A TEXT BOOK OF

PHARMACOGNOSY

FIRST YEAR DIPLOMA IN PHARMACY

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NIRALI PRAKASHAN

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1

HISTORY, DEFINITION AND SCOPE OF PHARMACOGNOSY

INTRODUCTION

The substances from plants and animal sources are being used as food since antiquity. Later on, these substances were differentiated as food stuffs and therapeutic agents, as man tried to explore and utilize these natural products for treating the ailments. Thus, their utility to remove the disorders earned them the title-**drug** (originally from French language).

(a) Hippocrates

(b) Aristotle

(c) Dioscorides

(d) Galen

Fig. 1.1 : The Great Contributors

As mentioned in *Papyrus Ebers*, an old document written in 1500 B.C., Egyptians were aware of medicinal uses of several plants and animals and also about human anatomy. The great Greek physician **Hippocrates** (460 – 360 B.C.) known as 'Father of Medicine', dealt with anatomy and physiology of human beings. **Aristotle**, the renowned philosopher (384 – 322 B.C.), is well known for his studies on animal kingdom and **Theophrastus** (370 – 287 B.C.) for plant kingdom.

Dioscorides, a Greek physician in 78 A.D. described several plants of medicinal importance in " De Materia Medica". It was **Pliny the Eider** (23 – 70 A.D.), who compiled 37 volumes of natural history. Greek Pharmacist **Galen** (131 - 200 A.D.) described various methods of preparation containing active constituents of crude drugs, and even at present the branch dealing with the extraction of plant and animal drugs is known as Galenical Pharmacy.

Gradually, all the natural products, utilized by physicians were compiled together to form the 'Materia Medica' giving their detailed information. The products from plants, animals and mineral origin are the three broad classes of naturally occurring drugs.

Indian history of medicinal plants is dated back to 3500 B.C. The curative properties of plants have been mentioned in the Suktas of *Rigveda* and *Atharvaveda*. *Ayurveda* has also described good number of plants with their therapeutic properties. The ancient well known treatises in Ayurveda are Charak Samhita and Susruta Samhita.

Definition :

While studying Sarsaparilla, it was **Seydler**, A German scientist, who coined the term Pharmacognosy in 1815 in his work entitled, "Analecta Pharmacognostica" from combination of two Greek words viz., *Pharmakon*, a drug and *gignosco*, to acquire the knowledge of. Further, **Tschirsh** made it more meaningful by restricting the term to the utilization of products from natural sources. Thus, pharmacognosy is the subject of crude drugs obtained from the plant, animal and mineral origins. It is the objective study of crude drugs of the natural sources processed scientifically. The word '**crude drug**' itself is self-explanatory and is used with the meaning of 'simple drug' and also as it exists in the natural form. The crude drugs are plant or animal drugs that have undergone no other processes than collection and drying.

Broadly, *Pharmacognosy is defined as the scientific and systematic study of structural, physical, chemical and biological characters of crude drugs along with their history, method of cultivation, collection and preparation for the market.*

The synthetic drugs do not fall within the scope of Pharmacognosy. With the recent developments in science and technology, several chemicals, which were originally found in plants and animals are synthesized at present. The reasons for their synthesis are either the scarcity or non-availability of natural drugs in which they occur, apart from the lack of knowledge of chemical processes required to extract them.

Scope of Pharmacognosy :

Most of the crude drugs are obtained from plants and only a small number comes from animal and mineral origins. Drugs obtained from plants consist of entire plants or their parts. Ephedra and datura are entire plants, while senna leaves and pods, nux-vomica seeds and cinchona bark are parts of plants. Crude drugs may also be obtained by simple physical processes like drying (opium) or extracting with water (catechu, agar).

Several other useful substances affecting health of animals and human beings are also included alongwith crude drugs in the study of Pharmacognosy. These substances include allergens, antibiotics, flavouring agents, colours, pesticides, immunizing agents, vehicles and diagnostic aids.

The following are few examples of each class of crude drugs.

