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Review Article

Role of Primary and Secondary Metabolites in Medicinal Plants

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ABSTRACT

The function of primary and secondary metabolites in medicinal plants is examined in this review. Secondary metabolites are specialised compounds that are not necessary for plant survival but play crucial roles in plant defence, attraction, and interaction with the environment. Primary metabolites are essential for the basic functions of plants, such as photosynthesis, respiration, and growth. Secondary metabolites and other bioactive substances found in medicinal plants have been utilised for ages to treat a wide range of illnesses and problems. The review focuses on the main categories of secondary metabolites, including phenolics, terpenoids, and alkaloids, as well as their potential medical benefits. The paper also covers the difficulties in identifying and isolating bioactive chemicals from medicinal plants, such as chemical composition variability and the requirement for environmentally friendly production techniques. In conclusion, this review sheds light on the function of primary and secondary metabolites in medicinal plants and underlines their potential for medication development.

Keywords: *Primary Metabolites, Secondary Metabolites, Medicinal Plants.*

INTRODUCTION

Role of Primary and Secondary Metabolites in Medicinal Plants

The term metabolism refers to the totality of metabolic processes necessary for an organism's cells to remain alive. Energy is needed by all living things for several essential processes as well as the synthesis of new organic molecules (Ahmad et al., 2014b). Secondary metabolites provide a wide range of components that are not present in all species since they are predominantly generated under various stress circumstances. Carbohydrates, proteins, lipids, and nucleic acids are produced as primary substances as a result of primary metabolism (Cai et al., 2014). Secondary metabolites produced by medicinal plants are utilised by humans for a variety of health benefits. Due to their unique function in plant metabolism, secondary metabolites—as opposed to universally present chemicals—are frequently referred to as special principles. These compounds are not always present in plants since they are often produced under artificially altered natural settings by specific tissues and organs to serve a specific function (Kala et al., 2006).

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The basis for their use as herbal remedies, in which individuals adopt the same molecules that plants employ for themselves, is their ability to synthesise a variety of bioactive principles with therapeutic effects for humans. To defend against oxidative or free radical damage in humans, for instance, people can use antioxidants produced in plants that provide protection against similar attacks in them (Kunle et al., 2012).

1. Importance of chemical constituents in medicinal plants:

Due to their numerous pharmacological effects, including their anti-inflammatory, antibacterial, and antifungal capabilities, medicinal plants considerably influence human health. The relevance of medicinal plants stems from the existence of certain chemicals that result in a physiological response in the human body (Ahmad & Asma, 2022b). These phytochemicals are present in all plant species and have a wide range of physiological and ecological functions. These bioactive secondary metabolites in plants primarily serve as a means of chemical defence against pathogens, predators, illnesses, and allopathic agents, among other abiotic and biotic difficulties (Naikoo et al., 2019). The active substances in medicinal plants that have significant therapeutic value are known as secondary metabolites. (Details are given in Table – 01).

They are incredibly small chemical compounds that are widely distributed throughout the plant kingdom, but their function in plant life is typically unknown (Salmerón-Manzano et al., 2020). The main chemical reactions that produce these metabolites in medicinal plants include condensation, substitution, reduction, and oxidation. A vast variety of phytochemicals, such as phenolic compounds, flavonoids, alkaloids, tannins, and terpenes, are produced and accumulated by medicinal plants. These phytochemicals are subsequently employed therapeutically or as precursors in the creation of effective pharmaceuticals (Okwu & Omodamiro, 2005). Numerous chemical substances that are biologically active each have a unique physiological activity in the human body.

2. Economic value:

Since medicines are necessary for maintaining a healthy community, which stimulates and maintains the economy, the value of medicinal herbs to the economies of low-income countries is significant and crucial (Cakilcioglu et al., 2011). There must be a strategic change from present practices for such low-income countries to achieve any appreciable level of self-reliance in terms of the availability of safe and effective pharmaceuticals for the control of endemic illness conditions. The significance of self-sufficiency in the present and future economic and political affairs of industrialised countries in the field of medicine requires that this distinction be given priority (Salako et al., 2014).

To achieve these, emerging nations must first prioritise their objectives and comprehend the economic significance of the abundant medical plants found there. To produce and maintain funding for medicinal plant research, policymakers' assistance and encouragement should be a top priority (Teshika et al., 2018). While doing so would help these low-income nations' economies, it would also improve healthcare delivery by making affordable access to basic medications possible for the majority of the populace (Venugopala et al., 2013).

According to Ahmad et al. (2014), 2014c, ISM creates about 25,000 potent plant-based formulations that are popular among rural Indians and are in increasing demand from everyday people. Additionally, it was found that more than 2000 tonnes of raw medicinal plant material are needed annually. Additionally, there are over 1500 herbal products available as dietary supplements. AYUSH is a local business with a market value of about INR 80–90 billion, whereas India exports medicinal herbs and related goods for about INR 10 billion. In 2012–2013, AYUSH exports were INR 24,741.2 crores; however, in the next fiscal year (2013–2014), they slightly decreased (Aniszewski, 2007).

