

Generation of Plant Secondary Metabolites and their Bio-Activities in Different Plants

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Abstract: Plant produces structurally and functionally many compounds which give diverse roles in growth and plant response and change as well biotic and abiotic stress. Plant secondary metabolites classified in many classes such as terpenoids, phenolic, compounds and alkaloids. Plants are known to be major source of developing new outcomes in medical perspective and drug production and plant secondary compounds are major sources for medical purposes and in pharmaceutical industries. And these secondary metabolites has accustomed a great interest in generation and increasing the importance for commercial purposes like plant tissue culture. In this review, primarily focusing on secondary metabolites production and their biological activities such as anti-microbial and anti-oxidant.

Keywords: Metabolites, plant secondary metabolites, microbial properties and biological activities.

Introduction

The metabolism can be delineated as the addition of all biochemical reaction accomplished by organisms and they referred as the intermediates of plant metabolism and normally barred to small molecules. Metabolites have varied biological function, structure, signaling molecules, repressive effects on enzyme activity and chemical action of their own defense mechanism and interaction with alternative organisms. And plant turn out in a massive and numerous assortment of primary compounds that is the good enterprise to participate directly in growth and development. The growing industrial importance of secondary metabolites in few back years emanated during an interest within the risk of sterilization and also the assembly of biologically active plant metabolites by suggests that in tissue culture technology [1].

The distinction between primary and secondary metabolites is dubious till several of the delegates in primary metabolism are overlapping with the delegates in secondary metabolites [2]. The mosaic behavior of delegates indicates mutual biochemical pathway being shared by primary and secondary metabolites [3].

Plant secondary metabolites are distinctive sources for prescription drugs, food additives and flavors. The value of plant cell cultures has many aggravations for the assembly of those secondary

metabolites. Standardized cultures, especially root cultures will build a big contribution within the production of secondary metabolites and they also represented as delegates biochemical pathways that were not precisely concerned within the traditional growth, development or delegates organisms [4].

These metabolites are those metabolites that are typically made during a part of successive growth and do not have any perform in development as well as are made by bound restricted categorization groups of micro-organisms and have uncommon organic structures and are typically shaped as mixtures of closely connected members. Not like primary metabolites, immediate death and in long term impairment of the organisms (survival, fecundity) has no significant change in the absence of secondary metabolites [5]. And those metabolites show a major role in plant defense mechanism contrary to herbivorous and other interspecies defenses [6, 7].

In new era, humans treat secondary metabolites as drugs, flavors and in other medicinal properties. Smetanska 2008 has compiled the methods for achieving the secondary metabolites from plant cell cultures is expressed as a specification of cell cultures or products [8]. And Kossel was the 1st to explain the metabolites as antithetical to primary metabolites. It has been apparently manifested that plant secondary metabolites gives a major role in alteration of plants to their nature (Kossel et al., 1981). In this review, we have examined the biological activities such as anti-microbial, anti-oxidants, anti-diabetic and also production of secondary metabolites from plants including pertinence of microbial secondary metabolites.

Secondary metabolites and classification

Secondary metabolites or natural substances may be described as heterogeneous team of instinctive metabolic substances which aren't necessary for vegetative growth and development of the developing organisms, while they are considered as differentiating compounds conversing modifying aspects such as signaling molecules in ecological interaction, symbiosis and defense mechanisms [9]. And to improve the human's health with antibiotics, enzyme inhibitors and growth promoters; the secondary metabolites secretions is accumulated. Out of all secondary metabolites announced in concordance of natural

substances (approx. 32,790 are terpenoids, 16,500 alkaloids & 8,000 are flavonoids).

Plant secondary metabolites are normally categorized according to their biochemical pathways into many molecule families like terpenoids, flavonoids, steroids and alkaloids.

Terpenes

The largest class of secondary metabolites is terpenoids and mostly substances are irresolvable in water. In plant growth and development, terpenoids have well characterized function and expressed primary metabolites rather than secondary metabolites. Such as the plant hormones, gibberellins are diterpenes and Brassinosteroids, another major class of plant regulators originate from triterpenes. The important function of terpenes is secondary metabolites surmised to be involved in plant defense mechanisms.