Table 1.1 : Different Sources for Drugs

Source	Examples
1. Vegetable	Cinnamon, digitalis, saffron, clove.
2. Animal	Bees wax, cantharides, cod-liver oil, gelatin.
3. Mineral	Chalk, bentonite, asbestos, talc, kaolin, fuller's earth.
4. Antibiotics	Penicillin, streptomycin, tetracycline.
5. Allergens	Pollen grains, mold spores, feathers, webs
6. Immunizing agents	Vaccines, sera, antitoxins.
7. Pesticides	Pyrethrin, rotenone, nicotine.

RELATIONSHIP TO ALLIED FIELDS OF STUDY

Even though, pharmacognosy is a branch of science dealing with crude drugs, it is very important to know all other indirectly related aspects of biomedicinals. To understand crude drugs completely, various terms used to describe the vegetable drugs as covered in botany and animal drugs as covered in zoology must be known to a pharmacognosist. He should also possess knowledge of pharmacology in order to understand the actions of drugs in human body. Pharmacology, like pharmacognosy, is an outgrowth of Materia Medica. Pharmaceutical chemistry and phytochemistry are also essential to understand the chemical composition of crude drugs. The art of preparing the galenicals and the use of pharmaceutical aids are covered under the subject, pharmaceutics. Knowledge of several other subjects apart from those mentioned above is necessary for various reasons. The knowledge of the principles of genetics, plant breeding and plant pathology is essential to understand cultivation of medicinal plants. The basic knowledge of biochemistry, chemical engineering and storage technology helps us to know the principles of collection, preparation and preservation of crude drugs. Chemotaxonomy and biosynthesis are the fields, which ought to be understood for inter-relationship of active constituents and their physiological importance to the plants and animals. Pharmacognosy plays a very important role in the development of pure sciences, e.g. in descriptive botany, plant classification (taxonomy) and plant chemistry (phytochemistry).

Thus, pharmacognosy is an important liaison between pharmaceutical and all related subjects.

TRADITIONAL INDIAN SYSTEMS OF MEDICINE

Ayurveda :

The system of Ayurveda-Ancient Science of Life-originated in India about 3000 years ago. It is one of the oldest systems of medicine identified exclusively with ancient Indian civilization and dealing with both preventive and curative aspects of life. The principles of positive health and therapeutic measures embedded in this system relate to mental, physical, social and spiritual welfare of human beings. Ayurveda encompasses the knowledge of Kayachikitsa (Internal medicine), Kaumarbhritya (Paediatrics), Trahchikitsa (Psychological medicine), Shalakya Tantra (Otorhinolaryngology and Ophthalmology), Shalya Tantra (Surgery) Agada Tantra (Toxicology), Rasayana Tantra (Geriatrics) and Vajikarana Tantra (Eugenics and Aphrodisiacs).

The Pharmacopoeia of Ayurveda consists of more than 8000 recipies made of natural drugs derived from herbal, mineral, animal and marine sources. These are used singly or in combinations and in varied forms such as decoctions, infusions, distillates, extracted juices, powders, pills, tablets, syrups, fermented liquids, bhasmas, medicated oils etc.

SIDDHA SYSTEM OF MEDICINE

The term ' Siddha ' means achievement and ' Siddhars ' were saintly personalities,who attained proficiency in medicine through practice of Bhakti and Yoga. This is the system of pre-vedic period identified with Dravidian culture and it is largely therapeutic in nature. Like Ayurveda, this system believes that all objects in universe are made up of five basic elements namely, earth, water, sky, fire and air. The identification of causative factors of diseases is done through pulse reading, colour of body, study of voice, urine examination, status of digestive system and examination of tongue. The literature of Siddha system is mostly in Tamil.

Few natural drugs used in Siddha system of medicine are :

Abini	:	(Papaver – somniferum),
Alari	:	(Nerium – Indicum),
Ethi	:	(Strychnous – Nux vomica),
Gomathi	:	(Datura – stramonium),
Haikalli	:	(Ephorbia – nerifolia),
Rotha Polam	:	(Aloe – barbadensis)

NATUROPATHY AND YOGA

Naturopathy is not merely a system of treatment; but also a way of life, which is based on laws of nature. The attention is particularly paid to eating and living habits, adoption of purificatory measures, use of hydrotherapy, mud packs, baths, massage etc.