AYUSH items made up 0.36 percent of all products sold in India in 2013-2014. The market for herbal remedies is predicted to reach USD 7 trillion by 2050 due to the fast-growing demand for them worldwide. There is great economic value in the work which has been done by Ahmad & Ghosh in the year 2022 on *Saraca asoca.* They have work certain bioactive metabolites like flavonoids, catechin, β-sitosterol, and lignin glycosides from *Saraca asoca* (Ashoka) to check their anti-cancer & antioxidant properties, the such result must be confirmed by another researcher and repetition work (Ahmad & Ghosh, 2022a).

3. Herbal drug delivery approaches:

A chemical molecule or, more frequently, a combination of chemical compounds derived from plants that act on the human body singly or in combination to fend off illness and maintain or restore health are known as herbal drugs or plant drugs (Sharma et al., 2017). In order to decrease drug degradation and loss, avoid negative side effects, improve drug bioavailability, and increase the portion of the medication stored in the necessary zone, several drug delivery and drug targeting systems are currently being developed. The relatively acidic pH of the stomach is likely to cause many components of herbal extracts to be degraded (Puneet et al., 2013). The liver may process additional substances before they are absorbed into the circulation.

According to Sharma et al. (2015), numerous studies are being carried out to develop new herbal drug delivery systems, including mouth-dissolving tablets, sustained and extended-release formulations, mucoadhesive systems, transdermal dosage forms, microparticles, microcapsules, nanoparticles, implants, and so on. Asoka Life Science Limited unveiled Res-Q, the first polyherbal mouth-dissolving tablet and speedy mouth-dissolving medication. It makes use of an original medication delivery system that boosts efficiency (Cheema & Singh, 2021; & Cho & Ko, 2005). A US patent covers the method of manufacturing a novel stable herbal medicinal formulation in the form of sustained-release micro granules comprising *Gingko biloba* extract (Sofowora et al., 2013). A patent describes the herbal-based oral composition for periodic retention within the buccal cavity of a human, comprising a mixture of herbs like *Reynoutria multiflora, Rhizoma drynariae, Rhizoma chuanxiong, Calculus bovis, Indigo naturalis, Ecliptae herba, Pericarpium trichosanthis, Sophora flavescens, Gleditsia sinensis, Angelica sinensis, Morus alba* (Rahman et al., 2021).

According to Salmerón-Manzano et al. (2020), TCH (traditional Chinese herbs) nanoparticles help to enhance absorption and dispersion in the body, hence enhancing efficacy. An innovative, chitosan-based sustained-release implant of herb extract has proven to be quite useful. In order to improve anastomosis and healing on muscles and tissues at the site of the organic incision in abdominal cavities, Danshen (Salvia miltiorrhiza) extract was coupled with CS-gelatin to construct an implant (Kunle et al., 2012). By incorporating Ayurvedic medicines into modern dosage forms, they can be administered more successfully. A methodical plan must be used to distribute the components of phytotherapeutics in order to maximise patient compliance and minimise recurrent administration. During Pandamic 2020 (Ahmad & Ghosh, 2020) worked on Benefits of dietary sesame seed and flaxseed to strengthen the immune system during COVID-19 pandemic and prevent Associated Comorbidities Related Health Risks (Ahmad, & Karmakar, 2023). Details of bioactive metabolites are given in Table – 01. Images of three important medicinal plants are illustrated in figure no. 01.

Bioinformatics and Medicinal Plants:

In order to meet the problems provided by climate change, agricultural advancement is being accelerated with the use of genomics and bioinformatics. Researchers can find genes that impart desirable features, like drought or heat tolerance, using genomic methods, and utilise this knowledge to create crops that can tolerate environmental challenges. Contrarily, a lot of genetic data is analysed and interpreted using bioinformatics, which helps researchers better comprehend the intricate relationships

between genes and the environment. Together, these technologies have the power to transform agriculture, enhancing crops' resistance to the effects of climate change and enabling them to satisfy the increasing food demands of a population that is expanding worldwide. The application of genetics and bioinformatics promises a promising road towards a more sustainable and secure food future, even though there are still obstacles to be solved, such as ensuring that farmers all over the world have access to these technologies (Ahmad, 2023a). Computational biology and its applications are required to keep track of so many bioactive metabolites and to continually find new secondary metabolites (Ahmad, 2023b).

