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HERBAL SCIENCE: EXPLORING THE PHYTOCHEMISTRY AND PHARMACOGNOSY OF MEDICINAL PLANTS

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ABSTRACT

India has a diverse cultural heritage due to its biodiversity. Currently, the Indian primary health care system depends upon both organised systems such as *Ayurveda*, *Siddha*, and *Unani*, as well as an unorganised traditional system of medicine like folk medicine. One of the renowned ancient medical systems is *Ayurveda*, where many medicinal plants are used therapeutically. Many studies have been carried out globally to verify the efficacy of numerous medicinal plants, due to which various plant-based medicines are formulated. The crude drugs that are procured from natural sources are considered to be the branch of Pharmacognosy. Pharmacognosy mainly deals with identifying natural drugs obtained from various plants, microbes, and animals, leading to a new approach towards drug delivery. Various important drugs originate from plants like atropine, morphine, colchicine, ricin, cannabidiol, THC, etc. Plants produce secondary metabolites, such as toxins, alkaloids, and biopolymers. On the other hand, Phytochemistry studies phytochemicals,chemicals derived from plants. Medicinal plants are a rich source of phytochemicals and natural compounds such as alkaloids, terpenes, glycosylated, phenolic compounds, flavonoids, etc. They are also an effective source of folk and modern medicine widely used to treat various ailments. The ancient wisdom in this traditional system of medicine (TSMs) is still not exhaustively explored. Plants seem to be valuable for minimising side effects and having a positive impact on human health. Through this article, we can explore new

avenues for discovering more efficient drugs with the help of medicinal plants, pharmacognosy, phytochemistry and their dependency on each other.

Keywords: *Ayurveda*, Medicinal plants, Phytochemistry, Pharmacognosy.

INTRODUCTION

Humans have always used plants as medicine to treat various health-threatening diseases and explore novel drug possibilities. Natural health products produced by medicinal plants are in demand worldwide. It has been found that almost 80% of the populations in developing countries rely on traditional medicine consisting of various medicinal plants.[1] The World Health Organization (WHO) states that around 90% of people in developing countries depend upon the traditional system of medicine for primary healthcare, with the usage of modern drugs in several areas. [2] Pharmacognosy embraces the use of traditional medicine. Most third-world countries rely on herbal medicines for their abundance and beneficial therapeutic properties. Consequently, pharmacognosy always subsists in pharmaceutical sciences and plays a censorial role in drug discovery.

India is renowned for practising classical, traditional systems of medicine such as *Ayurveda*, *Unani*, *Siddha*, *Sowa-Rigpa*, and *Yoga*. These antiquated medication and treatment methods have been illustrated in the *Vedas* and other ancient scriptures. *Among these systems, Ayurveda* is considered to have originated between 5000 and 2500 BC in India. [3].Medicinal and aromatic plants remain beneficial as food, medicine, and healing sources as they have been widely explored and are known for reducing various risk diseases. They are particularly valuable in treating and preventing diseases such as cancer, infectious diseases, and AIDS/HIV. The National Cancer Institute (NCI) is actively exploring plants for possible new treatments for these ailments.[4] In *Ayurveda*, drug treatments are personalized according to Dosha's constitution, illness, and environmental factors like *Desha*, *Kala*, *Ritu*, etc. For instance, an herb like *Piper longum* is a specific plant known for its various karma *Vrishya*, *Rasayana*, *Jeevaniya*, and *Balya* properties. *Ayurveda* encourages health through *Dinacharya(*daily), *Ratricharya*(nightly), and *Ritucharya*(seasonal) routines, a balanced approach to *Aahara*, *Nidra*, and *Brahmacharya* to live a holistic way of life.[5]

To understand the use of herbal medicines for pharmaceutical and therapeutic purposes, it is essential to recognise the role of phytochemistry and pharmacognosy in *Ayurveda* for the fulfilment of the aim of *Ayurveda*, i.e., to cure various diseases as well as to maintain the health of a healthy person. [6]

PRODUCTION

Plants activate their defence mechanisms instantly when they are attacked, including the rapid biosynthesis of phytochemicals, reducing plant nutrients such as nitrogen(N), phosphorus(P), potassium(K), and amino acids. [7]**.** The wide range of chemical compounds found in various plants are classified based on their role in plant metabolism and medicinal significance, known as constituents.

These constituents can be grouped into two primary categories:

(a) Active Constituents and

(b) Inert Constituents.

Active Constituents: The Active constituents are the chemical entities solely responsible for pharmacological, microbial, or therapeutic activities. Most drugs' constituents, such as alkaloids, glycosides, steroids, and terpenoids, are the primary constituents of this particular category.