Steroids and Terpenoids are wide group of substances derived biosynthetically from isopentenyl diphosphate and terpenoids have disparate variety of uncommon structures although steroids have a mutual tetra cyclic carbon structure.

Alkaloids

A wide variety of plant secondary metabolites (alkaloids) are heterocyclic nitrogen compounds. And primary metabolites are derived from some amino acids such as tyrosine and lysine. The biochemical pathway of alkaloids may be long and have complex chemically derived structures. Alkaloids known to have a pharmacological effect as well as in recreational drug process and also used in medicational purposes. Many of the alkaloids are harmful or toxic in nature to other organisms. To be a secondary metabolite, alkaloids are ought to play a defense mechanism in plant against pathogens. Because of alkaloids biological activity, around 10000 alkaloids have been utilized as stimulants and poisons in pharmaceutical industries.

Carotenoids and Flavonoids

Secondary metabolites have large variety of compounds that contains a phenol group (a hydroxyl group) that is chemically heterogeneous in nature in which many are soluble in organic solvents and some are water soluble carboxylic acids as well as some insoluble compounds are also present. The colored pigments of plants give properties that help for attraction to seed dispersers.

Carotenoids and flavonoids are two subtypes in secondary metabolites. Carotenoids are orange, pale yellow that gives a particular pigment in photosynthesis while flavonoids also indulge a large range of colored products. The most widespread group of pigmented flavonoids is the anthocyanin that is responsible for mostly purple and blue color developed in fruits and flowers. Another type of plant phenolic

compound with defensive mechanism is tannins. Tannins are normally known as toxins that can reduce the growth of many herbivores when added to their meal. Like cattle and deer characteristically avoid plants with high contents of tannins. And plant containing tannins also gives defense mechanism against micro-organisms.

Generation of secondary metabolites from plants

There are some methods of generation of secondary metabolites implies on extraction not specifically generation, from the plant tissue by various phytochemical processes. Recently in biotechnology science there is some technology like fermentation technology and plant tissue culture that is facilitated in vitro methods and generation of plant secondary metabolites. Entrapment or adsorption of cell that have optimum physico-chemical parameters and addition of suitable substrate for desired secondary metabolites productions.

For extraction and differentiation, plant cells and cultures can be entrenched under sterile conditions like explants. Cell-suspension, shoot, hairy root cultures are used to symphonize metabolite. The generation of secondary metabolites by hairy root culture on intact with Agro bacterium rhizogenes has received more attention. In terms of quantity and quality of metabolites through hairy root cultures is better than the synthesis by intact host plant root [10]. Moreover, for instant growth in plant tissue media related with plant hormones gives alternative benefit in biochemical studies. And genetic change in hairy root culture for plant secondary metabolites production.

Secondary metabolites	Biological activity	Reference
Pyrethrins	Insecticidal	Ramawat and Merillon [11]
Baccharine	Antineoplastic	
Quinine	Antimalarial	
Diosgunin	Ant fertility	
Morphine	Analgesic	
Jasmini	Sweetner	
Stevioside	Saffron	
Croun	Chili	
Caffeine	Antispasmodic	
Ajmalicive	Stimulant	
Papaverive	Hypertensive	
Codeine	Analgesic	

Biological enterprise of plant secondary metabolites in various plants:

Anti-microbial activity

Secondary metabolites produce by plants for protection against microbial and insect infection and some of these metabolites are maybe harmful to animals and some maybe not. Antibiotics act as chemotherapeutic agents in perspective to eradicate all the transmissible diseases in which some are resistant to multiple discovered effective drugs. Normally, through herbal remedies, many transmissible diseases are known to be cured. Antimicrobial enterprising of

various herbs in plant leaves, stem, and roots has been concerned.

