History, Definition and Scope of Pharmacognosy

CHAPTER 1

1.1. MEANING OF PHARMACOGNOSY

C. A. Seydler

Pharmacognosy, known initially as *materia medica*, may be defined as the study of crude drugs obtained from plants, animals and mineral kingdom and their constituents. There is a historical misinformation about who created the term *pharmacognosy*. According to some sources, it was C. A. Seydler, a medical student at Halle, Germany, in 1815; he wrote his doctoral thesis titled *Analectica Pharmacognostica*. However, recent historical research has found an earlier usage of this term. The physician J. A. Schmidt (Vienna) used that one in his *Lehrbuch der materia medica* in 1811, to describe the study of medicinal plants and their properties. The word *pharmacognosy* is derived from two Latin words *pharmakon*, 'a drug,' and *gignoso*, 'to acquire knowledge of'. It means 'knowledge or science of drugs'.

J. A. Schmidt

Crude drugs are plants or animals, or their parts which after collection are subjected only to drying or making them into transverse or longitudinal slices or peeling them in some cases. Most of the crude drugs used in medicine are obtained from plants, and only a small number comes from animal and mineral kingdoms. Drugs obtained from plants consist of entire plants, whereas senna leaves and pods, nux vomica seeds, ginger rhizome and cinchona bark are parts of plants. Though in a few cases, as in lemon and orange peels and in colchicum corm, drugs are used in fresh condition, and most of the drugs are dried after collections. Crude drugs may also be obtained by simple physical processes like drying or extraction with water. Therefore, aloe is the dried juice of leaves of *Aloe* species, opium is the dried latex from poppy capsules and black catechu is the dried aqueous extract from the wood of *Acacia catechu*. Plant exudates such as gums, resins and balsams, volatile oils and fixed oils are also considered as crude drugs.

Further drugs used by physicians and surgeons or pharmacists, directly or indirectly, like cotton, silk, jute and nylon in surgical dressing or kaolin; diatomite used in filtration of turbid liquid or gums; wax, gelatin, agar used as pharmaceutical auxiliaries of flavouring or sweetening agents or drugs used as vehicles or insecticides are used in pharmacognosy.

Drugs obtained from animals are entire animals, as cantharides; glandular products, like thyroid organ or extracts like liver extracts. Similarly, fish liver oils, musk, bees wax, certain hormones, enzymes and antitoxins are products obtained from animal sources.

Drugs are organized or unorganized. Organized drugs are direct parts of plants and consist of cellular tissues. Unorganized drugs, even though prepared from plants are not the direct parts of plants and are prepared by some intermediary physical processes, such as incision, drying or extraction with water and do not contain cellular tissue. Thus aloe, opium, catechu, gums, resins and other plant exudates are unorganized drugs.

Drugs from mineral sources are kaolin, chalk, diatomite and other bhasmas of Ayurveda.

1.2. ORIGIN OF PHARMACOGNOSY

Views on the beginning of life on planet Earth have forever remained controversial and an unending subject of debate. Nevertheless, we can say with certainty that the vegetable kingdom was already there when man made his appearance on Earth. As man began to acquire closure acquaintance with his environment, he began to know more about plants, as these were the only curative agents he had. As he progressed and evolved, he was not only able to sort on as to which plant served for eating and which did not, but he went beyond and began to associate curative characteristics with certain plants, classifying them as painkillers, febrifuge, antiphlogistics, soporific and so on. This must have involved no doubt, a good deal of trial and error, and possibly some deaths in the beginning also, but as it happened antidotes against poisons were also discovered. As we shall see later, drug substitutes were also forthcoming. All these states of affairs indicate that the origin of pharmacognosy, i.e. the study of natural curative agents points towards the accent of human beings on mother earth, and its historical account makes it clear that pharmacognosy in its totality is not the work of just one or two continental areas but the overall outcome of the steadfast work of many of the bygone civilizations like the Chinese, Egyptian, Indian, Persian, Babylonian, Assyrian and many more. Many of today's wonderful modern drugs find their roots in the medicines developed by the tribal traditions in the various parts of the world.

1.3. HISTORY OF PHARMACOGNOSY

In the early period, primitive man went in search of food and ate at random, plants or their parts like tubers, fruits, leaves, etc. As no harmful effects were observed he considered them as edible materials and used them as food. If he observed other effects by their eating they were considered inedible, and according to the actions he used them in treating symptoms or diseases. If it caused diarrhoea it was used as purgative, if vomitting it was used as memtic and if it was found poisonous and death was caused, he used it as arrow poison. The knowledge was empirical and was obtained by trial and error. He used drugs as such or as their infusions and decoctions. The results were passed on from one generation to the other, and new knowledge was added in the same way.

Ancient China

Chinese pharmacy, according to legend, stems from Shen Nung (about 2700 B.C.), emperor who sought out and investigated the medicinal value of several hundred herbs. He reputed to have tested many of them on himself, and to have written the first *Pen T-Sao*, or *Native Herbal*, recording 365 drugs. These were subdivided as follows: 120 emperor herbs of high, food grade quality which are non-toxic and can be taken in large quantities to maintain health over a long period of time, 120 minister herbs, some mildly toxic and some not, having stronger therapeutic action to heal diseases and finally 125 servant herbs that having specific action to treat disease and eliminate stagnation. Most of those in the last group, being toxic, are not intended to be used daily over a prolonged period of weeks and months. Shen Nung conceivably examined many herbs, barks and roots brought in from the fields, swamps and woods that are still recognized in pharmacy (podophyllum, rhubarb, ginseng, stramonium, cinnamon bark and ephedra).