Inert Constituents The Inert constituents are present in various plants but do not possess any particular therapeutic properties, so they are useful as adjuncts in drug formulation.[8]

IMPORTANCE OF MEDICINAL PLANTS

Aromatic plants are categorised into four groups:

1. Raw materials: These are largely used for essential oil extraction in the making of perfumes, foods, pharmaceuticals, and liquor industries.
2. Spices: Non-leafy parts used for flavouring.
3. Herbs: Leafy or soft flower parts used for flavouring.
4. Miscellaneous: The plant parts are also used for medicines, cosmetics, dyes, air fresheners, disinfectants, botanical pesticides, herbal teas, and insect repellents. [9]

PHYTOCHEMICALS

Phytochemistry studies the isolation, analysis, purification and characterisation of phytochemicals chemical structure and biological activity. The techniques most commonly used in phytochemistry are the extraction, isolation and structural characterisation by Mass Spectrometry(MS) and Nuclear Magnetic Resonance (NMR) of plant products, as well as various chromatographic techniques, such as High-Performance Liquid Chromatography(HPLC), Gas Chromatography(GC), Liquid Chromatography(LC).[10]

CLASSIFICATION OF PHYTOCHEMICALS

There are tens of thousands of phytochemicals. It is difficult to arrange these phytochemicals in a particular manner due to the large number of phytochemicals and rapid discoveries of new compounds. A basic classification divides phytochemicals into three chemically distinct groups: phenolics, terpenes, and nitrogen- and sulphur-containing compounds.

CLASSIFICATION OF COMMON PHYTOCHEMICALS [11]

MAJOR CLASS	SUB-CLASSES	REPRESENTATIVES
Phenolics	Polyphenols	Iso flavonoids, chalconoids, lignans, stilbenoids (e.g., resveratrol), curcuminoids, tannins (e.g., protocatechuic and chlorogenic acid.
	Aromatic acid	Phenolic acids (e.g., gallic acid, tannic acid, vanillin, ellagic acid), hydroxycinnamic acid.
Terpenes	Monoterpenes ($C_{10}H_{16}$)	Geraniol, limonene, pyrethroids, myrcene
	Sesquiterpenes ($C_{15}H_{24}$)	Costunolide
	Diterpenes ($C_{20}H_{32}$)	Abietic acid, cafestol, gibberellins
	Triterpenes ($C_{30}H_{48}$)	Azadirachtin, phytoecdysones
	Polyterpenes (C_5H_8)	Tetraterpene, for example, carotenoids, rubber
Terpenoids	Carotenoids (tetraterpenoids)	β-carotene, lycopene, phytoene
	Xanthophylls	Lutein, zeaxanthin
	Triterpenoid	Saponins, ursolic acid
	Nonprotein amino acids	Canavanine, azetidine-2,carboxylic acid
N (Organonitrides)	Alkaloids	Nicotine, morphine, caffeine, theobromine, theophylline
S (Organosulfides)	Allicin, alliin, piperine Glutathione, phytoalexins	

Organic chemicals, such as alkaloids, terpenes, flavonoids, lignans, plant steroids, curcumins, saponins, phenolics, flavonoids, and glycosides, are considered secondary components.[12]. Various bioactive phytochemical constituents in different parts of plants are useful for their medicinal properties.[13]

FLAVONOIDS

Flavonoids have been used in natural dyes [14,15], in cosmetics and skin care products [16,17], and anti-wrinkle skin agents [18]. Flavonoids have been used widely for anticancer activity, [19] antimicrobial effects, antiviral activity, antiangiogenic activity [20,21],

antimalarial activity, antioxidant activity, neuroprotective activity, antitumor effects, and antiproliferative agents [22].

ALKALOIDS

Alkaloids play an essential role in human medicines and the natural defence system. Alkaloids comprise approximately 20% of the known secondary metabolites found in plants [23]. Alkaloids protect plants from predators and regulate their growth [24]. Well-known alkaloids used in clinical settings include morphine, strychnine, quinine, ephedrine, and nicotine [25].

SAPONINS

The saponins are the largest class of natural glycoside of various plant natural products. They are generally considered necessary to defend plants against pathogens, pests and herbivores due to their antimicrobial, antifungal, antiparasitic, insecticidal and feeding deterrent properties.[24]

TERPENOIDS

Terpenoids are another type of terpene containing oxygen molecules constructed via biochemical modifications (removing or adding methyl groups) [25]. Terpenoids are alcohols, aldehydes, esters, ether, epoxides, ketones, and phenols. Examples of terpenoids are carvacrol, citronellal, geraniol, linalool, linalyl acetate, piperidone, menthol, and thymol.[26]. These bioactive compounds confer several biological activities, such as anticancer [28], anti-allergic [29], antibacterial [30], and antioxidant [31].

