Review Article *Chanda & Ramachandra, 10(1): Jan., 2019:6052-6058]*
CODEN (USA): IJPLCP ISSN: 0976-7126

INTERNATIONAL JOURNAL OF PHARMACY & LIFE SCIENCES
(Int. J. of Pharm. Life Sci.)

A review on some Therapeutic aspects of Phytochemicals present in Medicinal plants

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Abstract

Phytochemicals (from Greek phyto, meaning "plant") are chemical compound produced by plant have been used as traditional medicine. Medicinal plants have immense therapeutic properties due to presence of some biological active compound. Indian sub-continent has a long history of using plant as traditional medicine. It plays an significant role in preventing and treating of human diseases. It is evident from research that the plants have the potentiality of its medicinal value because it is a rich sources of phytochemical ingredients. This review provides a report on phytoconstituent of Indian medicinal plants and assessing their potentiality in protecting against different types of diseases.

Key-words: Medicinal Plants, Phytochemicals, Therapeutic aspects

Introduction

From ancient time, the belief has been that the plants contain some biologically active compounds with therapeutic properties useful for treatment of various ailments, including asthma, gastro-intestinal problems, skin disorders, respiratory and urinary complications, hepatic and cardiovascular disease etc. The medicinal value of these plants signifies a great potential for the discovery and development of new pharmaceuticals due to its chemical substances that produce a positive physiological action on the human body [1].Different parts of the plants, such as in the roots, stems, leaves, flowers, fruits or seeds are the deposited areas of phytochemical and are often seen as pigmented molecules in the outer layer of plant tissue [3]. Medicinally important plants having its pharmacological benefits due to accumulation of bioactive phytochemicals in the plant tissue considered as primary and secondary metabolites. Primary metabolites as organic compounds that comprises of glucose, starch, polysaccharide, protein, lipids and nucleic acid which are helpful for growth and development of the human body. Plants produce secondary metabolites which include alkaloids, flavonoids, saponins, terpenoids, steroids, glycosides, tannins, volatile oils etc [1,4].

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Secondary metabolites due to its therapeutic value which includes phytochemicals, a pharmacological active compounds plays an important role towards curing many diseases. Phytochemical includes (a) Alkaloids, having the characteristics of antispasmodic, antimalarial, analgesic, diuretic activities, (b)Terpenoids, having the properties of antiviral, anthelmintic, antibacterial, anticancer, antimalarial, anti-inflammatory ,(c) Glycosides are known for its antifungal and antibacterial properties,(d) Phenols and flavonoids are reported to have an antioxidant, anti-allergic, antibacterial properties etc. and (e)Saponins have the properties of anti-inflammatory, antiviral, plant defence activities[19,20].In India, a numerous studies have been conducted to validate the traditional use of medicinal plants by investigating the phytochemicals ingredients present. Based on the study from current works such as published literature, book etc effort has been made to maintain & manage the collected records and informations in consolidated form towards summarizing on the phytochemicals activity of the medicinal plants widely used in India.

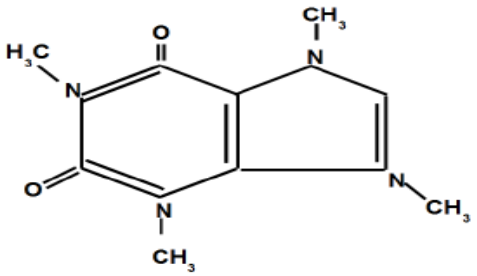
Phytochemical profile

Phytochemicals are secondary plant metabolites can be classified based on the chemical composition (containing nitrogen or not), chemical structure (for example, having rings, containing a sugar), the biosynthetic pathway (e.g., phenylpropanoid, which produces tannins) or their solubility in various solvents[17]. Investigative studies have demonstrated

that many of plants contain secondary metabolites can be divided into three chemically distinct namely alkaloids, terpenes and phenolics that could be potential sources for several effective drugs.