Inscriptions on oracle bones from the Shang Dynasty (1766–1122 B.C.), discovered in Honan Province, have provided a record of illness, medicines and medical treatment. Furthermore, a number of medical treatises on silk banners and bamboo slips were excavated from the tomb number three at Ma-Huang-Tui in Changsha, Hunan Province. These were copied from books some time between the Chin and Han periods (300 B.C.–A.D. 3) and constitute the earliest medical treatises existing in China.

The most important clinical manual of traditional Chinese medicine is the *Shang Hang Lun* (*Treatise on the Treatment of Acute Diseases Caused by Cold*) written by Chang Chung-Ching (142–220). The fame and reputation of the Shang Han Lun as well as its companion book, *Chin Kuei Yao Lueh* (*Prescriptions from the Golden Chamber*), is the historical origin of the most important classical herbal formulas that have become the basis of Chinese and Japanese-Chinese herbalism (called 'Kampo').

With the interest in alchemy came the development of pharmaceutical science and the creation of a number of books including Tao Hong Jing's (456–536) compilation of the *Pen T'sao Jing Ji Zhu* (*Commentaries on the Herbal Classic*) based on the Shen Nong Pen T'sao Jing, in 492. In that book 730 herbs were described and classified in six categories: (1) stone (minerals), (2) grasses and trees, (3) insects and animals, (4) fruits and vegetables, (5) grains and (6) named but unused. During the Sui dynasty (589–618) the study of herbal medicine blossomed with the creation of specialized books on plants and herbal medicine. Some of these set forth the method for the gathering of herbs in the wild as well as their cultivation. Over 20 herbals were chronicled in the *Sui Shu JingJi Zhi* (*Bibliography of the History of Sui*). These include the books *Zhong Zhi Yue Fa* (*How to Cultivate Herbs*) and the *Ru Lin Cat Yue Fa* (*How to Collect Herbs in the Forest*).

From the Sung Dynasty (960–1276) the establishment of pharmaceutical system has been a standard practice throughout the country. Before the ingredients of Chinese medicine can be used to produce pharmaceuticals, they must undergo a preparation process, e.g. baking, simmering or roasting. The preparation differs according to the needs for the treatment of the disease. Preparation methods, production methods and technology have constantly been improved over time.

In 1552, during the later Ming Dynasty, Li Shi Zhen (1518–1593) began work on the monumental *Pen T'sao Kan Mu* (*Herbal with Commentary*). After 27 years and three revisions, the *Pen T'sao Kan Mu* was completed in 1578. The book lists 1892 drugs, 376 described for the first time with 1160 drawings. It also lists more than 11,000 prescriptions.

Ancient Egypt

The most complete medical documents existing are the *Ebers Papyrus* (1550 B.C.), a collection of 800 prescriptions, mentioning 700 drugs and the *Edwin Smith Papyrus* (1600 B.C.), which contains surgical instructions and formulas for cosmetics. The *Kahun Medical Papyrus* is the oldest—it comes from 1900 B.C. and deals with the health of women, including birthing instructions.

A fragment of Ebers Papyrus

However, it is believed that the *Smith Papyrus* was copied by a scribe from an older document that may have dated back as far as 3000 B.C. Commonly used herbs included: senna, honey, thyme, juniper, cumin, (all for digestion); pomegranate root, henbane (for worms) as well as flax, oakgall, pine-tar, manna, bayberry, ammi, alkanet, aloe, caraway, cedar, coriander, cyperus, elderberry, fennel, garlic, wild lettuce, nasturtium, onion, peppermint, papyrus, poppy-plant, saffron, watermelon, wheat and zizyphus-lotus. Myrrh, turpentine and acacia gum were also used.

Ancient India

In India knowledge of medicinal plants is very old, and medicinal properties of plants are described in *Rigveda* and in *Atharvaveda* (3500–1500 B.C.) from which *Ayurveda* has developed. The basic medicinal texts in this world region—The Ayurvedic writings—can be divided in three main ones *(Charaka Samhita, Susruta Samhita, Astanga Hrdayam Samhita)* and three minor ones (*Sarngadhara Samhita, Bhava Prakasa Samhita, Madhava Nidanam Samhita).* Ayurveda is the term for the traditional medicine of ancient India. Ayur means life and veda means the study of which is the origin of the term. The oldest writing—*Charaka Samhita*—is believed to date back six to seven centuries before Christ. It is assumed to be the most important ancient authoritative writing on Ayurveda. The *Susruta Samhita* is thought to have arisen about the same time period as the *Charaka Samhita*, but slightly after it *Astanga Hrdayam* and the *Astanga Sangraha* have been dated about the same time and are thought to date after the *Charaka* and *Susruta Samhitas*. Most of mentioned medicines origin from plants and animals, e.g. ricinus, pepper, lilly, valerian, etc.

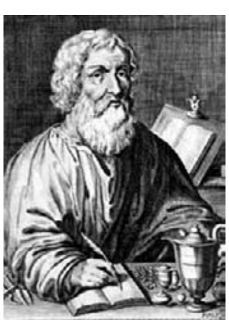
Ancient Greece and Rome

Greek scientists contributed much to the knowledge of natural history. Hippocrates (460–370 B.C.) is referred to as father of medicine and is remembered for his famous oath which is even now administered to doctors. Aristotle (384–322 B.C.), a student of Plato was a philosopher and is known for his writing on animal kingdom which is considered authoritative even in twentieth century. Theophrastus (370–287 B.C.), a student of Aristotle, wrote about plant kingdom. Dioscorides, a physician who lived in the first century A.D., described medicinal plants, some of which like belladonna, ergot, opium, colchicum are used even today. Pliny wrote 37 volumes of natural history and Galen (131–A.D. 200) devised methods of preparations of plant and animal drugs, known as 'galenicals' in his honour.

