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ANTIMICROBIAL ACTIVITY OF SECONDARY METABOLITES FROM PLANTS- A REVIEW

M. Gokhale * and M. Wadhwani

Department of Botany & Microbiology, St. Aloysius (Autonomous) College, Jabalpur - 482001, Madhya Pradesh, India.

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Correspondence to Author:
M. Gokhale

Assistant Professor, Department of Botany & Microbiology, St. Aloysius (Autonomous) College, Jabalpur - 482001, Madhya Pradesh, India.

E-mail: mamtashrirang@gmail.com

ABSTRACT: Plants are valuable sources of natural products. Despite the availability of different approaches for the discovery of therapeutically, natural products remain as one of the best reservoirs of new structural types. They play a major role in the cure of various diseases from ancient time. Role of plant metabolites to inhibit the growth and activity of pathogenic bacteria is cherished. Research towards the invention of sources of plant metabolites gives sustenance against the problem of development of resistant pathogen. The review presents information about some new sources of phytometabolites against pathogens.

INTRODUCTION: The secondary metabolites are the products which are derived from nitrogen metabolism of the plant, they are in low abundance. They play a major role in the adaptation of plants to their environment [1]. A brief description of the antimicrobial activities of secondary metabolites from some plant reported is presented in Table. Plants used for traditional medicine contain a wide range of substances that can be used to treat chronic as well as infectious diseases [2, 3]. Due to the development of adverse effects and microbial resistance to the chemically synthesized drugs, men turned to ethnopharmacognosy [4]. They found thousands of phytochemicals from plants as safe and broadly effective alternatives with less adverse effect.

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Much beneficial biological activities such as anticancer, antimicrobial, antioxidant, anti-inflammatory, analgesic and wound healing activity were reported. In many cases, the people claim the benefit of certain natural or herbal products [5, 7]. However, clinical trials are necessary to demonstrate the effectiveness of a bioactive compound to verify this traditional claim [8, 9].

Types of Secondary Metabolites: The beneficial medicinal effects of plant materials typically result from the combination of secondary metabolites such as alkaloids, steroids, tannins, and phenol compounds, flavonoids, resins, fatty acids, gums which are capable of producing definite physiological action on the body.

Phenol Compounds: Phenolics are compounds possessing one or more aromatic rings with one or more hydroxyl groups. They are broadly distributed in the plant kingdom and are the most abundant secondary metabolites of plants, with more than 8,000 phenolic structures currently known, ranging from simple molecules such as phenolic acids to

highly polymerized substances such as tannins. Plant phenolics are generally involved in defense against ultraviolet radiation or aggression by pathogens, parasites, and predators, as well as contributing to plants' colors [10].

Alkaloids: Alkaloids are found primarily in plants and are especially common in certain families of flowering plants. More than 3,000 different types of alkaloids have been identified in a total of more than 4,000 plant species. The chemical structures of alkaloids are extremely variable. Generally, an alkaloid contains at least one nitrogen atom in an amine-type structure- *i.e.,* one derived from ammonia by replacing hydrogen atoms with hydrogen-carbon groups called hydrocarbons. This or another nitrogen atom can be active as a base in acid-base reactions. The first alkaloid to be isolated and crystallized was the potent active constituent of the opium poppy, morphine, in about 1804. Alkaloid knew as antimalarial agent [11].

Sterols: Plant sterols (PS) are C_{28} and C_{29} carbon steroid alcohols [12] that are integral components of plant cell membranes, be key components of plant plasma membrane microdomains [13] and may exert similar functions in human cells. These compounds cannot be synthesized by humans and are introduced through the diet where they are found concentrated in plant foods, especially those with are lipid rich [14].

Tannins: Tannins are astringent, bitter plant polyphenols that either bind and precipitate or shrink proteins. The astringency from the tannins is that which causes the dry and puckery feeling in the mouth following the consumption of red wine, strong tea or an unripened fruit [15]. The term tannin refers to the use of tannins in tanning animal hides into leather; however, the term is widely applied to any large polyphenolic compound containing sufficient hydroxyls and other suitable groups (such as carboxyls) to form strong complexes with proteins and other macromolecules. Tannins have molecular weights ranging from 500 to over 3000. [16]

Saponins: Saponins are natural high molecular weight glycosides of triterpene steroids with a very wide distribution in the plant kingdom [17] as well as in lower marine animals, such as starfish [18]. In the past, saponins were characterized according to their surface-active properties and ability to form persistent foams [19] saponins exhibited a range of biological activities [20]. On the other hand, saponins also have beneficial pharmacological effects. They are anticholesterolemic due to the formation of a complex with cholesterol in the gastrointestinal tract thus preventing absorption [21]. Other activities include anti-inflammation, anti-parasite and anti-virus [22, 23].