Alkaloid

Alkaloids are generally present in higher plants, particularly in dicots, whereas only a few have been noted in lower plants. The alkaloids can occur in the whole plant or in the specific plant organ. Alkaloids are derived from amino acid mostly contain one or more carbon rings which usually contain nitrogen. The type of Alkaloids and plant families depend upon the position of nitrogen atom in the carbon ring. Alkaloids play important roles in plants as it checks the feeding of herbivores, protects from pathogenic hit, and inhibitions of competitors [1]. Alkaloids have several pharmacological importance like antihypertensive (many indole alkaloids) and antiarrhythmic (quinidine, spareien) effects, antimalarial activity (quinine) and anticancer actions (dimeric indoles, vincristine, vinblastine). A few alkaloids contains caffeine, nicotine, and morphine etc possessing the stimulant property used as the analgesic and quinine as the anti-malarial drug [3].



Caffeine

Fig.1: Chemical Structure of Nitrogen atom in heterocyclic rings [4].

Phenol

Plant synthesizes another secondary product that contain a phenol group is basically a hydroxyl functional heterogeneous group present on an aromatic ring. The phenolic compounds are present in medicinal plants that are important secondary metabolites and show a wide range of pharmacological activities like anticancer, anti-inflammatory. The polyphenols consisted of nine compounds, namely gallic acid, quercitrin, quercetin, kaempferol-3-O-glucoside, 3-O-geraniin, 1-O-galloyl-4,6-trihydroxy-3,4,31-trimethoxydiphenoyl-β-D-glucose, 2,3-di-O-galloyl-β-D-glucose, and 1,2,3-tri-O-galloyl-β-D-glucose.[1].Phenol compounds include flavanoid and tannin, details of which are given below.

Flavonoids

Flavonoids, a group of plant secondary metabolites, where the molecular framework is catagorised by variable phenolic structures, and possess anticancer activity[1]. Flavonoids are diveded into two classes due to position of the benzenoid substituent such as flavone (2-position) and isoflavone (3- position). Flavanoids generally are produce naturally and linked with sugars in conjugated form falls under any one class, may be categorized as monoglycosidic, diglycosidic, etc. The glycosidic linkage is normally located at position 3 or 7 and the carbohydrate unit can be L-rhamnose, Dglucose, glucorhamnose, galactose or arabinose[3].Flavanoids be active ingredients of numerous herbal medicines[2].

Tannin

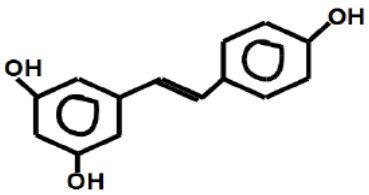
A common characteristics of phenolic compounds is the presence of at least one hydroxyl-substituted aromatic ring system.On the other hand when a compound contain 10 hydroxyl groups ,these compounds referred as Tannin. Hydrolysable is another important group of tannins represent Esters lies between gallic acid and sugars. Tannins posses antioxidants, with anti-inflammatory, antidiarrhoeal, cytotoxic, antiparasitic, antibacterial, antifungal and antiviral activities[2]. Tannins are a heterogeneous group of high molecular weight polyphenolic compounds with the capacity to form reversible and irreversible complexes with proteins(mainly), polysaccharides (cellulose, hemicellulose, pectin, etc.), alkaloids, nucleic acids and minerals, etc. Based of their structural characteristics it is therefore possible to divide the tannins into four major groups: Gallotannins, ellagitannins, complex tannins, and condensed tannins[3].

(1) Gallotannins are all those tannins in which galloyl units or their *meta*-depsidic derivatives are bound to diverse polyol-, catechin-, or triterpenoid units[3]. These gallotannins are widely distributed in plants, often in bark, leaves and fruits[2].

(2) Ellagitannins are those tannins in which atleast two galloyl units are C–C coupled to each other, and do not contain a glycosidically linked catechin unit.

(3)Complex tannins are tannins in which a catechin unit is bound glycosidically to a gallotannin or an ellagitannin unit.

(4) Condensed tannins are all oligomeric and polymeric proanthocyanidins formed by linkage of *C*-4 of one catechin with *C*-8 or *C*-6 of the next monomeric catechin.



Resveratrol

Fig. 2: Chemical Structure of Aromatic aliphatic ring containing phenols [4].