Pharmacy separated from medicine and materia medica, the science of material medicines, describing collection, preparation and compounding, emerged.

Even upto the beginning of twentieth century, pharmacognosy was more of a descriptive subject akin mainly to botanical science, and it consisted of identification of drugs both in entire and powdered conditions and concerned with their history, commerce, collection, preparation and storage.

The development of modern pharmacognosy took place later during the period 1934–1960 by simultaneous application of disciplines like organic chemistry, biochemistry, biosynthesis, pharmacology and modern methods and techniques of analytic chemistry, including paper, thin layer, and gas chromatography and spectophotometry.



Hippocrates

Aristotle and Plato

Theophrastus

Galen

Pliny

The substances from the plants were isolated, their structures elucidated and pharmacological active constituents studied. The development was mainly due to the following four events:

1. Isolation of penicillin in 1928 by William Fleming and large-scale production in 1941 by Florey and Chain.
2. Isolation of resperpine from rauwolfia roots and confirming its hypotensive and tranquilizing properties.
3. Isolation of vinca alkaloids, especially vincristine and vinblasting. Vincristine was found useful in the treatment of leukaemia. These alkaloids also have anticancer properties.
4. Steroid hormones like progesterone were isolated by partial synthesis from diosgenin and other steroid saponins by Marker's method. Cortisone and hydrocortisone are obtained from progesterone by chemical and microbial reaction.

This period can also be termed antibiotic age, as besides pencillin, active antibiotics like streptomycin, chloramphenicol, tetracycline and several hundred antibiotics have been isolated and studied extensively.

Some of the important aspects of the natural products that led to the modern development of drugs and pharmaceuticals are as follows:

Isolation of phytochemicals

Strong acting substances such as glycosides of digitalis and scilla, alkaloids of hyoscyamus and belladonna, ergot, rauwolfia, morphine and other alkaloids of opium were isolated and their clinical uses studied.

Structure activity relationship

Tubocurarine and toxiferine from curare have muscle relaxant properties because of quaternary ammonium groups. The hypotensive and tranquillizing actions of reserpine are attributed to the trimethoxy benzoic acid moiety which is considered essential. Mescaline and psilocybine have psychocative properties. Presence of a lactone ring is essential for the action of cardiac glycosides. Likewise anthraquinone glycosides cannot have their action without satisfying the positions at C3, C1, C8, C9 and C10.

Drugs obtained by partial synthesis of natural products

Oxytocic activity of methyl ergometrine is more than that of ergometrine. In ergotamine, by 9:10 hydrogenation, oxytocic activity is suppressed and spasmolytic activity increases. We have already referred to the preparation of steroid hormones from diosgenin by acetolysis and oxidation and further preparation of cortisone by microbial reactions.

Steroid hormones and their semisynthetic analogues represent a multimillion dollar industry in the United States.

Natural products as models for synthesis of new drugs

Morphine is the model of a large group of potent analgesics, cocaine for local anaesthetics, atropine for certain spasmolytics, dicoumarol for anticoagulants and salicin for salicylic acid derivatives. Without model substances from plants a large number of synthetics would have been missed.

Drugs of direct therapeutic uses

Among the natural constituents, which even now cannot be replaced, are important groups of antibiotics, steroids, ergot alkaloids and certain antitumour substances. Further, drugs as digitoxin, strophanthus glycosides, morphine, atropine and several others are known since long and have survived their later day synthetic analogues.

Biosynthetic pathways

Biosynthetic pathways are of primary and secondary metabolites. Some of the important pathways are Calvin's cycle of photosynthesis, shikimic acid pathway of aromatic compounds, acetate hypothesis for anthracene glycosides and isoprenoid hypothesis for terpenes and steroids via acetate-mevalonic acid-isopentyl pyrophosphate and squalene.

Progress from 1960 onwards

During this period only a few active constituents mainly antibiotics, hormones and antitumour drugs were isolated or new possibilities for their production were found. From 6-amino penicillanic acid, which has very little antibiotic action of its own, important broad-spectrum semisynthetic penicillins like ampenicillin and amoxicillin were developed.

From ergocryptine, an alkaloid of ergot, bromocryptine has been synthesized. Bromocryptine is a prolactin inhibitor and also has activity in Parkinson's disease and in cancer. By applications of several disciplines, pharmacognosy from a descriptive subject has again developed into an integral and important disciplines of pharmaceutical sciences.

Technical products

Natural products, besides being used as drugs and therapeutic aids, are used in a number of other industries as beverages, condiments, spices, in confectioneries and as technical products.

The coffee beans and tea leaves besides being the source of caffein are used as popular beverages. Ginger and wintergreen oil are used less pharmaceutically but are more used in preparation of soft drinks. Mustard seed and clove are used in spice and in condiment industry. Cinnamon oil and peppermint oil besides being used as carminatives are used as flavouring agents in candies and chewing gum. Colophony resin, turpentine oil, linseed oil, acacia, pectin, and numerous other natural products are used widely in other industries and are called technical products.

