
Herbs for Health

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By
Pouneh Pouramini and Goetz Hensel

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PREFACE

Nowadays, a general tendency of society to use medicinal herbs and herbal medicines can be observed. This tendency is due to the diversification of consumer culture and some known side effects of chemical drugs. Besides, there is growing confidence in the use of herbal medicines, as evidenced by the use of essential oils from medicinal plants in a wide range of food, pharmaceuticals, cosmetics, and hygiene products.

Most consumers who use herbal medicines for self-medication think that nature means health. Due to their limited knowledge about the side effects and how and when medicinal plants can have a beneficial health outcome, they often achieve a negative result.

Unintentional use of toxic medicinal plant species, mixing with other herbs, ignorance of contamination or toxicity, use of high doses of the herbs, inappropriate use of the herbs, and interaction with other herbs and their side effects all these are the result of insufficient knowledge about medicinal herbs and herbal medicines.

Just remember that of the over 620,000 plant species, more than 95% have not yet been studied as medicinal products. Each plant contains hundreds of ingredients with different effects. The combination of these ingredients in the correct dosage and application makes them a medicinal plant. Today, millions of people worldwide use many herbal remedies in herbal medicine, homoeopathy, mud therapy, and other complementary therapies.

This book intends to provide an overview of medicinal plants that a broad public can understand. It describes medicinal herbs from all over the world and their therapeutic effects. The known active ingredient (s) of each plant is (or are) described, including known side effects and their potential interactions with other herbs or medicines, as well as their preferred administration. However, always consult a doctor in the case of a severe illness.

Pouneh Pouramini and Goetz Hensel

CHAPTER ONE

Secondary Metabolites of Medicinal Plants



1.1. What are Secondary Metabolites?

In addition to their generic compounds, medicinal plants also have a secondary ingredient; these substances, which include thousands of compounds, are known as secondary metabolites. They are classified according to their characteristics (Pengelly 2004). Current estimates show that well over 300,000 secondary metabolites exist (Ramawat and Mérillon 2013). The active ingredients of medicinal plants include complex chemical compounds produced and stored in various plants' organs and are commonly used as pharmaceutical raw materials (Pengelly 2004).

In general, plant metabolites are divided into two categories:

1. **Primary metabolites:** “The primary metabolism of a plant produces primary metabolites such as lipids, fats, carbohydrates, and amino acids” (Velu, Palanichamy, and Rajan 2018; M. Thakur et al. 2019) for the biological function of plants. They are the same in every plant species and are produced in green plants by photosynthesis and carbon metabolism (Pengelly 2004).
2. **Secondary metabolites:** “The secondary metabolism in plants produces secondary metabolites which are generally crucial for the protective and self-defence functions in plant cells caused by an ecological imbalance or harmful infections” (Velu, Palanichamy, and Rajan 2018). “These compounds are generally in lower quantities than primary metabolites” (Mérillon and Ramawat 2020). These compounds are essential for humans. They are widely “used as pharmaceuticals, agrochemicals, colours, flavours, fragrances, biopesticides, and food additives” (M. Thakur et al. 2019).

1.2. Classification of Secondary Metabolites in Medicinal Plants

“The plant-derived secondary metabolites are further classified into different types of natural compounds based on their definite chemical

structure in nature” (Velu, Palanichamy, and Rajan 2018). The most important classifications of secondary metabolites include:

1. Phenols
2. Polyphenols like tannins, flavonoids, and anthocyanins
3. Glycosides
4. Terpenoids or terpenes like essential oils, resins, oleoresins, and bitter compounds
5. Alkaloids
6. Saponins

1.3. Phenols

“Phenolic compounds are the largest and most important plant secondary metabolite widely available in all kinds of fruits, vegetables, tea leaves, and other green plants” (Velu, Palanichamy, and Rajan 2018).

“Phenolic compounds have significant antioxidant, anticancer, antimicrobial, antiseptic, and anti-inflammatory pharmacological properties. Phenolic compounds are active against oxidative stress and in the management of other diseases” (Velu, Palanichamy, and Rajan 2018).