The system of Yoga is as old as Ayurveda. The eight components of Yoga are restraint, observance of austerity, physical postures, restraining of sense organs, breathing exercises, contemplation, meditation and samadhi. Yoga exercises have potential in improvement of better circulation of oxygenated blood in the body, restraining the sense organs, improvement of social and personal behaviour and induction of tranquility and serenity in the mind.

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2

DRUGS AND PHARMACEUTICAL AIDS OF NATURAL ORIGIN

INTRODUCTION

Though, a pharmacist is responsible for the entire process of manufacturing the pharmaceutical products, isolation or extraction of active principles from crude drugs has become a chemical or biochemical operation, rather than a pharmaceutical one. Drugs are rarely administered in singular form. They are essentially mixed with various types of additives or adjuncts or converted them into effective drugs. Thus, a pharmacist during the manufacturing process of dosage forms comes across the actual drugs and the adjuncts used alongwith them.

DRUGS

Etymological survey reveals that the word drug has its origin in French language and has been derived from the word *drogue*, which means any substance used in preparation of medicine. However, at present the term drug includes not only the medicines, but several other related substances without any pharmacological action.

Technically and legally the term drug as defined in India under Drugs and Cosmetics Act of 1940 reads as follows :

1. All medicines for internal or external use of human beings or animals and all substances intended to be used for or in diagnosis, treatment, mitigation or prevention of disease in human beings or animals.

2. Such substances, other than food, intended to affect the structure or any function of the human body or intended to be used for the destruction of vermin or insects, which

cause disease in human beings or animals as may be specified from time to time by the Central Government by notification in Official Gazette.

Hence, apart from the therapeutic agents, diluting agents, vehicles, flavours, colours and many other pharmaceutical aids from animal, vegetable or mineral origin confirming to above limitations are also covered under the term ' drug '.

In recent years, investigation of natural products has produced large number of potential drugs and many of them are used for several other purposes in various industries. Drugs from natural origin are being used suitably in confectioneries, food industries and beverages; as spices and condiments and for other purposes as technical products. The following illustrations indicate their industrial applications other than as drugs. Papain, proteolytic enzyme from papaya, is used in beer industry to remove the chill-haze, liquorice in chewing tobacco, oleoresin of ginger in soft drink industry, tea and coffee as beverage, cloves as condiment, oil of mentha as flavouring agent and pectin in food industry. Oil of linseed is heavily consumed in paint and varnish industry, colophony in paper manufacture, starches as sizing agents in textile industry and several volatile oils are used in perfumery.

The medicinal importance of plants in the treatment of human ailments is immense and has been so since the dawn of civilization. Until the beginning of the era of natural product chemistry in the beginning of twentieth century, the chemical composition of crude drugs remained ill defined in a structural sense. The majority of phytopharmaceuticals are derived from Spermatophyta. Some useful resins, oils and ephedrine are obtained from species of Gymnospermae, while Angiospermae provides a variety of useful drugs. Algae are a source of limited number of drugs such as agar and alginic acid. The fungi provides a number of life saving drugs especially antibiotics and ergot alkaloids. The microbial preparations include vaccines (viral, rickettsial, bacterial and toxoids). The animal derived drugs are hormones, animal extractives, enzymes, insects, fish oils and gelatin. Currently, useful marine products are protamine, pralidoxine kainic acid and agar. The phytopharmaceuticals of commercial significance from higher plants are quinine, quinidine, nicotine, tropane alkaloids-scopolamine and atropine, emetine, caffeine, sennosides, vinca alkaloids, reserpine, xanthotoxin, psoralen, pyrethrins, morphine and other opium alkaloids, diosgenin, solasodine, digoxin and lanatosides, volatile oils from sandal wood, umbelliferous fruits, rose, vetiver, lemon, lemon-grass, etc. spices and other products.

PHARMACEUTICAL AIDS OF NATURAL ORIGIN

The substances, which are of little or no therapeutic value, but are essentially used in manufacture or compounding of various pharmaceuticals are known as pharmaceutical aids or pharmaceutical necessities (Table 2.1).