Pharmaceuticals aids

Some of the natural products obtained from plants and animals are used as pharmaceutical aids. Thus gums like acacia and tragacanth are used as binding, suspending and emulsifying agents. Guar gum is used as a thickening agent and as a binder and a disintegrating agent in the manufacturing of tablets. Sterculia and tragacanth because of their swelling property are used as bulk laxative drugs. Mucilage-containing drugs like ishabgul and linseed are used as demulcents or as soothing agents and as bulk laxatives. Starch is used as a disintegrating agent in the manufacture of tablets and because of its demulcent and absorbent properties it's used in dusting powders. Sodium alginate is used as an establishing, thickening, emulsifying deflocculating, gelling and filming agent. Carbohydrate-containing drugs like glucose, sucrose and honey are used as sweetening agents and as laxative by osmosis.

Agar, in addition to being used as a laxative by osmosis, is also used as an emulsifying agent and in culture media in microbiology. Saponins and sponin-containing drugs are used as detergents, emulsifying and frothing agents and as fire extinguishers. Tincture quillaia is used in preparation of coal tar emulsions. Saponins are toxic and their internal use requires great care, and in some countries their internal use as frothing agents is restricted. Glycyrrhiza is used as sweetening agent for masking the taste of bitter and salty preparations.

Fixed oils and fats are used as emollients and as ointment bases and vehicles for other drugs. Volatile oils are used as flavouring agents.

Gelatin is used in coating of pills and tablets and in preparation of suppositories, as culture media in microbiology and in preparation of artificial blood plasma. Animal fats like lard and suet are used as ointment bases. Beeswax is used as ointment base and thickening agent in ointments. Wool fat and wool alcohols are used as absorbable ointment bases.

Thus, from the above description it can be seen that many of the natural products have applications as pharmaceutical aids.

Discovery of new medicines from plants—nutraceutical use versus drug development

Little work was carried out by the pharmaceutical industry during 1950–1980s; however, during the 1980–1990s, massive growth has occurred. This has resulted in new developments in the area of combinatorial chemistry, new advances in the analysis and assaying of plant materials and a heightened awareness of the potential plant materials as drug leads by conservationists. New plant drug development programmes are traditionally undertaken by either random screening or an ethnobotanical approach, a method based on the historical medicinal/food use of the plant. One reason why there has been resurgence in this area is that conservationists especially in the United States have argued that by finding new drug leads from the rainforest, the value of the rainforests to society is proven, and that this would prevent these areas being cut down for unsustainable timber use. However, tropical forests have produced only 47 major pharmaceutical drugs of worldwide importance. It is estimated that a lot more, say about 300 potential drugs of major importance may need to be discovered. These new drugs would be worth $147 billion. It is thought that 125,000 flowering plant species are of pharmacological relevance in the tropical forests. It takes 50,000 to 100,000 screening tests to discover one profitable drug. Even in developed countries there is a huge potential for the development of nutraceuticals and pharmaceuticals from herbal materials. For example the UK herbal materia medica contains around 300 species, whereas the Chinese herbal materia medica contains around 7,000 species. One can imagine what lies in store in the flora-rich India!

1.4. SCOPE OF PHARMACOGNOSY

Crude drugs of natural origin that is obtained from plants, animals and mineral sources and their active chemical constituents are the core subject matter of pharmacognosy. These are also used for the treatment of various diseases besides being used in cosmetic, textile and food industries. During the first half of the nineteenth century apothecaries stocked the crude drugs for the preparation of herbal tea mixtures, all kinds of tinctures, extracts and juices which in turn were employed in preparing medicinal drops, syrups, infusions, ointments and liniments.

The second half of the nineteenth century brought with it a number of important discoveries in the newly developing fields of chemistry and witnessed the rapid progress of this science. Medicinal plants became one of its major objects of interest and in time, phytochemists succeeded in isolating the pure active constituents. These active constituents replaced the crude drugs, with the development of semisynthetic and synthetic medicine, they became predominant and gradually pushed the herbal drugs, which had formerly been used, into the background. It was a belief that the medicinal plants are of no importance and can be replaced by man-made synthetic drugs, which in today's scenario is no longer tenable. The drug plants, which were rapidly falling into disuse a century ago, are regaining their rightful place in medicine. Today applied science of pharmacognosy has a far better knowledge of the active constituents and their prominent therapeutic activity on the human beings. Researchers are exploiting not only the classical plants but also related species all over the world that may contain similar types of constituents. Just like terrestrial germplasm, investigators had also diverted their attention to marine flora and fauna, and wonderful marine natural products and their activities have been studied. Genetic engineering and tissue culture biotechnology have already been successful for the production of genetically engineered molecules and biotransformed natural products, respectively.

Lastly, crude drugs and their products are of economical importance and profitable commercial products. When these were collected from wild sources, the amount collected could only be small, and the price commanded was exorbitantly high. All this has now changed. Many of the industrially important species which produced equally large economic profits are cultivated for large-scale crop production. Drug plants, standardized extracts and the therapeutically active pure constituents have become a significant market commodity in the international trade. In the light of these glorious facts, scope of pharmacognosy seems to be enormous in the field of medicine, bulk drugs, food supplements, pharmaceutical necessities, pesticides, dyes, tissue culture biotechnology, engineering and so on.

Scope for doctoral graduates in pharmacognosy is going to increase in the coming years. The pharmacognosist would serve in various aspects as follows:

Academics: Teaching in colleges, universities, museums and botanical gardens.

Private industry: Pharmaceutical companies, consumer products testing laboratories and private commercial testing laboratories, the herbal product industries, the cosmetic and perfume industries, etc.

Government: Placement in federal agencies, such as the Drug Enforcement Agency, the Food and Drug Administration, the U.S. Department of Agriculture, Medicinal plant research laboratories, state agencies like forensic laboratories, environmental laboratories, etc.