Table 01: Details of Secondary Metabolites and their medicinal applications

Plant Name	Common Name	Family	Parts used	Chemical constituents	Secondary metabolites	Therapeutic use	References
Sesamum indicum	Sesame seed	Pedaliaceae	Leaf, stem, and seed	Unsaturated fatty acids, mainly linoleic acid, oleic acid, palmitic and stearic acid	Polyphenols, alkaloids, flavanoids, terpenoids, and glycosides	Antioxidant, antimicrobial, antiinflammatory, antidiabetic, anticancer, antihyperlipidemic, hepatoprotective, anthelmintic, antileishmanial, gastroprotective, larvicidal, and vasorelaxant activities	Ahmad and Ghosh, 2020
Saraca asoca	Ashoka	Fabaceae	Bark and leaves	Glycosides, Flavonoids, Tannins and Saponins	Saponins, flavonoids	Internal bleeding, anti-inflammatory treatment for arthritis, hemorrhoids, infertility, insomnia	Ahmad and Ghosh, 2022
Chlorophytum borivilianum	Safed musli	Liliaceae	Root	25 alkaloids, vitamins, proteins, carbohydrates, steroids, saponins, potassium, calcium, magnesium, phenol, resins, mucilage, and polysaccharides	Stigmasterol and hecogenin	Aphrodisiac agent and revitalizer, as general sex tonic remedy for diabetes, arthritis and increasing body immunity	Ahmad et al., 2014a
Piper nigrum	Black pepper or maricha	Piperaceae	Seeds and fruits	Piperine, piperidine, pyrrolidines, oleoresins, chavicine, amides, α- and β-pinene, limonene, myrcene, linalool	Piperine, myrcene, alpha-phellandrene, linalool	Indigestion, nausea, diarrhea, arthritis, asthma, bronchitis, colic pain, cough, cold, sex drive, menstrual pain, stuffy nose, sinus infection, dizziness	Ahmad and Asma, 2022
Chlorophytum borivilianum	Safed musli	Liliaceae	Root	25 alkaloids, vitamins, proteins, carbohydrates, steroids, saponins, potassium, calcium, magnesium, phenol, resins, mucilage, and polysaccharides	Stigmasterol and hecogenin	Aphrodisiac agent and revitalizer, as general sex tonic remedy for diabetes, arthritis and increasing body immunity	Ahmad et al., 2014a
Adhatoda vasica	Basak	Acanthaceae	Leaves, roots, flowers and stem bark	Vasicine, l-vasicinone, deoxyvasicine, maiontone, vasicinolone and vasicinol	Alkaloids, sterols, terpenes, flavonoids, saponins, anthraquinones, glycosides, tannins, resins, lactones, quinines	Bronchitis, tuberculosis and other lung, bronchiole disorders, asthma, dental ailments, diarrhoea and dysentery	Aniszewski, 2007
Andropgraphis paniculata	Kalmegh	Acanthaceae	Fresh and dried leaves	Diterpenoids, flavonoids, and polyphenols	Andrographidine A, 5-hydroxy-7,8,2',5'-tetramethoxy-flavone-5-O-beta-D-glucopyranoside	Common cold, diarrhoea, fever, jaundice, cancer, diabetes, high blood pressure, ulcer, leprosy, bronchitis	Cai et al., 2014
Tinospora cordifolia	Gulancha	Menispermaceae	Stem, root, bark, leaf	alkaloids, glycosides, steroids, phenolics, aliphatic compounds, polysaccharides alkaloids, glycosides, steroids, phenolics, aliphatic compounds, polysaccharides alkaloids, glycosides, steroids, phenolics, aliphatic compounds, polysaccharides Tinosporide, Palmatine, Berberine, Alkaloids, glycosides, steroids, phenolics, aliphatic compounds, polysaccharide, protein	Anthraquinones, terpenoids, and saponins	Fever, jaundice, chronic diarrhea, cancer, dysentery, bone fracture, pain, asthma, skin disease, poisonous insect, snake bite, eye disorders	Cheema and Singh, 2021
Cinchona officinalis	Cinchona	Rubiaceae	Bark	Quinine, Cinchotannic acid, Cinchonidine, quinidine, cinchonine	Quinine	Increasing appetite; promoting the release of digestive juices; and treating bloating, fullness, and other stomach problems	Kala et al., 2006
Marraya koenigii	Curry	Rutaceae	Leaf and stem	Mahanine, Mahanimbine, Isomahanine, koenimbine,	Alkaloids, terpenoids, flavonoids and phenolic	Piles, inflammation, itching, fresh cuts, dysentery, bruises, and edema	Naikoo et al. 2019

				Isolongifolene, Pyrayafoline D, Koenoline, 9-formyl-3-methyl carbazole			
Centella asiatica	Thankuni	Apiaceae	Whole plant	Sesquiterpenes, plant sterols, pentacyclic triterpenoids, saponins, asiatic acid, eugenol derivatives, caffeoylquinic acids, terminolic acid and flavonoids	Asiaticoside, madecassoside and sapogenins	Diarrhoea, fever, amenorrhea, mental clarity, wound healing, skin disease like leprosy, lupus, varicose ulcers, eczema,	Sharma et al., 2015
Allium cepa	Onion	Amaryllidaceae	Leaf, stem, bulb, root	Allicin, quercetin, fisetin, other sulphurous compounds: diallyl disulphide and diallyl trisulphide	S-trans-prop-1-enyl cysteine sulfoxide (PECSO), flavonols, anthocyanin, phytosterols and saponins	Antimicrobial, antioxidant, anti-inflammatory, antidiabetic, anti-hypertensive, bronchitis, asthma, inflammatory disorders, dysentery, ulcer wounds, scars, keloids, pain and swelling after bee or wasp stings	Teshika, et al., 2014

a. *Saraca asoca* b. *Cinchona officinalis* c. *Adhatoda vasica*

Figure 01: Important Medicinal Plants

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