They are obtained from various sources such as animals, vegetables, minerals and purely synthetic. Since the synthetic compounds are not covered in pharmacognosy, the substances other than synthetic source shall be dealt with in this book.

Table 2.1 : Sources of Pharmaceutical Aids

Animal	Vegetable	Mineral	Synthetic
Bees Wax	Balsam of tolu	Bentonite	Acetic acid
Civet	Carnauba wax	Kieselguhr	Boric acid
Cochineal	Cocoa	Kaolin	Calcium stearate
Gelatin	Cardamom	Paraffin	Citric acid
Honey	Colophony	Pumice	Dextrose
Lactose	Peppermint	Talc	Lactic acid
Musk	Pectin	Calamine	
Spermaceti	Starch	Asbestos	
Wool fat	Vanilla	Chalk	

Depending upon the use or application, pharmaceutical aids from different sources can be classified as shown in Table 2.2.

Table 2.2 : Classification of Pharmaceutical Aids

Class	Examples
1. Acidulents	1. Tamarind, lemon juice
2. Colours	2. Caramel, cochineal, turmeric, saffron, indigo, chlorophyll, β-carotene.

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Class	Examples
3. Disintegrating agents	3. Starch, psyllium husk, CMC, microcrystalline cellulose.
4. Diluents	4. Cinnamon water, peppermint water, corn oil, peanut oil, wild cherry syrup, seasame oil, glucose, lactose.
5. Emulsifying and suspending agents	5. Acacia, agar, alginic acid, bentonite, methyl cellulose, gelatin, tragacanth, guar gum.
6. Filter aids	6. Talc, bentonite, kieselguhr.
7. Flavours	7. Cardamom, cinnamon, rose, benzaldehyde, anethol, cocoa, lemon oil, orange peel, nutmeg.
8. Hardening agents	8. Bees wax, hard paraffin.
9. Lubricants	9. Talc, cocoa butter, magnesium stearate.
10. Ointment bases	10. Bees wax, lanolin, polyethylene glycol, paraffin, petroleum jelly, spermaceti, wool fat.
11. Solvents	11. Alcohol, glycerine, propylene glycol, triethanolamine.
12. Sweetening agents	12. Glycyrrhiza, honey, sorbitol, saccharin.
13. Thicknening agents	13. Pectin, tragacanth, methyl cellulose.
14. Vehicles	14. Arachis oil, honey, sesame oil.

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3

CLASSIFICATION OF NATURAL DRUGS

INTRODUCTION

The crude drugs obtained from different natural sources are used in treatment of wide spectrum of diseases. For their adequate study, it is necessary to arrange them in scientific and systematic manner. Their huge number and varied occurrence make it difficult to put them in a uniform pattern.

For pharmacognostic study, crude drugs can be arranged in one of the following classes.

1. ALPHABETICAL CLASSIFICATION

Either the Latin names or English names of drugs are considered for this purpose of classification. This classification is adopted by the following books.

1. British Pharmacopoeia (English).
2. British Pharmaceutical Codex (English).
3. United States Pharmacopoeia (English).
4. Pharmacopoeia Internationalis (Latin).
5. Indian Pharmacopoeia (English).
6. British Herbal Pharmacopoeia (English).

However, this type of classification does not help in distinguishing the drugs from plants, animals or mineral sources and also does not indicate whether they are organised or unorganised.

2. TAXONOMICAL CLASSIFICATION

It is a type of biological classification and restricted mainly to crude drugs from plant source. It indicates the phylum, class, sub-class, order, family, genus and species of the crude drugs. It is criticized for its failure to recognise the organised or unorganised nature of crude drugs in their morphological studies. The taxonomical system of classification can be elaborated further as follows (Table 3.1).