Undoubtedly, the plant kingdom still holds large number of species with medicinal value which have yet to be discovered. Lots of plants were screened for their pharmacological values like, hypoglycaemic, hepatoprotective, hypotensive, antiinflammatory, antifertility, etc. pharmacognosists with a multidisciplinary background are able to make valuable contributions in the field of phytomedicines.

1.5. FUTURE OF PHARMACOGNOSY

Medicinal plants are of great value in the field of treatment and cure of disease. Over the years, scientific research has expanded our knowledge of the chemical effects and composition of the active constituents, which determine the medicinal properties of the plants. It has now been universally accepted fact that the plant drugs and remedies are far safer than that of synthetic medicines for curing the complex diseases like cancer and AIDS. Enormous number of alkaloids, glycosides and antibiotics have been isolated, identified and used as curative agents. The modern developments in the instrumental techniques of analysis and chromatographical methodologies have added numerous complex and rare natural products to the armoury of phytomedicine. To mention a few, artemissinin as antimalarial, taxol as anticancer, forskolin as antihypertensive, rutin as vitamin P and capillary permeability factor and piperine as bioavailability enhancer are the recent developments. Natural products have also been used as drug substitutes for the semisynthesis of many potent drugs. Ergotamine for dihydroergotamine in the treatment of migraine, podophyllotoxin for etoposide, a potent antineoplastic drug or solasodine and diosgenin that serve for the synthetic steroidal hormones are the first-line examples of the recent days.

In the Western world, as the people are becoming aware of the potency and side effects of synthetic drugs, there is an increasing interest in the plant-based remedies with a basic approach towards the nature. The future developments of pharmacognosy as well as herbal drug industry would be largely dependent upon the reliable methodologies for identification of marker compounds of the extracts and also upon the standardization and quality control of these extracts. Mother earth has given vast resources of medicinal flora and fauna both terrestrial and marine, and it largely depends upon the forthcoming generations of pharmacognosists and phytochemists to explore the wonder drug molecules from this unexploited wealth.

Little more needs to be said about the present-day importance of medicinal plants, for it will be apparent from the foregoing that the plant themselves either in the form of crude drugs or even more important, for the medicinally active materials isolated from them, have been, are and always will be an important aid to the physician in the treatment of disease.

1.6. PHARMACOGNOSTICAL SCHEME

To describe drugs in a systematic manner is known as pharmacognostical scheme, which includes the following headings:

Biological Source

This includes the biological names of plants or animals yielding the drug and family to which it belongs. Botanical name includes genus and species. Often some abbreviations are written after the botanical names, of the biologist responsible for the classification, for example, *Acacia arabica* Willd. Here Willd indicates the botanist responsible for the classification or nomenclature. According to the biennial theory, the botanical name of any plant or animal is always written in italic form, and the first letter of a genus always appears in a capital later.

Biological source also includes the family and the part of the drug used. For example, biological source of senna is, Senna consists of dried leaflets of *Cassia angustifolia* Delite, belonging to family Leguminosae.

Geographical Source

It includes the areas of cultivation, collection and route of transport of a drug.

Cultivation, Collection and Preparation

These are important to mention as these are responsible for quality of a drug.

Morphological Characters

In case of organized drugs, the length, breadth, thickness, surface, colour, odour, taste, shape, etc. are covered under the heading morphological characters, whereas organoleptic properties (colour, odour, taste and surface) should be mentioned, if the drug is unorganized.

Microscopical Characters

This is one of the important aspects of pharmacognosy as it helps in establishing the correct identity of a drug. Under this heading all the detailed microscopical characters of a drug is described.

Chemical Constituents

The most important aspect which determines the intrinsic value of a drug to which it is used is generally described under this heading. It includes the chemical constituents present in the drug. These kinds of drugs are physiologically active.

Uses

It includes the pharmaceutical, pharmacological and biological activity of drugs or the diseases in which it is effective.

Substituents

The drug which is used during non-availability of original drug is known as substituent. It has the same type of physiological active constituents; however, the percentage quantity of the drug available may be different.

Adulterants

With the knowledge of the diagnostic characters of drugs, the adulterants can be detected. One should have the critical knowledge of substances known to be potential adulterants. Most of the times the adulterants are completely devoid of physiologically active constituents, which leads in the deterioration of the quality. For example, mixing of buffalo milk with goat milk is substitution, whereas mixing of water in the milk is adulteration. In the first case, goat milk is substitute and in the second case water is adulterant.

Chemical Tests

The knowledge of chemical tests becomes more important in case of unorganized drugs whose morphology is not well defined.

Classification of Drugs of Natural Origin

CHAPTER
3

3.1. INTRODUCTION

The flora and fauna of mother earth has a great diversity. The number of plant species divided in about 300 families and 10,500 genera are supposed to be about 2–2.5 lacs. At least 100–150 species of medicinal plants are currently cultivated and about 30–40 of them are the large-scale field corps. Drugs of the animal and mineral origin have also been used since the beginning and even today many such crude drugs are important, commercial products. All these drugs of natural origin have been used as the curative agents and even in this age of scientific discoveries and invention, natural drug have been the primary choice as a source of drug. Human inquisitiveness has gone beyond the terrestrial regions and exploited the seas and oceans which contain about 5 lacs species of marine organisms. Therapeutically active constituents found in these organisms open yet another great natural source of drugs of unending search.

Crude drugs can be regarded as the substances either used directly or indirectly as a drug which have not been changed or modified in its chemical composition.

The crude drugs of natural origin can be divided into two main categories as organized crude drugs and unorganized crude drugs.