1.4. Polyphenols

Polyphenols are natural compounds occurring in plants. They are found to be recognized by their nutritional value, since they may help reduce the risk of chronic diseases and have a positive effect on health. This effect is due to their free radical scavenging capacity, which, among other biological effects, increases antioxidant activity and prevents cellular oxidation.

“More than 8,000 polyphenolic compounds from different plants have now been documented” (Velu, Palanichamy, and Rajan 2018).

1.4.1. Tannins

“Tannins are polyphenolic biomolecules with a high molecular weight. They distribute widely in many plant species. Tannins bind and precipitate proteins and various other organic compounds, including amino acids and alkaloids” (Laddha and Kulkarni 2019). “The biological role of many tannins is related to protecting against microbial infection, insect or animal activity” (Sieniawska and Baj 2017).

“Apricots, barley, basil, cloves, coffee, dry fruits, grapes, mint, oats, peaches, pine, pomegranates, rice, rosemary, rye, strawberries, tea, and wine are some important sources of tannins, and they can be from bark, fruits, gall, leaves, seeds, and roots. Various reports have shown that tannins possess skin anti-inflammatory, anti-bacterial, anti-viral, anti-microbial, anti-diabetic, anti-hypercholesterolemic, chronic disease, antioxidant, anti-diarrhoea, astringent and anti-carcinogenic activities” (Laddha and Kulkarni 2019).

1.4.2. Flavonoids

“The flavonoids constitute the largest group of polyphenols with low molecular weight and are considered responsible for the colour and taste of many fruits and vegetables” (Martín et al. 2017). “These compounds occur as yellow and white plant pigments (the Latin *flavus* means yellow). Rutin was discovered in rue (*Ruta graveolens*) in 1842 and it later became known as vitamin P (permeability factor). Flavonoids exist in free form and glycoside form. Their functions include protecting plant tissues from damaging UV radiation, acting as antioxidants, enzyme inhibitors, pigments, and light screens. The compounds are involved in photosensitization and energy transfer, the action of plant growth hormones and growth regulators, and the defence against infection” (Pengelly 2004). “Flavonoids play a significant role in plant pollination by producing a beautiful colour over the flowers' petals by filtering the ultraviolet rays that attract the insect for pollination” (Velu, Palanichamy, and Rajan 2018).

“More than 9,000 different flavonoids have been described, and around 5,000 of the flavonoids studied have antioxidant activities” (Martín et al. 2017). “The six major subclasses of flavonoids include the flavones (apigenin, luteolin), flavanols (quercetin, myricetin),

flavanones (naringenin, hesperidin), catechins or flavanols (epicatechin, gallic catechin), anthocyanidins (cyanidin, pelargonidin), and isoflavones (genistein, daidzein)” (Murti 2017). “The primary essential flavonoids include quercetin, quercitrin, and kaempferol, widely distributed to almost over 70% of the total plant species analysed” (Velu, Palanichamy, and Rajan 2018).

“Flavonoids have been used in folk medicine worldwide. The main benefits of flavonoids are their antioxidant, anti-cancer, anti-tumour, anti-inflammatory, anti-allergic, anti-ulcer, anti-hepatoprotective, anti-spasmodic, anti-viral, anti-fungal, and anti-bacterial activities” (Murti 2017).

1.4.3. Anthocyanins

“Anthocyanins are the largest group of phenolic pigments and the most crucial group of water-soluble pigments in plants, responsible for the red, purple, and blue colours found in many fruits, vegetables, cereal grains, and flowers. Anthocyanins are found in all plant tissues, including leaves, stems, roots, flowers and fruits. Please note that anthocyanins are readily distinguished from other flavonoids as they undergo rearrangements in response to pH” (Martín et al. 2017).

“Anthocyanins have antioxidant activities and prevent radical formation. They are linked to a decrease in several diseases, such as diabetes mellitus, cancer, and cardiovascular diseases” (Martín *et al.*, 2017).

1.5. Glycosides

“Glycosides are colourless alkaloid compounds with crystalline structures generally composed of carbon, hydrogen, oxygen, sulphur, and nitrogen. Most of the glycosides accumulated in the plants are inactive compounds” (Velu, Palanichamy, and Rajan 2018). “The classification of glycosides is based on the aglycon's nature, which can be one of a wide range of molecular types, including phenols, quinones, terpenes, and steroids” (Pengelly 2004).