Table 3.1 : Illustration of Taxonomical Classification

Class	Order	Family	Drugs
I. Gymnospermae	-	Ephedraceae	Ephedra
II. Angiospermae			
Subclass :	-	Graminae	Rice, Wheat, Maize
Monocotyledonae		Liliaceae	Aloe, colchicum
Subclass :		Zinzeberaceae	Cardamom, turmeric
Dicotyledonae	Rutales	Rutaceae	Buchu, orange peel, bael, lemon peel.
	Rosales	Rosaceae	Wild cherry bark, quillaia bark, almond oil, rose oil.
	Rosales	Leguminosae	Glycyrrhiza, balsam tolu, tragacanth, senna, tamarind.
	Umbelliflorae	Umbelliferae	Asafoetida, caraway, fennel,
	Contortae	Apocynaceae	Kurchi, rauwolfia, Strophanthus, vinca
	Tubiflorae	Solanaceae	Belladonna, datura, capsicum, hyoscyamus

Animal drugs are classified as fishes, arthropods, mammals etc. Most of the crude drugs do not represent whole plants or animals. Minerals get excluded from this classification.

3. MORPHOLOGICAL CLASSIFICATION

In this type of classification, the crude drugs are divided into the parts of plants like leaves, fruits, flowers, woods, barks, dried lattices, extracts, gums etc. (Table 3.2).

Table 3.2 : Illustration of Morphological Classification

Part of Plant	Drugs
Woods	Quassia, guaiacum, sandalwood.
Barks	Arjuna, cinchona, kurchi, cascara, cinnamon.
Flowers	Clove, rose, saffron, santonica, pyrethrum.
Leaves	Coca, digitalis, senna, vasaka, eucalyptus.
Fruits	Bael, colocynth, lemon, orange, fennel, coriander.
Seeds	Linseed, nutmeg, colchicum, nux-vomica.
Subterranean-parts	Ginger, turmeric, aconite, rauwolfia, podophyllum, colchicum corm, squill, rhubarb.
Entire organisms	Ephedra, ergot, cannabis, lobelia, belladonna herb, cochineal, cantharides.
Gums	Acacia, tragacanth, sterculia, guar, ghatti.
Latices	Opium, papaya, Gutta purcha, rubber
Dried juices	Aloe, kino, red gum.
Extracts	Catechu, agar, gelatin.

This type of classification is more convenient for practical purposes. Even if the chemical nature is not known, a drug can be studied for pharmacognostic character. This type of classification is very useful in identifying the adulterants used.

Since some drugs do not represent the exact morphological part, it is difficult to classify them properly. In the natural state, crude drugs from plant source can be readily distinguished. But operations like collection, drying, preparation for the market produce distortion of the natural form making their recognition very difficult. The morphological characteristics, however, do not reflect on chemical composition and biological behaviour of a crude drug. Animal drugs and minerals are difficult to classify by this method.

4. PHARMACOLOGICAL CLASSIFICATION

Under this system of classification, the drugs are classified according to pharmacological actions of their chief constituents (Fig. 3.1). Thus, the drugs similar in their action are put together, regardless of their morphology, biological behaviour and chemical nature (Table 3.3).

Table 3.3 : Illustration of Pharmacological Classification

Pharmacological action	Examples
Carminatives	Coriander, caraway, cinnamon, clove.
Purgatives	Cascara-sagrada, aloe, senna, rhubarb,
Cardiotonics	Digitalis, squill, strophanthus, thevetia, arjuna
Anthelmintics	Artemisia, male-fern, quassia.
Anti-cancer	Podophyllum, vinca, taxus .
Anti-spasmodics	Hyoscyamus, datura, stramonium.
Anti-amoebic	Kurchi, ipecacuanha.
Bitters	Gentian, cinchona, nux-vomica.