Organized Drugs

Organized drugs consist of the cellular organization in the form of anatomical features. These are mostly the crude drugs from plant sources. Almost all of the morphological plant parts or the entire plant itself can be called as an organized drugs. A long list can be made of such crude drugs. To mention few of them, like, Cinchona bark, Sandalwood, Quassia wood, Senna, Digitalis leaves, Nux vomica seeds, Rauwolfia roots and many other examples of above-mentioned groups or crude drugs exemplified by some other morphological organs can be quoted as the example of organized crude drugs.

Microscopical and anatomical studies are preeminent for such crude drugs. These can be used directly in medicine or can be used by modifying or by extracting the active ingredient from it. The simple medicines prepared from these drugs are herbal teas, extracts, tinctures, etc., and it may be extensively processed for the isolation and purification of pure therapeutically active constituent which is ultimately responsible for the action of the drug.

Unorganized Drugs

The unorganized drugs do not have the morphological or anatomical organization as such. These are the products which come directly in the market but their ultimate source remains the plants, animals or minerals. Microscopical studies are not required for such crude drugs. These includes products like plant exudates as gums, oleogums, oleogumresins, plant lattices like that of opium, aloetic juices like aloes or dried extracts of black and pale catechu, agar, alginic acid, etc., are products coming under this group. Other products like essential oils, fixed oils, fats and waxes obtained from vegetable or animal sources, although hydro-distilled or extracted from plant, become the direct commodity for use. Unorganized crude drugs may be miscellaneous mineral products like *shilajit*. These products may be solid, semisolid or liquid and the physical, chemical and analytical standards may be applied for testing their quality and purity.

3.2. CLASSIFICATION OF CRUDE DRUGS

The most important natural sources of drugs are higher plant, microbes and animals and marine organisms. Some useful products are obtained from minerals that are both organic and inorganic in nature. In order to pursue (or to follow) the study of the individual drugs, one must adopt some particular sequence of arrangement, and this is referred to a system of classification of drugs. A method of classification should be:

(a) simple,
(b) easy to use, and
(c) free from confusion and ambiguities.

Because of their wide distribution, each arrangement of classification has its own merits and demerits, but for the purpose of study the drugs are classified in the following different ways:

1. Alphabetical classification
2. Taxonomical classification
3. Morphological classification
4. Pharmacological classification
5. Chemical classification
6. Chemotaxonomical classification
7. Serotaxonomical classification

Alphabetical Classification

Alphabetical classification is the simplest way of classification of any disconnected items. Crude drugs are arranged in alphabetical order of their Latin and English names (common names) or sometimes local language names (vernacular names). Some of the pharmacopoeias, dictionaries and reference books which classify crude drugs according to this system are as follows:

1. Indian Pharmacopoeia
2. British Pharmacopoeia
3. British Herbal Pharmacopoeia
4. United States Pharmacopoeia and National Formulary
5. British Pharmaceutical Codex
6. European Pharmacopoeia

In European Pharmacopoeia these are arranged according to their names in Latin where in United States Pharmacopoeia (U.S.P.) and British Pharmaceutical Codex (B.P.C.), these are arranged in English.

Merits

- It is easy and quick to use.
- There is no repetition of entries and is devoid of confusion.
- In this system location, tracing and addition of drug entries is easy.

Demerits

There is no relationship between previous and successive drug entries.

Examples: Acacia, Benzoin, Cinchona, Dill, Ergot, Fennel, Gentian, Hyoscyamus, Ipecacuanha, Jalap, Kurchi, Liquorice, Mints, Nux vomica, Opium, Podophyllum, Quassia, Rauwolfia, Senna, Vasaka, Wool fat, Yellow bees wax, Zeodary.

Taxonomical Classification

All the plants possess different characters of morphological, microscopical, chemical, embryological, serological and genetics. In this classification the crude drugs are classified according to kingdom, subkingdom, division, class, order, family, genus and species as follows.

Class: Angiospermae (Angiosperms) are plants that produce flowers and Gymnospermae (Gymnosperms) which don't produce flowers.

Subclass: Dicotyledonae (Dicotyledons, Dicots) are plants with two seed leaves; Monocotyledonae (Monocotyledons, Monocots) with one seed leaf.

Superorder: A group of related plant families, classified in the order in which they are thought to have developed their differences from a common ancestor. There are six superorders in the Dicotyledonae (*Magnoliidae, Hamamelidae, Caryophyllidae, Dilleniidae, Rosidae, Asteridae*), and four superorders in the Monocotyledonae (*Alismatidae, Commelinidae, Arecidae*, and *Liliidae*). The names of the superorders end in *–idae.*

Order: Each superorder is further divided into several orders. The names of the orders end in *–ales.*

Family: Each order is divided into families. These are plants with many botanical features in common, and are the highest classification normally used. At this level, the similarity between plants is often easily recognizable by the layman. Modern botanical classification assigns a type plant to each family, which has the particular characteristics that separate this group of plants from others, and names the family after this plant.

The number of plant families varies according to the botanist whose classification you follow. Some botanists recognize only 150 or so families, preferring to classify other similar plants as subfamilies, while others recognize nearly 500 plant families. A widely accepted system is that devised by Cronquist in 1968, which is only slightly revised today. The names of the families end in *–aceae.*

Subfamily: The family may be further divided into a number of subfamilies, which group together plants within the family that have some significant botanical differences. The names of the subfamilies end in *–oideae.*

Tribe: A further division of plants within a family, based on smaller botanical differences, bin still usually comprising many different plants. The names of the tribes end in *–eae.*

Subtribe: A further division based on even smaller botanical differences, often only recognizable to botanists. The names of the subtribes end in *–inae.*

Genus: This is the part of the plant name that is most familiar; the normal name that you give a plant—Papaver (Poppy), Aquilegia (Columbine), and so on. The plants in a genus are often easily recognizable as belonging to the same group.