Terpenes

Terpenes are the largest class of secondary metabolites having hydrocarbons and the combination of several five-carbon isoprene units, resulting from hydrocarbons[17]. Terpenes interact with biomembranes and membrane proteins and most of the terpenoids are lipophilic. In general, terpenes show cytotoxic activities against a wide range of organisms, ranging from bacteria and fungi to insects and vertebrates have been widely used in herbal medicine against infections[2]. The word Terpens and terpenoids are increasingly used interchangeable and their main differences between them is that Terpens are hydrocarbons where is Terpenoids have been denatured by oxidation or chemically modified [23]. Terpenoids can be thought as modified terpenes in which methyl groups have been moved or removed, or oxygen atoms added[17]. The followings are the classification of Terpenoid according to the number of isoprene unit [3].

(a) Hemiterpenoids: Consist of a single isoprene unit. The only hemiterpene is the Isoprene itself, but oxygen-containing derivatives of isoprene such as isovaleric acid and prenol is classify as hemiterpenoids.

(b) Monoterpenoids: Biochemical modifications of monoterpenes such as oxidation or rearrangement produce the related monoterpenoids. Monoterpenoids have two isoprene units. Monoterpenes may be of two types i.e linear (acyclic) or contain rings e.g.Geranyl pyrophosphate, Eucalyptol, Limonene,Citral, Camphor and Pinene.

(c) Sesquiterpenes: Sesquiterpenes have *three isoprene* units e.g. Artemisinin, Bisabolol and Fernesol, oil of flowers, or as cyclic compounds, such as Eudesmol, found in Eucalyptus oil.

(d) Diterpenes: It composed for four isoprene units. They derive from geranylgeranyl pyrophosphate. There are some examples of diterpenes such as cembrene, kahweol, taxadiene and cafestol. Retinol, retinal, and phytol are the biologically important compounds while using diterpenes as the base.

e) Triterpenes: It consists of *six* isoprene units e.g. Lanosterol and squalene found in wheat germ, and olives.steroidal glycosides, the cucurbitacins (occurring in members of the Cucurbitaceae and a few other families) express substantial cytotoxic activities; they inhibit tumor growth *in vitro* and *in vivo*.

Saponin

Saponins are a group of secondary metabolites found widely distributed in the families of monocots, and are less frequent in dicots (Araliaceae, Fabaceae, Plantaginaceae, Scrophulariaceae, Solanaceae). Triterpene saponins are abundant in several dicot families, such as Ammaranthaceae (formerly Chenopodiaceae), Caryophyllaceae, Phytolaccaceae, Poaceae, Primulaceae, Ranunculaceae, and Sapotaceae. They are absent in gymnosperms Saponin act upon wounding-induced decompartmentation ,as it stored as bidesmosidic (containing two sugar chains one attached to the C-3 and one at C-22compounds) in the vacuole, which are cleaved to the active monodesmosidic (C-3 position) compounds by a β-glucosidase or an esterase.Saponin are chemically classified as a glycosylated steroids,triterpenoids, and steroid alkaloids.An agylone is the compound remaining after the glycosyl group on a glycoside is replaced by hydrogen atom.Steroid aglycones have two derivatives known as spirostan and furostan. Another important feature of sapogenin (aglycone) is the linkage with the carbohydrate part that consists of one or more sugar moieties containing glucose, galactose, xylose, arabinose, rhamnose, or glucuronic acid glycosidically[3].

Glycoside

Glycoside is a class of natural products composed of two molecules consists of (1) sugar which is primarily D-glucose, sometimes it can be L-rhamnose and L-fructose and (2) aglycone composed of flavonoid or a terpene. Aglycone is a part of cardiac glycosides which is highly toxic and found in number of plants. Aglycone of cardiac glycosides which can be categorized in two chemical groups cardenolide and bufadienolide.[18]. Cardenolide plays a important role in cardiac activity. The most important phenomenon of transport activities of cells and neuronal signalling depends on the Na+-, K+-ATPase, building up Na+ and K+ gradients which is inhibited by cardiac glycosides causes death through cardiac and respiratory arrest[2].

Essential oil

Essential oil are hydrophobic liquids that can be extracted from many plants.It is also known as

volatile oils,ethereal oils. Essential oil associated with the plant material from which the oil is extracted, is a complex mixture of volatile plant constituents characterized by low molecular weight components,such as terpenes, terpenoids, and other aromatic and aliphatic chemical compounds[1].

