1

Pharmacognosy

DEFINITION

Pharmacognosy is the study of the science of naturally derived drugs, and poisons. It is related to the study of the physical, chemical, and biological properties of drugs produced from natural sources such as plants, microbes, and animals. Modern pharmacognosy is related to the study of natural products from various sources including plants, bacteria, fungi, and marine organisms.

Plants are the source of many active ingredients used for medicinal purposes. Examples include salicylic acid and caffeine, indole alkaloids from *Vinca rosea*, morphine, atropine, and Aloe gel. These natural compounds provide a great basis for the discovery of new drugs.

It is believed that people find plant-derived medicines that exist in nature and are not synthetic. About 25% of prescription medicines in the USA are believed to have an active ingredient from a natural source. In developing countries, it is estimated that about 80% of their populations rely on traditional medicines made from plants and herbs. To study a plant drug, following points are considered:

1. **Biological Source:** The biological source of a drug is mentioned in the Latin language which also includes the family to which it belongs. After the Latin name, the name of the researcher botanist responsible for the classification is mentioned in abbreviated form. The plant family to which the drug belongs determines certain of its characters.
2. **Habitat:** The principal areas of collection and routes of transport are considered under this head.
3. **Plant Habit:** The general structure of the plant and morphology of crude plant drugs are studied.
4. **Cultivation, Collection and Preparation for the market:** These factors require particular attention when they affect the appearance or quality of the product.
5. **Morphology and Sensory Characters:** A knowledge of details of macroscopical structure is important. Cells and tissues are examined of powdered drugs.
6. **Histology:** Microscopical characters such as cell structure and arrangement, starches, epidermal trichomes, calcium oxalate crystals and fibres are studied under this head.
7. **Commercial Varieties, Substitutes and Adulteration:** With a knowledge of the diagnostic characters of official drugs, a critical examination of commercial samples may be made to determine their quality, and substances known to be potential substitutes or adulteration.

8. **Chemical Constituents:** The pharmacologically active constituents, the percentage of the more potent components, constituents affecting, the mode of preparation, the identity and class of such compounds are considered.
9. **Evaluation of Drug:** The purity and quality of drugs are determined.
10. **Uses:** Various medicinal uses and toxic effects are studied.

HISTORY OF PHARMACOGNOSY

The term 'pharmacognosy' was used for the first time by the Austrian physician Schmidt in 1811 and by Anotheus Seydler in 1815 (Greek: *Pharmakon* = drug; *Gnosy* = knowledge) in a work titled *Analecta Pharmacognostica*.

During the 19th century and the beginning of the 20th century, pharmacognosy was used to define the branch of medicine or commodity sciences which deals with drugs in their crude, or unprepared form. Crude drugs are the dried, unprepared material of plant, animal or microbes origin, used for medicine.

At the beginning of the 20th century, the subject had developed mainly on the botanical side. It is related with the description and identification of drugs both in their whole form and in powder state. It has been developed for quality control purposes, pharmacopoeial protocols and related health regulatory frameworks. At the same time, development in other areas of research has widely expanded the subject.

PRESENT STATUS

Pharmacognosy is still a relevant science for the discovery of future medicines. Japan and the United States of America (USA) are very active in the field. Researchers are encouraged to develop natural products as medicines.

Since the beginning of this century, more than half of the world's tropical forest area has been destroyed. Experts estimate that only 5–10% of all plants in the world have been systematically investigated for their pharmacological activity.

The future developments of pharmacognosy and the herbal drug industry are dependent upon reliable procedures for the identification of marker compounds of the plant extracts. The standardization and quality control of these extracts are important procedures.

Pharmacognosy gives a sound knowledge of the vegetable drugs under botany and animal drugs. It also includes plant taxonomy, and plant breeding, plant pathology, plant genetics and with this knowledge, one can improve the cultivation methods for both medicinal and aromatic plants.