GLYCOSIDES

Several glycosides have therapeutic uses, with others known to possess pharmacological activities with remarkable therapeutic potential. The pharmacological activities include analgesic, anti-inflammatory, cardiotonic, antibacterial, antifungal, antiviral, and anticancer effects.[32].

PHENOLIC

Phenolic acids are found in various plant-based foods, such as seeds, fruit peels, and vegetable leaves. They are typically present in bound form, such as amides, esters, or glycosides, and rarely in free form [33].

PHARMACOGNOSY

Pharmacognosy evolved from the Greek words “Pharmakon”, i.e. (drug), and “gnosis”, i.e. (knowledge). Pharmacognosy is the knowledge about natural products' physical, chemical, biochemical, and biological consequences for both medicinal and health benefit purposes. As a result of sustained interest in medicinal plants, it has contributed to the development of many associated fields of study, such as organic products, pharmacology, pharmaceuticals, biomedicine, spectrometry, and biotechnology.[34]

In short, three primary basic disciplines emerged as being largely prevalent in the development of drugs:

- **Pharmacognosy:** includes significant information regarding medicines derived from natural sources such as plants, animals and microorganisms,
- **Medicinal Chemistry:** covering entirely the specific knowledge not only confined to the science of "synthetic drugs" but also the fundamentals of drug design.
- **Pharmacology:** dealing mainly with the actions of ‘drug’ and their respective effects on the different body Systems.[35]

Pharmacognosy include:

- Identification of natural drug sources
- Determination of morphological characters
- Planning for the cultivation of medicinal plants.

Crude drugs are complex mixtures of natural products, extracts, and exudates that are not pure compounds. They can be dried plants, animal material, or minerals. [36].

Crude drugs can be classified into two groups: organised and unorganised.

Organised

- Entire plants: Mentha spp., Lobelia spp.
- Entire parts of plants: Tulsi, Clove, Fennel, Cinchona, Liquorice, aloe vera etc.
- Minerals: Talc, Kaolin, Chalk.
- Marine sources: Sponges, Red algae, Agar.

Unorganised

- Mixed preparations derived from plants or animals, such as opium, aloes, tragacanth, balsams, resins, muskeg, and beeswax.[37]

Natural materials have played a vital role in treating and preventing diseases. Pharmacognosy, a key branch of pharmaceutical research, underpins drug discovery through molecular pharmacology and phytochemistry. It connects traditional herbal medicine with modern drug development, facilitating the identification of new chemical entities (NCEs) and exploring bioactive compounds from natural sources.[38]

DISCUSSION

Infectious diseases are one of the most susceptible problems of the world, due to which 57 million people die because of these infectious diseases every year. Over the past three decades, many new antibiotics have been produced by pharmacological industries to prevent these diseases. The different parts of the plant, such as root, leaves, bark, flower, seeds and fruits, containing different secondary metabolites in the form of phytochemicals that have many traditional values along with pharmacological properties, can be used to treat diseases like rheumatism, insanity, snakebite, chest pain, jaundice, malaria, headache, cough, cancer etc. The treasure of Indigenous knowledge transfer is decreasing from generation to generation due to oral transmission and the deprivation of documentation. Researchers worldwide have spent their lives for a long time discovering new drugs to diagnose, prevent and treat various life-threatening diseases. To protect human lives from these dangerous diseases, some new and powerful drugs must be found and developed from the different parts of the plant. To promote the development of new drug synthesis and extraction of bioactive components, proper knowledge of pharmacognosy and phytochemistry is essential.