Plants	Anti-microbial activity
Duranta erecta	The anti-microbial activity results showed that methanolic extract of the stem part has potency against <i>A. flavus</i> , <i>P. chrysogenum</i> , and <i>Rhizopus</i> spp. And root extract showed <i>P. chrysogenum</i> . [12]
Petrea volubilis	The anti-microbial activity enterprise among all the parts and mainly against fungus <i>P. funiculosum</i> and in leaf and root against bacteria <i>D. subtilis</i> and against <i>S. aureus</i> [13]
Trichosanthes cucumerina	The maximum activity shows in fruit part against <i>P. funiculosum</i> and <i>S. aureus</i> . And also shows moderate activity in leaf parts against bacteria like <i>P. aeruginosa</i> , <i>S. aureus</i> , and <i>E. coli</i> and <i>B. subtilis</i> [14].
Sida acuta Burm f	In this plant, anti-fungal activity was found in different plant parts against <i>Candida albicans</i> [15].
Gomphrena celosioides	It showed the presence of phytosterols and show the maximum activity against <i>E.coli</i> in stem part.[16]

Anti-diabetic activity

In terms of anti-diabetic enterprising activity, Diabetes mellitus is a metabolic disorder in which increased the blood sugar level with lack of insulin secretion. In India, diabetes is most common disease. Type-1 and Type-2 are two different types of diabetes (insulin-dependent and insulin-independent). Hindrance of starch digestion by enzyme inhibition like alpha-amylase that leads to reduction in starch hydrolysis to maltose and low post-prandial hyper-glycemia.

Plants	Anti-diabetic activity
Aloe vera L	Flavonoids and alkaloids both were found with alpha-amylase inhibitory activity in different extracts of leaves of Aloe vera L.[17]
Azadirachta indica A Juss	In terms of flavonoids and alkaloids, alpha-amylase inhibitory enterprising showed equally and outcome revealed that is higher anti-diabetic ratio is present in flavonoids while lesser anti-diabetic activity present in alkaloids [18].
Mangifera indica L	Stem bark of <i>Mangifera indica</i> L showed 55.15 ± 0.14% to 55.5 ± 0.14% in flavonoids and alkaloids tests. [19].
Andrographis paniculata Nees	Alpha-amylase inhibitory activity of <i>Andrographis paniculata</i> Nees were found to have goofy in whole plant of flavonoids. [20].
T. cucumerina	The fruit and leaf part of the plant are good source of flavonoids that is why alpha-

	amylase activity showing their anti-diabetic ratio. [14].
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Anti-oxidant activity

Free radicals are main causative agent for oxidative damage and all organisms are protected from free radical by anti-oxidant mechanisms and neutralize the free radicals. Free radicals may damage the cell structures and nucleic acids. There are some medicinal plants produced by natural antioxidants may stabilize the free radicals. Therefore, the medicinal plants have capabilities to remove the free radicals and interest has been shown of natural based anti-oxidants in natural based systems of scavenging free radicals and may give replacements for harmful synthetic anti-oxidants.

Plants	Anti-oxidant activity
Rumex vesicarius	<i>R. vesicarius</i> shows higher anti-oxidant activity by methanolic extraction. The leaf showed maximum anti-oxidant activity by DPPPH assay. And other methods like lipid peroxidation assay, FRAP assay showed higher anti-oxidant activity in all parts of plants.[21]
Petrea volubilis L	By lipid peroxidation assay, leaf of <i>P. volubilis</i> shows maximum anti-oxidant activity. And root also showed high anti-oxidant ratio.[13]
Duranta erecta	<i>Duranta erecta</i> shows the presence of 14 compounds that are mutual in all plant parts like Benzene 1,4- diol and some compounds are very similar to flavonoids were found 2H-1-Benzopytran-2-one. The root extract shows higher anti-oxidant activity than leaf and stem part in DPPH and peroxidation assays.[12]
Limonia acidissima	According to TLC, it shows the presence of Kaempferol, quercetin and Lutein compound. Leaf of <i>Limonia acidissima</i> shows highest anti-oxidant ratio as compared to other plant parts. Presence of flavonoids are already known in previous studies.[22]
Digera muricata	Stem part of <i>D. muricata</i> shows the maximize value or highest anti-oxidant activity by DPPH assay with value of 89.01 ± 1.23% [23].

Conclusion

This review clarifies the importance of plant secondary metabolites and their biological activities like anti-oxidant, anti-microbial and anti-diabetic activities from different types of plant sources. Secondary metabolites are one of the essential requirements in case of growth and protection or defense mechanism. Many advantages of the plant secondary metabolites such as recovery of the outcome will be much easier and particularly in plant cultures.

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