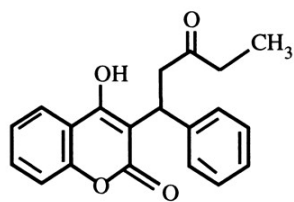


Carpaine, the major alkaloid of *C. papaya* occurs in all of the green parts of the plant and in the seeds. It also occurs in other members of family Caricaceae, its chemistry and pharmacology properties (Burdick, 1971).



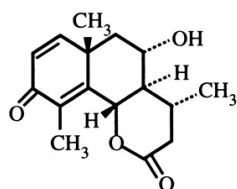
fructose

A fructose isolated from blue berries (*Vaccinium* spp.) possess antibacterial activity against *E. coli* which can be utilized safely for today's *E. coli* resistant variety for potential therapy (Ofek et al., 1996).



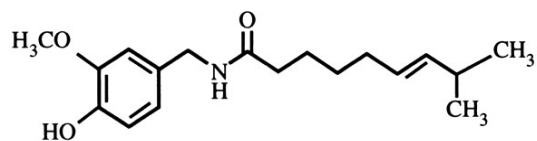
warfarin

Warfarin is a particularly well-known coumarin which is used both as an oral anticoagulant and, interestingly, as a rodenticide (Keating and Kennedy, 1997).



artemisinin

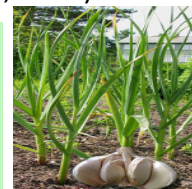
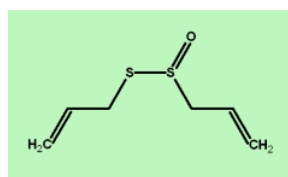
Terpenoids are synthesized from acetate units, and as such they share their origins with fatty acids. They differ from fatty acids in that they contain extensive branching and are cyclized. Examples of common terpenoids are menthol and camphor (monoterpenes) and farnesol and artemisinin (sesquiterpenoids). Artemisinin and its derivative  $\alpha$ -arteether, also known by the name qinghaosu, find current use as antimalarials (Vishwakarma, 1990).



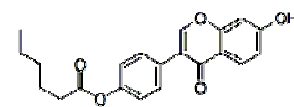
capsaicin

A survey of the Mayan pharmacopoeia revealed that tissues of *Capsicum species* (Solanaceae) are included in a number of herbal remedies for a variety of ailments of probable microbial origin. Using a filter disk assay, plain and heated aqueous extracts from fresh *Capsicum*

*annuum*, *Capsicum baccatum*, *Capsicum chinese*, *Capsicum frutescens*, and *Capsicum pubescens* varieties were tested for their antimicrobial effects with fifteen bacterial species and one yeast species. Two pungent compounds found in *Capsicum species* (capsaicin and dihydrocapsaicin) were also tested for their antimicrobial effects. The plain and heated extracts were found to exhibit varying degrees of inhibition against *Bacillus cereus*, *Bacillus subtilis*, *Clostridium sporogenes*, *Clostridium tetani*, and *Streptococcus pyogenes* (Cichewicz and Thorpe, 1996).

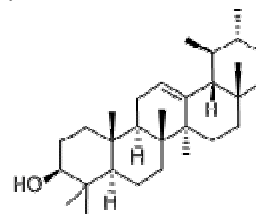


Alliin isolated from *Allium sativum* possess a large number of antibacterial properties as it possess sulphur sulphur double bond which is characteristic feature of sulfa drugs so can be used as antibacterial drug (Tada et al., 1988)

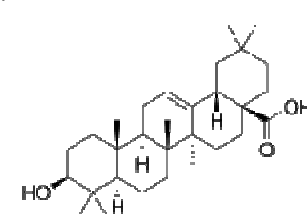


JHF 1

*Jasminum grandiflorum* L is described in Ayurveda to treat several diseases such as ulcer, stomatitis, and skin disease. Leaves are used to apply locally as in single or compound formulation in leprosy. Isolation of two new antimicrobial compounds 3,5 dihydroxy 2,4 dimethyl hexanoic acid 4-hydroxy phenyl ester (JHF 1) and 2 Hydroxymethyl 3methyl butric acid phenyl ester (JHF2) were found active against *K. pneumonia* and *S. aureus* (Bhosale et al., 2011).

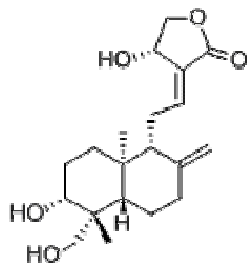


alpha amyrin



oleanolic acid

Pentacyclic triterpenoids (Betulinic acid, amyirin, oleanolic acid, ursolic acid, rotundic acid, ursolic acid, imberbic acid, Zeylasteral ) have shown anti staphylococcal activities and although individually weaker than common antibiotics produced from bacteria and fungi, synergistically these compounds may use different mechanism of action or pathways to exert their antimicrobial effects, as implicated in the lower MICs. Therefore, the use of current antibiotics could be maintained in their combination with plant derived antibacterial agents as a therapeutic option in the treatment of *S. aureus* infections (Chung et al., 2008).



Two antibacterial compounds viz 3 O β-D-glucosyl 14 deoxyandrographolide and 14 deoxyandrographolide were isolated from *Andrographis paniculata* possessed antibacterial activity.

## CONCLUSION

Plant produced a diverse array of secondary metabolites, many of which have antimicrobial activity. Some of these compounds are constitutive, existing in healthy plants in their biologically active forms. Others such as cyanogenic glycoside and glucosinolates, occur as inactive precursor and are activated in response to tissue damage or pathogen attack. In the present paper, a summarize picture of how Indian Medicinal Plants are working as antimicrobial agents and their past, present and future prospects, both as potential antimicrobial crude drugs as well as a source for natural compounds that act as new anti-infection agents. In the past few decades, the search for new anti-infection agents has occupied many research groups in the field of ethnopharmacology. Further, this review deals with the correlations with the structure activity relationship between bioactives and Indian Medicinal Plants potentials in terms of biopotentials..

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