“Most glycosides are incredibly bitter due to the presence of lactone groups that act on the gustatory nerves, resulting in the excess secretion of salivary to increase the appetite and digestion” (Velu,

Palanichamy, and Rajan 2018). “They occur in seeds, in swollen underground roots or shoots, and flowers and leaves. Some are even toxic, especially cyanogenic and cardiac glycosides” (Pengelly 2004). “Cardiac glycosides are chiefly responsible for heart disorders and common in individual plant families such as Fabaceae, Rosaceae, Leguminosae, and Linaceae. Compositae chalcone glycosides are mainly used for anticancer activities” (Velu, Palanichamy, and Rajan 2018; Bolarinwa et al. 2016).

1.6. Terpenes or Terpenoids

“Terpenes or terpenoids are the largest category of natural substances, with more than 30,000 compounds. The broader functions of terpenes in plant biology include light-harvesting pigments in photosynthesis, insect pollinators' attraction, defence against pathogens, and mediating in plants' interactions with other organisms” (Obiloma et al. 2019).

“Chemically, terpenoids are unsaturated hydrocarbon in the liquid form mostly available in resins and essential oils” (Velu, Palanichamy, and Rajan 2018).

“The uses of terpenes as flavour, food additives, vitamins, sweeteners, pharmaceuticals, medicines, and folklore spices in aromatherapy products have benefitted humankind” (Obiloma et al. 2019). “The most comprehensively studied of which is the effect of terpenes in the prevention and treatment of cancer. For example, paclitaxel derivatives (paclitaxel and docetaxel) are one of the most commonly used drugs in cancer chemotherapy. Other important therapeutic uses of terpenoids include their anti-microbial, anti-fungal, anti-viral, anti-hyperglycaemic, anti-inflammatory, antioxidant, anti-parasitic, and immunomodulatory functions, as well as their being a skin permeation enhancer” (Ramawat and Mérillon 2013).

1.6.1. Essential Oils

“Essential oils are aromatic and volatile liquids obtained from plant material, including the flowers, roots, bark, leaves, seeds, peel, fruits, wood, and the whole plant itself. The applications of essential oils for

different purposes are varied and include their use in food, beverages, and cooking. Since they enhance taste, there are reported applications in the manufacture of perfumes, cosmetics, soap, shampoo, and cleaning gels” (Ríos 2016).

“Essential oils have a crucial part in the medical field due to their extraordinary medicinal properties” (Hanif et al. 2019). “They are used as medicines for the treatment of infectious diseases. Their antioxidant properties have antibacterial, antifungal, anti-viral, nematocidal, and insecticidal effects” (Ríos 2016). “Pathogenic illnesses caused by viruses, fungi, and bacteria or non-pathogenic diseases can be treated using respective essential oils” (Hanif et al. 2019).

Essential oils are used for aromatherapeutic applications due to their properties. “They provide relief from various complaints such as indigestion, depression, insomnia, headaches, breathing difficulties, muscle aches, urinary complications, swollen joints, and skin diseases” (Hanif et al. 2019).

“Almost 3,000 different essential oils have been described, and about 300 are used commercially in the flavouring and fragrances market” (Ríos 2016).

1.6.2. Resins

“Resins are solid, brittle substances secreted by plants into special ducts, often due to damage to the plant by wounding, wind damage, and other causes. Their primary role appears to be the protection of the plant from attack by fungi and insects. Resins are insoluble in water but soluble in alcohol and fixed oils” (Pengelly, 2004).

“Classifying individual resins is difficult; they are sometimes mixtures with other plant constituents, such as gum-resins, oleo-gum-resins, and glycoresins. One of the most well-known resins is from the *Pinus* genus (Pinaceae) and named rosin. This amber-coloured resin is mainly used in varnishes and other industrial products” (Pengelly 2004).

1.6.3. Oleoresins

“Some oleoresins occur naturally as gums or exudates directly from trees and plants. They are usually only partially solvent-soluble and