Flavonoids: Flavonoids are a group of polyphenolic compounds, which are widely distributed throughout the plant kingdom and about 3000 varieties of flavonoids are known. The basic structural feature of flavonoid compounds is the 2-phenyl-benzopyrene or flavone nucleus, which consists of two benzene rings linked through a heterocyclic pyrene ring [24]. Flavonoids can be classified according to the biosynthetic origin. Some classes, for example, chalcones, flavanones, flavan-3-ols and flavan-3, 4-diols are both intermediates in biosynthesis as well as end products that can accumulate in plant tissues.

Other classes are only known as end products of biosynthesis, for example, anthocyanidins, proanthocyanidins, flavones, and flavonols. Two additional classes of flavonoid are those in which the 2-phenyl side chain of flavanone isomerises to the 3 positions, giving rise to isoflavones and related isoflavonoids. The neoflavonoid is formed through further isomerization to the 4 position [25].

In leaves, these compounds are increasingly believed to promote physiological survival of the plant, protecting it from fungal pathogens and UV-B radiation. Also, flavonoids are involved in photo sensitization, energy transfer, the action of plant growth hormones and growth regulators, control of Respiration, photosynthesis morphogenesis and sex determination [26].

Medicinal Properties of Flavonoids: Increasingly, flavonoids are becoming the subject of medical research. They have been reported to possess many useful properties, including anti-inflammatory activity, oestrogenic activity, enzyme inhibition, antimicrobial activity, anti-allergic activity, antioxidant activity, vascular activity, and cytotoxic anti-tumor activity. Flavonoids inhibit a perplexing number and variety of eukaryotic enzymes and

have a tremendously wide range of activities. In the case of enzyme inhibition, this has been postulated to be due to the interaction of enzymes with different parts of the flavonoid molecule, *e.g*., carbohydrate, a phenyl ring, phenol and benzopyrone ring [27].

Flavonoids are ubiquitous in photosynthesizing cells and therefore occur widely in the plant kingdom. They are found in fruit, vegetables, nuts, seeds, stems and flowers as well as tea, wine, propolis, honey represent a common constituent of the human diet [28]. The flavonoids are secondary metabolites of low molecular weight, widely distributed in the plant kingdom, with several biological activities. There are some reports about antimicrobial activity of flavonoids, *e.g*., apigenin, a monohydroxylated flavone in B ring, quercetin a dihydroxylatedflavonol in B ring and myricetin a trihydroxylatedflavonol in B ring [29].

Antimicrobial Activity of Secondary Metabolites against Microorganism: Plant secondary compounds are usually classified according to their biosynthetic pathways. Three large molecular families are generally considered: phenolics, terpenes and steroids, and alkaloids. A good example of a widespread metabolite family is given by phenolics: because these molecules are involved in lignin synthesis, they are common to all higher plants. However, other compounds such as alkaloids are sparsely distributed in the plant kingdom and are much more specific to define plant genus and species [30] **Table 1**.

TABLE 1: ANTIMICROBIAL ACTIVITY OF SECONDARY METABOLITES FROM PLANTS

S. no.	Plant name	Organ	Secondary metabolites	Antimicrobial activity against
1	*Alchornea laxiflora, Adansonia digitata, Newbouldia laevis, Cnidoscolus acontifolius*	leaf	Saponins, flavonoids, alkaloids, tannins, terpenoids, carbohydrates, cardioactive glycosides, steroids phenols, resins, anthraquinones, reducing sugars	*S. aureus, E. coli, B. subtilis, P. aeruginosa* [31]
2	*Arbutus unedo* L.	Root	Quinones, anthraquinones, reducteurs, compounds, anthocyanins, flavonoids,tannins	*Escherichia coli, Staphylococcus aureus* & *Pseudomonas aeruginosa* [32]
3	*Phyllanthus emblica* L.	Leaf fruit	Alkaloids, oil, fat, glyceroids, carbohydrates, phenolics, tannins, lignin, saponins, flavonoids, terpinoids	*E.coli, P. aeruginosa, S. aureus* & *Bacillus subtilis* [33]
4	*Cassia auriculatalinn*	Flower	Alkaloids, flavonoids, glycosides, proteins, saponins, tannins, phenols terpenoids	*S. aureus, E. coli, B. subtilis, Candida albicans,* & *Aspergillus niger* [34]
5	*Psidium guajava*	Leaf fruit stem	Reducing sugar, tannins, saponins, terpenoids, alkaloid, polyphenols	*S.aureus, P. aeruginosa* & *E. coli* [35]
6	*Arbutus unedo* L.	Root	Quinines, reducters compounds, anthocyanins, flavonoids, tannins	*E. coli, S. aureus, P.aeruginosa* [36]
7	*Chenopodium album* Linn.	Flower leaf	Lipid, phenols, lignins, alkaloids, flavonoids, glycosides, saponins	*E. coli, P. aeruginosa, Bacillus cereus* & *S. aureus* [37]
8	*Aristolochita bracteolate* Lam.	leaf	Flavonoids, glycosides, phenols, terpenoids, steroids, tannins, lignin, saponins	*S. aureus, B. subtilis, E. coli, Klebsiella pneumonia* [38]
9	*Azadirachata indica* Linn.	Leaf	Alkaloids, glycosides, flavonoids & saponins	*Bacillus pumillus, P. aeruginosa* & *S. aureus* [39]
10	*Acalypha indica*	Leaf	Alkaloids, tannins, saponins, steroids & proteins	*S. aureus and B. subtilis, E. coli & Klebsiella* [40]
11	*Anabasis aphylla* L.	Leaf	Terpenoids, saponins, flavonoids, alkaloids, sterols, steroids,	*S. aureus, Entrococcusfaecalis, Bacillus polymyxa, P. aeruginosa, S. typhi, Proteus mirabilis, Aspergillus niger, Candida albicans* [41]
12	*Barleria cristata*	Bark	Flavonoids	*S. aureus, Bacillus subtillis &*