Species: This is the level that defines an individual plant. Often, the name will describe some aspect of the plant—the colour of the flowers, size or shape of the leaves, or it may be named after the place where it was found. Together, the genus and species name refer to only one plant, and they are used to identify that particular plant. Sometimes, the species is further divided into subspecies that contain plants not quite so distinct that they are classified as varieties. The name, of the species should be written after the genus name, in small letters, with no capital letter.

Variety: A variety is a plant that is only slightly different from the species plant, but the differences are not so insignificant as the differences in a form. The Latin is *varietas*, which is usually abbreviated to var. The name follows the genus and species name, with var. before the individual variety name.

Form: A form is a plant within a species that has minor botanical differences, such as the colour of flower or shape of the leaves. The name follows the genus and species name, with form (or f.) before the individual variety name.

Cultivar: A cultivar is a cultivated variety—a particular plant that has arisen either naturally or through deliberate hybridization, and can be reproduced (vegetatively or by seed) to produce more of the same plant.

The name follows the genus and species name. It is written in the language of the person who described it, and should not be translated. It is either written in single quotation marks or has cv. written in front of the name.

Kingdom	Plants
Subkingdom	Tracheobionta—Vascular plants
Superdivision	Spermatophyta—Seed plants
Division	Magnoliophyta—Flowering plants
Class	Magnoliopsida—Dicotyledons
Subclass	Asteridae
Order	Asterales
Family	Asteraceae—Aster family
Genus	*Tridax* L.—tridax

Merits

Taxonomical classification is helpful for studying evolutionary developments.

Demerits

This system also does not correlate in between the chemical constituents and biological activity of the drugs.

Morphological Classification

In this system, the drugs are arranged according to the morphological or external characters of the plant parts or animal parts, i.e. which part of the plant is used as a drug, e.g. leaves, roots, stem, etc. The drugs obtained from the direct parts of the plants and containing cellular tissues are called as *organized* drugs, e.g. rhizomes, barks, leaves, fruits, entire plants, hairs and fibres. The drugs which are prepared from plants by some intermediate physical processes such as incision, drying or extraction with a solvent and not containing any cellular plant tissues are called *unorganized* drugs. Aloe juice, opium latex, agar, gambir, gelatin, tragacanth, benzoin, honey, beeswax, lemon grass oil, etc., are examples of unorganized drugs.

Organized drugs

Woods: Quassia, Sandalwood and Red Sandalwood.
Leaves: Digitalis, Eucalyptus, Gymnema, Mint, Senna, Spearmint, Squill, Tulsi, Vasaka, Coca, Buchu, Hamamelis, Hyoscyamus, Belladonna, Tea.
Barks: Arjuna, Ashoka, Cascara, Cassia, Cinchona, Cinnamon, Kurchi, Quillia, Wild cherry.
Flowering parts: Clove, Pyrethrum, Saffron, Santonica, Chamomile.
Fruits: Amla, Anise, Bael, Bahera, Bitter Orange peel, Capsicum, Caraway, Cardamom, Colocynth, Coriander, Cumin, Dill, Fennel, Gokhru, Hirda, Lemon peel, Senna pod, Star anise, Tamarind, Vidang.
Seeds: Bitter almond, Black Mustard, Cardamom, Colchicum, Ispaghula, Kaladana, Linseed, Nutmeg, Nux vomica, Physostigma, Psyllium, Strophanthus, White mustard.
Roots and Rhizomes: Aconite, Ashwagandha, Calamus, Calumba, Colchicum corm, Dioscorea, Galanga, Garlic, Gention, Ginger, Ginseng, Glycyrrhiza, Podophyllum, Ipecac, Ipomoea, Jalap, Jatamansi, Rauwolfia, Rhubarb, Sassurea, Senega, Shatavari, Turmeric, Valerian, Squill.
Plants and Herbs: Ergot, Ephedra, Bacopa, Andrographis, Kalmegh, Yeast, Vinca, Datura, Centella.
Hair and Fibres: Cotton, Hemp, Jute, Silk, Flax.

Unorganized drugs

Dried latex: Opium, Papain
Dried Juice: Aloe, Kino
Dried extracts: Agar, Alginate, Black catechu, Pale catechu, Pectin
Waxes: Beeswax, Spermaceti, Carnauba wax
Gums: Acacia, Guar Gum, Indian Gum, Sterculia, Tragacenth
Resins: Asafoetida, Benzoin, Colophony, copaiba Guaiacum, Guggul, Mastic, Coal tar, Tar, Tolu balsam, Storax, Sandarac.
Volatile oil: Turpentine, Anise, Coriander, Peppermint, Rosemary, Sandalwood, Cinnamon, Lemon, Caraway, Dill, Clove, Eucalyptus, Nutmeg, Camphor.
Fixed oils and Fats: Arachis, Castor, Chalmoogra, Coconut, Cotton seed, Linseed, Olive, Sesame, Almond, Theobroma, Cod-liver, Halibut liver, Kokum butter.
Animal Products: Bees wax, Cantharides, Cod-liver oil, Gelatin, Halibut liver oil, Honey, Shark liver oil, shellac, Spermaceti wax, wool fat, musk, Lactose.
Fossil organism and Minerals: Bentonite, Kaolin, Kiesslguhr, Talc.

Merits

Morphological classification is more helpful to identify and detect adulteration. This system of classification is more convenient for practical study especially when the chemical nature of the drug is not clearly understood.