Pharmacognosy is used by pharmaceutical industries to screen, characterize and produce new drugs for the treatment of human diseases. Often, naturally occurring drugs cannot be mass-produced, so they must be studied in order to develop with synthetic procedures.

According to the Botanical Survey of India, India is home to more than 8,000 species of medicinal plants. The country has a rich history of traditional healing systems, e.g. Ayurveda, Unani, and Homeopathy medicinal systems.

All plants produce chemical compounds as part of their normal metabolic activities. These phytochemicals are divided into:

1. Primary metabolites such as sugars and fats, which are found in all plants; and
2. Secondary metabolites—compounds which are found in a smaller range of plants, serving more specific functions.

For example, some secondary metabolites are toxins used by plants for their protection and others are pheromones used to attract insects for pollination. It is these secondary metabolites and pigments that can have therapeutic actions in humans and which can be refined to produce drugs. Examples are inulin from the roots of dahlias, morphine and codeine from the opium poppy, quinine from the cinchona bark, tetrahydrocannabinol (THC) and cannabidiol constituents from the cannabis, and digoxin from the foxglove.

Plants synthesize a variety of phytochemicals. Polyphenols (phenolics) such as anthocyanins, isoflavones, phytoestrogens and tannins give tea its astringency. Glycosides are molecules in which a sugar is bound to a non-carbohydrate moiety. Terpenes are a large and diverse class of organic compounds, produced by a variety of plants, which are often strong smelling and thus may have a protective function. The carotenoids produce shades of red, yellow and orange in pumpkin, maize, and tomatoes. An antimalarial drug, artemisinin, is isolated from *Artemisia annua* herb, a herb known in Chinese medicine to treat fever. The extracts of this plant showed antimalarial activity.

SCOPE OF PHARMACOGNOSY

The scope of pharmacognosy includes the study of the physical, chemical, biochemical and biological properties of drugs, drug substances, or potential drugs or drug substances of natural origin and the search for new drugs from natural sources. Research problems in pharmacognosy include studies in the areas of phytochemistry, microbial chemistry, biosynthesis, biotransformation, chemotaxonomy, and other biological and chemical sciences. It involves plant-related natural health products for the benefit of human health. The other fields of the subject are concerned with the study of botany, ethnobotany, marine biology, microbiology, herbal medicine, phytochemistry, biotechnology, pharmacology, and clinical pharmacy. The following fields are now focused in the subject pharmacognosy:

- **Medical ethnobotany:** The study of traditional uses of plants for medicinal purposes;
- **Ethnopharmacology:** The study of pharmacological qualities of traditional medicinal substances;
- **Phytotherapy:** The study of medicinal use of plant extracts;
- **Phytochemistry:** The study of chemicals derived from plants, including the identification of new phytoconstituents derived from plant sources;
- **Marine pharmacognosy:** The study of chemicals derived from marine organisms (many marine and aquatic organisms such as algae, nematodes, sponges, and fishes have soft bodies which are an easy target for predators, bacteria, and fungi); and
- **Zoopharmacognosy:** The process by which animals self-medicate, by selecting and using plants, soils, and insects to treat and prevent disease.

Pharmacognosy is a multidisciplinary science. During the evolution of the scope of this subject area, phytochemistry and phytochemical analysis have become integral parts of pharmacognosy. Molecular biology has become essential to medicinal plant drug discovery. It is concerned with the screening assays directed toward physiologically relevant molecular targets.

Modern pharmacognosy has been developed rapidly due to the improvement made in the technology of isolation processes which include the development of techniques such as column, paper, thin layer, high-performance liquid and droplet counter-current

chromatographic procedures. These methods have allowed the rapid isolation of compounds previously difficult to obtain by classical methods. The most important factor has been the discovery of new spectroscopic techniques which are used to identify structures of the isolated compounds. Although more than 100 plants are used in modern medicine in various parts of the world. The list of the most important ones along with their pharmacological properties is tabulated in Table 1.1.