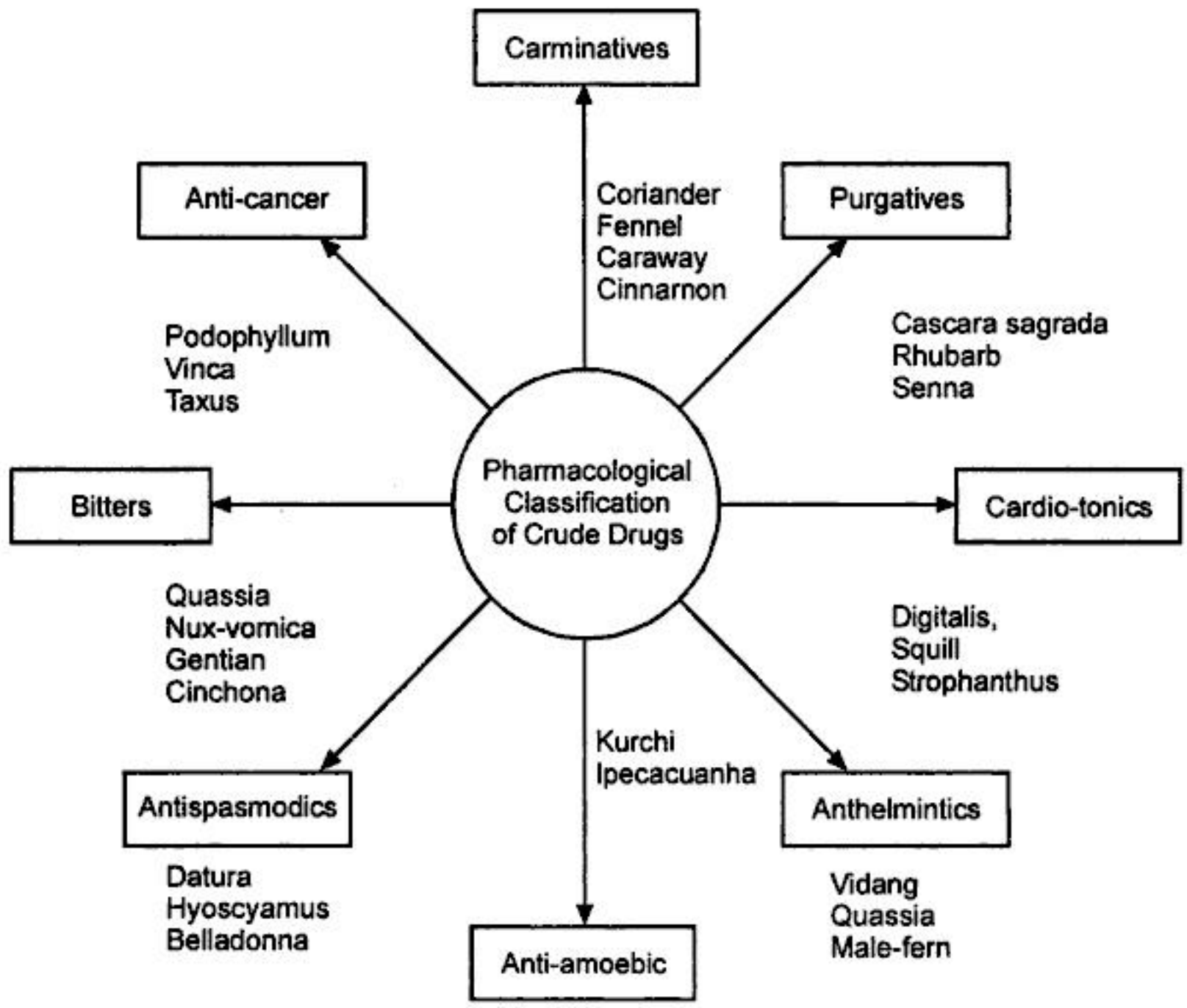

Fig. 3.1 : Pharmacological Classification of Crude Drugs

The special advantages which the method enjoys is that, even if the contents of the crude drugs are not known, they can be classified properly on the basis of therapeutic or pharmacological property.

Crude drugs used as Pharmaceutical aids do not find any place in this class.

However, the drugs which are dissimilar in their action of mechanism, even though their therapeutic effect is same (e.g. bulk purgatives, irritant purgatives etc.) are put together. It is also possible that the same drug with two different actions on the body, may be classified separately at both the places. For example, cinchona is grouped as antimalarial and bitter and nux-vomica as bitter and stimulant.

5. CHEMICAL CLASSIFICATION

This type of classification is applicable to crude drugs containing similar type of chemicals (Table 3.4). It is useful for phytochemical studies of crude drugs.