REFERENCES

1. Mahady GB. Global harmonisation of herbal health claims. *J Nutr.* 2001; 131:1120S– 1123S. [PubMed] [Google Scholar]
2. WHO global report on traditional and complementary medicine [Internet]. 2019. Available from: https://www.who.int/traditional-Complementary integrative medicine/Who Global Report on Traditional and Complementary Medicine2019.pdf [Accessed 2020-01-1] S
3. Farnsworth NR, Blowster RN, Darmratoski D, Meer WA, Cammarato LV. Studies on Catharanthus alkaloids IV evaluation using TLC and ceric ammonium sulphate spray reagent. Lloydia. 1967; 27:302-314
4. Taylor L. Plant Based Drugs and Medicines [Internet]. 2000. Available from: http://www.rain-tree.com/plantdrugs.htm#.W6T0x2hKjIU [Accessed: September 21, 2018*]* .
5. Pharmacognosy Fundamentals, Applications and Strategy Edited by Simone Badal University of the West Indies, Kingston, Jamaica Rupika Delgoda University of the West Indies, Kingston, Jamaica ISBN: 978-0-12-802104-0
6. Phytochemistry of pharmacologically important medicinal plants – A Review Int. J. Curr. Res. Chem. Pharm. Sci. (2016). 3(11): 56-66 © 2016, IJCRCPS. (p-ISSN: 2348-5213: e-ISSN: 2348-5221) Volume 3, Issue 11 - 2016.1 P. Saranraj * S. Sivasakthi and M. S. Deepa 2
7. Bassard JE, Halkier BA. How do we prove the existence of metabolons? Phytochemistry Reviews. 2018 Apr;17(2):211-227.
8. PHARMACOGNOSY AND PHARMACOBIOTECHNOLOGY(Revised-Expanded Second Edition) Ashutosh Kar: NEW AGE INTERNATIONAL (P) LIMITED, PUBLISHERS ISBN (13): 978-81-224-2915-2
9. Textbook of Pharmacognosy and Phytochemistry Shah and Seth © 2010 Elsevier First Edition 2010 ISBN: 978-81-312-2298-0
10. Herbal medicine: Old practice and modern perspectives Sami Ullah Qadir, Vaseem Raja, in Phytomedicine, 2021.
11. PHYTOCHEMISTRY Fundamental Modern techniques and applications Editors Chukwuebuka Egbuna Jonathan Chinenye Ifemeje Stanley Chidi Udedi Shashank Kumar.
12. PHYTOCHEMISTRY AND PHARMACOGNOSY Massuo J. Kato University of São Paulo, São Paulo, 5508-000, SP, Brazil John M. Pezzuto University of Hawaii at Hilo, College of Pharmacy, Hilo, Hawaii, USA 96720 .
13. Thilakarathna S., Rupasinghe H. Flavonoid Bioavailability and Attempts for Bioavailability Enhancement. *Nutrients.* 2013; 5:3367–3387. doi: 10.3390/nu5093367. [PMC free article] [PubMed] [Cross Ref] [Google Scholar]