				Streptococcus mutans [42]
13	*Andrographis paniculata* & *Melia azadirach*	Leaf	Triterpenoids, reducing sugars, tannins, alkaloids, flavonoids, saponins	*Pseudomonas fluorescence, Vibrio cholerae, E. coli, K. pneumoniae, Salmonella typhi, S. aureus, Tricophyton rubrum, Aspergillus niger, Aspergillus fumigatus, &Candida albicans* [43]
14	*Bauhinia purpurea* Linn.	Stem bark	Steroids, triterpenoids, alkaloids, fatty acids, phytol esters	*B. subtilis, S. aureus, E. coli, P. aeruginosa, Salmonella typhimurium, Klebsiella, A. niger & Claviceps purpurea* [44]
15	*Bauhinia purpurea*	Stem bark	Saponins, tannins, flavonoids, phenols, cardiac glycosides, anthraquinones	*B. subtilis, Bacillis amyloliquefaciens, Bacillus pumilus, Micrococus luteus, S. Pseudomonas, E. coli & Salmonella typhi* [45]
16	*Phyllanthus acidus*	Leaf fruit	Alkaloids, flavonoids, steroids and phenols	*Proteus vulgaris, Shigella boydii, Shigella flexneri, K. aerogenes & Corneybacterium* [46]
17	*Punica granatum*	Fruit	Glycosides, tannins, vitamin C, carbohydrate, free amino acids, proteins	*E. coli, S. aureus & S. typhi* [47]
18	*Momordica charantia*	Leaf	Carbohydrates, proteins and aminoacids, phytosterols, phenolic compounds and tannins and steroids	*B. subtilis, S. mutans, S. aureus, E. coli, P. aeruginosa & K. pneumoniae* [48]
19	*Gloriosa superba* Linn.	Seed tuber	Alkaloids, glycosides, steroids, tannin, terpenoids	*B. cereus, B. subtilis, Streptococcus cremoris, S. faecalis, S. aureus, E. coli, P. aeruginosa, Salmonella typhi, K. pneumonia & Proteus vulgaris* [49]
20	*Ocimum sanctum* L.	Leaf root	Steroidal compounds, alkaloids, tannins	*E. coli, Proteus mirabilis & S. aureus* [50]
21	*Momordica charantia* L.	Leaf	Saponins, steroids, tannins, glycosides, alkaloids, flavonoids	*S. aureus, B. subtilis, E. coli, & P. aeruginosa* [51]
22	*Euphorbia hirta*	Whole plant Flower Stem Leaf Root	Carbohydrates, protein, lipid, flavonoids, alkaloids, saponins, resins, sterols, steroids, acidic compounds, tannins, anthraquinone, phenols, terpenoids	*B. cereus, B. subtilis, E. faecalis , S. aureus, S. epidermidis, K. pneumoniae, S. typhimurium, S. marcescens, S. dysentriae & S. sonnei* [52]

CONCLUSION: Increasing resistance in pathogenic microorganisms generating a challenge in the world of medicine. It is valuable if the researchers establish the importance of medicinal flora, particularly by working on the specific medicinal impact of every plant part against a specific type of pathogen. This establishment medicinal value of plants will make easy their conservation in society.

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