Table 1-A: Phytochemical activities of Medicinal Plant on some Diseases

Diseases	Plant species	Family	Plant Parts	Secondary Metabolites	Phytochemicals	Ref
Skin disease	*Azadirachta indica*	Meliaceae	Fruit & stem bark	Terpenes* (Sterol)	β –sitosterol°,nimbin	5,6
	Abroma angusta	Malvaceae	Root	Terpenes* (Sterol)	β-sitosterol° and stigmasterol	7
				Alkaloid	Betaine,friedelin	
	Acalypha indica	Euphorbiaceae	Leaves	Alkaloid	Acalyphine	6
				Terpenes* (Sterol)	Sitosterol °	
Diarrhoea	*Argyreria nervosa*	Convovulaceae	Leaves & fruit	Terpenes* (Sterol)	β-sitosterol °,epifriedinol	8
	Barleria prionitis	Acanthaceae	Leaves	Terpenes* (Sterol)	β-sitosterol °	9
	Centella asiatica	Apiaceae	Leaves	Terpenes*	β-sitosterol °	6
Urinary Trouble	*Leonotis nepetifolia*	Lamiaceae	Root	Terpenes* (Sterol)	β-sitosterol	10
	Costus speciosus	Zingiberaceae	Rhizome	Saponin	Diosgenin,trigogenin	5
				Terpenes* (Sterol)	β-sitosterol °	
	Cyperus rotundus	Cyperaceae	Tuber	Terpenes* (Sterol)	β –Sitosterol °,oleanolic acid and others.	6
Gastrointestinal trouble	*Cocos nucifera*	Arecaceae	Fruit	Glycosides	cucurbitacin β glycoside	6
	Aconitum deinorrhizum	Ranunculaceae	Tuber & root	Glycosides	3-O-β-D-glucopyranoside	11
	Alstonia scholaris	Apocynaceae	Leaves	Glycosides	isoflavone apioglucosides, formononetin 7-0-Beta-D-apiofuranosyl(1-6)- Beta-D-glucopyranoside	12
	Tinospora cordifolia	Menispermaceae	Leaves, Root, Stem	Alkaloid	Berberne,timberine and palmatine.	5
Kidney problem	*Gloriosa superba*	Colchicaceae	Leaves	Terpene*	terpenoids	13
	Ampelocissus latifolia	Vitaceae	Leaves	Terpene*	Diterpenes	14
	Vitex negundo	Lamiaceae	Fruit	Terpene*	Diterpene 6β, 7β-diacetoxy-13-hydroxy-labda-8, 14-diene	15

Jaundice	*Phyllanthus emblica*	Phyllanthaceae	Fruit	Alkaloid	4-methoxy-securinine(phylanthine)4-methoxy-norsecurinine	5
	Achyranthes aspera	Amaranthaceae	Leaves	Alkaloid	Achyranthine and betaine	6
				Saponin	Saonin A and B	
	Berberis aristata	Berberidaceae	Root and stem bark	Alkaloids	Berberine,berine,taxilamine, jatrorrhizine and others berbamine	6
Nervous disorder	*Ficus benghalensis*	Moraceae	Leaves	Flavainoids	Quercitin,3-galactoside and rutin	5,7
	Syzygium cumini	Myrtaceae	Fruit pulp	Flavainoids	Quercetin	6
	Tectona grandis	Lamiaceae	Leaves	Flavanoids	Rutin and quercitin	24