Demerits

- The main drawback of morphological classification is that there is no corelation of chemical constituents with the therapeutic actions.
- Repetition of drugs or plants occurs.

Pharmacological Classification

Grouping of drug according to their pharmacological action or of most important constituent or their therapeutic use is termed as pharmacological or therapeutic classification of drug. This classification is more relevant and is mostly a followed method. Drugs like digitalis, squill and strophanthus having cardiotonic action are grouped irrespective of their parts used or phylogenetic relationship or the nature of phytoconstituents they contain.

Sl. No.	Pharmacological category	Example
1.	Drug acting on G.I.T.	
	Bitter	Cinchona, Quassia, Gentian
	Carminative	Fennel, Cardamom, Mentha
	Emetic	Ipecac
	Antiamoebic	Kurchi, Ipecac
	Laxative	Agar, Isabgol, Banana
	Purgative	Senna, Castor oil
	Cathartic	Senna
2.	Drug acting on Respiratory system	
	Expectorant	Vasaka, Liquorice, Ipecac
	Antitussive	Opium (codeine)
	Bronchodilators	Ephedra, Tea
3.	Drug acting on Cardiovascular system	
	Cardio tonic	Digitalis, Strophanthus, Squill
	Cardiac depressant	Cinchona, Veratrum
	Vasoconstrictor	Ergot
	Antihypertensive	Rauwolfia
4.	Drug acting on Autonomic nervous system	
	Adrenergic	Ephedra
	Cholinergic	Physostigma, Pilocarpus
	Anticholinergic	Datura, Belladonna
5.	Drug acting on Central nervous system	
	Central analgesic	Opium (morphine)
	CNS depressant	Belladonna, Opium, Hyoscyamus
	CNS stimulant	Tea, Coffee
	Analeptic	Nuxvomica, Camphor, Lobelia
6.	Antispasmodic	Datura, Hyoscyamus, Opium, Curare
7.	Anticancer	Vinca, Podophyllum, Taxus
8.	Antirheumatic	Aconite, Colchicum, Guggal
9.	Anthalmintic	Quassia, Vidang
10.	Astringent	Catechu, Myrobalans
11.	Antimalarial	Cinchona, Artemisia
12.	Immunomodulatory	Ginseng, Ashwagandha, Tulsi
13.	Immunizing agent	Vaccines, Sera, Anti toxin
14.	Drug acting on skin membrane	Beeswax, Wool fat, Balsam of Tolu, Balsam of Peru
15.	Chemotherapeutic	Antibiotics
16.	Local Anesthetic	Coca

Merits

This system of classification can be used for suggesting substitutes of drugs, if they are not available at a particular place or point of time.

Demerits

Drugs having different action on the body get classified separately in more than one group that causes ambiguity and confusion. Cinchona is antimalarial drug because of presence of quinine but can be put under the group of drug affecting heart because of antiarrhythmic action of quinidine.

Chemical Classification

Depending upon the active constituents, the crude drugs are classified. The plants contain various constituents in them like alkaloids, glycosides, tannins, carbohydrates, saponins, etc. Irrespective of the morphological or taxonomical characters, the drugs with similar chemical constituents are grouped into the same group. The examples are shown in this table.

Sl. No.	Chemical constituent group	Examples
1.	Alkaloids	Cinchona, Datura, Vinca, Ipecac Nux vomica
2.	Glycosides	Senna, Aloe, Ginseng, Glycyrrhiza, Digitalis
3.	Carbohydrates and its derived products	Acacia, Tragacanth, Starch, Isabgol
4.	Volatile oil	Clove, Coriander, Fennel, Cinnamon, Cumin
5.	Resin and Resin combination	Benzoin, Tolu Balsam, Balsam of peru
6.	Tannins	Catechu, Tea
7.	Enzymes	Papain, Caesin, Trypsin
8.	Lipids	Beeswax, Kokum butter, Lanolin

Merits

It is a popular approach for phytochemical studies.

Demerits

Ambiguities arise when particular drugs possess a number of compounds belonging to different groups of compounds.

Chemotaxonomical Classification

This system of classification relies on the chemical similarity of a taxon, i.e. it is based on the existence of relationship between constituents in various plants. There are certain types of chemical constituents that characterize certain classes of plants. This gives birth to entirely a new concept of chemotaxonomy that utilizes chemical facts/characters for understanding the taxonomical status, relationships and the evolution of the plants.

For example, tropane alkaloids generally occur among the members of Solanaceae, thereby, serving as a chemotaxonomic marker. Similarly, other secondary plant metabolites can serve as the basis of classification of crude drugs. The berberine alkaloid in Berberis and Argemone, Rutin in Rutaceae members, Ranunculaceae alkaloids among its members, etc., are other examples.

It is the latest system of classification that gives more scope for understanding the relationship between chemical constituents, their biosynthesis and their possible action.

Serotaxonomical Classification

The serotaxonomy can be explained as the study about the application or the utility of serology in solving the taxonomical problems. Serology can be defined as the study of the antigen–antibody reaction. Antigens are those substances which can stimulate the formation of the antibody. Antibodies are highly specific protein molecule produced by plasma cells in the immune system. Protein are carriers of the taxonomical information and commonly used as antigen in serotaxonomy.

It expresses the similarities and the dissimilarities among different taxa, and these data are helpful in taxonomy. It determines the degree of similarity between species, genera, family, etc., by comparing the reaction with antigens from various plant taxa with antibodies present against a given taxon.

Serology helps in comparing nonmorphological characteristics, which helps in the taxonomical data. This technique also helps in the comparison of single proteins from different plant taxa.