14. Kumar N., Pruthi V. Potential applications of ferulic acid from natural sources. *Biotechnol. Rep.* 2014; 4:86–93. [PMC free article] [PubMed] [Google Scholar]
15. Villela A., van Vuuren M.S., Willemen H.M., Derksen G.C., van Beek T.A. Photostability of a flavonoid dye in the presence of aluminium ions. *Dyes Pigment.* 2019; 162:222–231. doi: 10.1016/j.dyepig.2018.10.021. [Cross Ref] [Google Scholar]
16. Paramita V., Kusumayanti H., Amalia R., Leviana W., Nisa Q.A. Application of Flavonoid and Anthocyanin Contents from Rambutan (Nephelium lappaceum) Peel as Natural Dyes on Cotton Fabric. *Adv. Sci. Lett.* 2018; 24:9853–9855. doi: 10.1166/asl.2018.13160. [Cross Ref] [Google Scholar]
17. Lanzendörfer G., Stäb F., Untiedt S. Cosmetic and Dermatological Preparations with Flavonoids. WO/1996/018379. 1996 Jun 20.
18. Danihelová M., Viskupičová J., Šturdík E. Lipophilization of flavonoids for their food, therapeutic and cosmetic applications. *Acta Chim. Slovaca.* 2012; 5:59–69. doi: 10.2478/v10188-012-0010-6. [Cross Ref] [Google Scholar]
19. Chuarienthong P., Lourith N., Leelapornpisid P. Clinical efficacy comparison of anti-wrinkle cosmetics containing herbal flavonoids. *Int. J. Cosmet. Sci.* 2010; 32:99–106. doi: 10.1111/j.1468-2494.2010.00522.x. [PubMed] [Cross Ref] [Google Scholar]
20. Zhao L., Yuan X., Wang J., Feng Y., Ji F., Li Z., Bian J. A review on flavones targeting serine/threonine protein kinases for potential anticancer drugs. *Bioorganic Med. Chem.* 2019; 27:677–685 doi:10.1016/j.bmc.2019.01.027. [PubMed] [Cross Ref] [Google Scholar]
21. Zhao K., Yuan Y., Lin B., Miao Z., Li Z., Guo Q., Lu N. LW-215, a newly synthesised flavonoid, exhibits potent anti-angiogenic activity in vitro and in vivo. *Gene.* 2018; 642:533–541. doi: 10.1016/j.gene.2017.11.065. [PubMed] [Cross Ref] [Google Scholar]
22. Camero C.M., Germanò M.P., Rapisarda A., D'Angelo V., Amira S., Benchikh F., Braca A., De Leo M. Anti-angiogenic activity of iridoids from Galium tunetanum. *Rev. Bras. de Farmacogn.* 2018; 28:374–377. doi: 10.1016/j.bjp.2018.03.010. [Cross Ref] [Google Scholar]
23. Patel K., Kumar V., Rahman M., Verma A., Patel D.K. New insights into the medicinal importance, physiological functions and bioanalytical aspects of an important bioactive compound of foods 'Hyperin': Health benefits of the past, the present, the future. *Beni-Suef Univ. J. Basic Appl. Sci.* 2018; 7:31–42. doi: 10.1016/j.bjbas. 2017.05.009. [Cross Ref] [Google Scholar]
24. Kaur R., Arora S. Alkaloids—Important Therapeutic Secondary Metabolites of Plant Origin. *J. Crit. Rev.* 2015;2:1–8. [Google Scholar]
25. Chik S.C.C., Or T.C.T., Luo D., Yang C.L.H., Lau A.S.Y. Pharmacological Effects of Active Compounds on Neurodegenerative Disease with *Gastrodia* and *Uncaria* Decoction, a Commonly Used Post Stroke Decoction. *Sci. World J.* 2013; 2013:1–22. doi: 10.1155/2013/896873. [PMC free article] [PubMed] [Cross Ref] [Google Scholar]
26. Kurek J. *Alkaloids—Their Importance in Nature and Human Life.* IntechOpen; London, UK: 2019. Introductory Chapter: Alkaloids—Their Importance in Nature and for Human Life. [Google Scholar]
27. Augustin JM, Kuzina V, Andersen SB, Bak S. Molecular activities, biosynthesis and evolution of triterpenoid saponins. *Phytochemistry*. 2011; 72:435–57. [PubMed] [Google Scholar]
28. Pandey A.K., Kumar P., Singh P., Tripathi N.N., Bajpai V.K. Essential oils: Sources of antimicrobials and food preservatives. *Frontiers in Microbiology.* 2017;7 [PMC free article] [PubMed] [Google Scholar]
29. Hyldgaard M., Mygind T., Meyer R.L. Essential oils in food preservation: Mode of action, synergies, and interactions with food matrix components. *Frontiers in Microbiology*. 2012;3:12. [PMC free article] [PubMed] [Google Scholar]
30. Potočnjak I., Gobin I., Domitrović R. Carvacrol induces cytotoxicity in human cervical cancer cells but causes cisplatin resistance: Involvement of MEK-ERK activation. *Phytotherapy Research.* 2018; 32:1090–1097. [PubMed] [Google Scholar]
31. Kobayashi Y., Sato H., Yorita M., Nakayama H., Miyazato H., Sugimoto K., Jippo T. Inhibitory effects of geranium essential oil and its major component, citronellol, on degranulation and cytokine production by mast cells. *Bioscience, Biotechnology, and Biochemistry*. 2016; 80:1172–1178. [PubMed] [Google Scholar]

32. Guimarães A.C., Meireles L.M., Lemos M.F., Guimarães M.C.C., Endringer D.C., Fronza M., Scherer R. Antibacterial activity of terpenes and terpenoids present in essential oils. *Molecules.* 2019; 24:2471. [PMC free article] [PubMed] [Google Scholar]
33. Wang C.-Y., Chen Y.-W., Hou C.-Y. Antioxidant and antibacterial activity of seven predominant terpenoids. *International Journal of Food Properties.* 2019; 22:230– 238. [Google Scholar]
34. Benito Soto-Blanco, in Herbal Biomolecules in Healthcare Applications, 2022 Chapter 12 - Herbal glycosides in healthcare
35. Pereira D.M., Valentão P., Pereira J.A., Andrade P.B. Phenolics: from chemistry to biology. *Molecules.* 2009;14(6):2202–2211. [Google Scholar]
36. Sartor L. Pezzato E, Donà M, Dell'Aica 1, Calabrese F, Morini M, et al. Prostate carcinoma and green tea: (-) epigallocatechin-3-gallate inhibits inflammation triggered MMP-2 activation and invasion in murine TRAMP model. Inter J Cancer 2004;112(5):823-9
37. Pharmacognosy Fundamentals, Applications and Strategy Edited by Simone Badal University of the West Indies, Kingston, Jamaica Rupika Delgoda University of the West Indies, Kingston, Jamaica ISBN: 978-0-12-802104-0
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