Table 1-B: Phytochemical activities of Medicinal Plant on some Diseases

Diseases	Plant species	Family	Plant Parts	Secondary Metabolites	Phytochemistry	Ref.
Fever	*Aegal marmelos*	Rutaceae	Leaves	Phenol	Anthraquinones-7,8-Dimethoxy-1-hydroxy-2-methyl anthraquinone	5,6
			Root	Glycoside	lyonoresinol,(-)-4-epilyoniresinol,(+)-lyonoresinol	
	Aloe vera	Asphodelaceae	Leaves	Phenol	anthraquinones	5.7
				Glycoside	isobarbaloin(C-glucoiside)	
	Bauhinia racemosa	Fabaceae	Leaves	Phenol	hydroquinone, catechol and 4-nitrophenol	5,16
				Glycoside	3-glucoside	
Diabetes	*Andrographis paniculata*	Acanthaceae	Root	Flavanoids	Apigenin-7-4'-di-O-methylether ,5-hydroxy-7,8-,2',3'-tetramethoxy flavone	5,6
	Bacopa monnieri	Plantaginaceae	Aerial parts	Flavanoids	Glucuronyl-7-apigenin and glucuronyl-7-luteolin	6
	Tamarindus indica	Fabaceae	Leaves	Flavanoids	Apigenin,vitexin,isovitexin,orientin	6
Ear problem	*Ocimum sanctum*	Fabaceae	Leaves	Triterpenoid	Ursolic acid, campesterol, chlolesterol &stigmasterol	6,7
	Ficus religiosa	Moraceae	Bark and leaves	Triterpenes phytosterols	β -sitosterol °and its glucoside,stigmasterol and lupen-3-one, α-amyrin, β-amyrin and lupeol	5,6,7
	Euphorbia tirucalli	Euphorbiaceae	Latex & Root	Triterpenes and phytosterols	-β-Amyrin,24-methylenecycloartenol,and β-sitosterol °	6

*Dominant secondary metabolite °Dominant phytochemical

Discussion

In this review the present information shows that the phytochemicals responsible for curing a particular disease may be available in diverse medicinal plants which belong from different plant families. Investigation being carried out through the literature survey and we categorized the most 10 common prevalent diseases like skin diseases, jaundice, ,diarrhoea, kidney problem, urinary trouble, diabetes , gastro-intestine, fever, nervous disorder ,ear problem and taken each three plant for same ailment belongs to different families. Table-1A and 1B depicted the phytochemical characteristics of different medicinal plant and their secondary metabolites, chemical structure etc. The table also shows that different plant belongs to different families' cures same ailments. From the table, it's evident that terpenes are the most abundant phytochemicals among the plants which is mostly found in leaves .The occurrence of dominant secondary metabolites out of total secondary metabolites is terpene(38%), followed by flavonoids (16%), alkaloids (16%), glycosides (16%) and rest 14%. Secondary metabolite are interconnected among the different plants species of different plant families that cures same ailments as for example from table shows diseases like skin disease, diarrhoea, urinary trouble and kidney problem terpenes are found in all three species followed by glycoside in fever and flavanoids in diabetes.It also reveals that at least two secondary metabolite are common as alkaloids in skin disease . As discussed earlier triterpenes are modified version of terpenes. Triterpenes is found in three plant species which cures ear problem.The table gives a preliminary idea that secondary metabolite are mostly present in leaves and also shows the some alternative plant species for a particular ailments.

Conclusion

The review reveals secondary metabolites (terpenes, alkaloids, flavanoids,phenols etc) which shows a wide range of pharmacological activities like antihypertensive effects, antimalarial activity, anticancer actions, antioxidants, anti-inflammatory, antidiarrhoeal, cytotoxic, antiparasitic, antibacterial, antifungal and antiviral activities.The study will help the researcher for identification of individual gene families for making secondary metabolites from different plants and makes it possible to conduct comparative genomic analysis. This review indicates the significance for the research in developing the plant gene target methods which will help for the extensive growth and development of medicinal plant. However, with the help of new methodology and analytical techniques many more of these phytochemicals can be identified and the development of more isolation can be done. Secondary metabolite plays an important role of many bioactivities. Based on many published paper, indigenous medicinal plants of India would emerge to be a hopeful source of novel drugs can be used as potentially of new pharmaceuticals. There is a urgent need for advance research and further investigations of endemic plants and their constituents are required to entirely know the molecular mechanisms of their action *in vitro* and *in vivo* with the aids to guarantee the plant extracts are safe for human can be use in market as proof based medicines.

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How to cite this article
Chanda S. and Ramachandra T.V. (2019). A review on some Therapeutic aspects of Phytochemicals present in Medicinal plants, *Int. J. Pharm. Life Sci.*, 10(1):6052-6058.
Source of Support: Nil; Conflict of Interest: None declared

Received: 18.12.18; Revised: 27.12.18; Accepted: 28.01.19