Table 1.1: Important active constituents of plants used in medicine		
Plants	**Active Constituents**	**Pharmacological Activities**
1. *Dioscorea*, Agave, and *Solanum* species	Steroidal hormones	Anti-inflammatory, Hormonal, Antiarthritic
2. *Papaver somniferum*	Morphine, Codeine, Papaverine	Sedative, Antitussive, Smooth muscle relaxant
3. Cinchona species	Quinine, Quinidine	Antimalarial, Antiarrhythmic
4. *Datura stramonium, Hyoscyamus niger, Dubosia* species	Hyoscyamine, Hyoscine, Atropine	Parasympatholytic
5. *Digitalis lanata*	Digitoxin, Digoxin, Lanatosides	Cardiotonic
6. *Cathranthus roseus*	Ajmalacine, Vincristine, Vinblastine	Vasodilator Anticancer
7. *Rauwolfia serpentina*	Reserpine, Rescinamine, Deserpidine	Hypotensive Vasodilator
8. *Camellia sinensis* (Tea)	Caffeine	CNS stimulant
9. *Erythroxylum coca*	Cocaine	Anaesthetic
10. Ephedra *species*	Ephedrine	Sympathomimetic
11. *Pilocarpus jaborandi*	Pilocarpine	Parasympathomimetic
12. *Cephaelis acuminata, C. ipecacuanha*	Emetine	Antiamoebic
13. *Claviceps purpurea*	Ergotamine, Ergometrine,	Oxytocic, Vasodilator, Vasoconstriction
14. *Plantago ovata*	Psyllium mucilage	Laxative
15. *Vinca minor, Voacanga africana*	Vincamine	Vasodilator
16. *Glycyrrhiza glabra*	Glycyrrhetinic acid	Anti-inflammatory
17. *Cassia angustifolia, C. acutifolia*	Sennosides	Laxative
18. *Berberis asiatica*	Berberine	Antidiarrheal
19. *Podophyllum peltatum*	Podophyllotoxin	Anticancer
20. *Colchicum autumnale*	Colchicine	Gout
21. *Theobroma cacao*	Theobromine	CNS stimulant, Diuretic
22. *Coffea arabica*	Theophylline	CNS stimulant, Diuretic

In addition to pure constituents, the crude extracts of Aloe, *Artemisia annua* herb, Belladonna, Capsicum oleoresin, Cascara sagrada, Digitalis, Glycyrrhiza, Henbane, Ipecac, Opium, Podophyllum, Rhubarb, Stramonium and Valerian are used in modern medicine. Besides these, the essential oils of Anise seeds, Camphor, Cinnamon leaves, Clove, Japanese mint, Lemongrass, and Peppermint are also used in modern medicine.

Liver and stomach preparations of animals are prescribed in therapy of pernicious anaemia. Bile secreted in the liver is given for biliary secretion as a sodium salt to increase diuresis.

Pure active chemical constituents have been isolated from medicinal plants for the last 50 years. These phytoconstituents replaced the crude drugs, with the development of semisynthetic and synthetic medicine. Plant drugs, their extracts and their medicinal active constituents have become a significant market commodity in the international trade. The scope of pharmacognosy is significant in the field of medicine, bulk drugs, food supplements, pharmaceutical necessities, pesticides, dyes, tissue culture biotechnology, engineering and so on. The pharmacognosy personnel serve in various fields as follows:

Academics: Teaching in academic institutions, museums and botanical gardens.

Private industry: Pharmaceutical companies, consumer products testing laboratories, commercial testing laboratories, herbal product industries, cosmetic and perfume industries, and marketing field.

Government: Placement in federal agencies, such as the drug enforcement agency, the food and drug administration, medicinal plant research laboratories, forensic laboratories, and environmental laboratories.

Drug discovery from medicinal plants continues to provide new and important leads against various pharmacological targets including cancer, HIV/AIDS, Alzheimer's disease, malaria, and pain. Several natural product/drugs of plant origin have either recently been introduced or are currently involved in late-phase clinical trials.