Table 3.4 : Illustrations of Chemical Classification

Type of Chemical	Examples
Alkaloids	Aconite, cinchona, nux-vomica, vinca, ipecac, belladonna, opium, tea.
Glycosides	Digitalis, senna, squill, aloe, dioscorea, liquorice, wild cherry.
Lipids	Castor oil, peanut oil, mustard, wool fat, cod-liver oil.
Volatile oils	Peppermint, clove, eucalyptus, valerian.
Tannins	Myrobalan, kino, catechu, galls.
Vitamins	Yeast, cod-liver oil, shark-liver oil.
Resins and resin combinations	Benzoin, balsam tolu, storax, asafoetida, myrrh colophony, guggul, shellac.
Carbohydrates & derived products	Agar, honey, starch, tragacanth, acacia, guar gum, sterculia.

However, this type of classification fails in proper placement of drugs containing two different types of chemicals. For example, certain drugs are found to contain alkaloids and glycosides (cinchona), fixed oil and volatile oil (nutmeg), fixed oil and enzyme (bitter almond) together and hence makes it difficult to categorize them properly.

Eventhough, much importance is attached to this type of classification at present, morphological system is the method of choice for practical purposes.

6. CHEMOTAXONOMICAL CLASSIFICATION

This is a recent approach to the study of classification of crude drugs, wherein equal importance is given to their taxonomy and biogenesis. The phytochemical screening of several drugs has revealed that there is a close relationship between chemical contents of the plant and its taxonomical status. Earlier workers classified the algae into red, green and brown varieties, but it was only during last three decades that modern methods of extraction and characterization of phytoconstituents have led to the chemical screening of many thousands of plant species. The status of berberine, rutin and other flavonoids in species of higher plants is of chemotaxonomical significance.

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4

INTRODUCTION TO PARTS OF A PLANT

INTRODUCTION

Either single or various parts of the same plant can be used as source of drug and hence it becomes necessary to know various parts of a plant scientifically. Natural drugs may either constitute cellular or acellular organ of the plant. Cellular drugs are broadly known as organised crude drugs whereas acellular drugs as unorganised crude-drugs.

Before dealing with the drugs in details, one should know how to distinguish clearly between organised (cellular) and unorganised (acellular) crude drugs.

Table 4.1 : Difference between Organised and Unorganised Drugs

Organised crude drugs	Unorganised crude drugs
1. As the term indicates these are 'organs' of plants or animals and are made up of cells or definite structure. These drugs are named as flowers, seeds, fruits, insects etc.	1. These are derived from parts of plant or animal by some process of extraction and followed by purification, if necessary, e.g. juices, extracts, resins etc.
2. These are solid in nature.	2. These are solid, semisolid or liquids in nature, e.g., oils and balsams.
3. Botanical or zoological terminology can be used to describe these drugs.	3. Such terminology is inadequate to describe them, but one has to look for their physical characters, such as the solubility in various solvents, density, optical rotation, refractive index, whichever is applicable.

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4. Microscopic characters are one of the important criteria for the identification of organised drugs. **Examples :** Digitalis, cinchona, clove, fennel, jalap, ephedra, cochineal etc.	4. Chemical tests and physical standards are confirmatory tests for identification of these drugs. **Examples :** Aloe, agar, colophony, opium, castor oil, bees-wax, pepsin etc.

ORGANISED DRUGS

I. LEAVES

There are several leaves, which find use in the practice of pharmacy. Leaves are flat, thin, green appendages to the stem, containing, supporting and conducting strands in their structures.

In pharmacognosy, the word leaf includes leaf, compound leaf and leaflets. Depending upon their biological sources, leaves, many a time, include the flowering tops. In certain cases, the minimum percentage of active constituents is specified. The basic difference between the leaf and the leaflet is as follows.

Table 4.2 : Difference between Leaf and Leaflet

Leaf	Leaflet
1. In case of leaves, bud or branch is present in the axil.	It is absent in leaflets.
2. Leaves are arranged spirally and they are solitary in nature.	Leaflets are arranged in pairs.
3. Leaves lie in different planes.	Leaflets lie in the same plane.
4. Leaves are generally symmetrical at the bases, e.g. digitalis, belladonna, vasaka	Leaflets are asymmetrical at the bases, e.g. senna, neem, rose.

Apart from the normal characteristics i.e. their arrangement on the stems, their apices, margin, petiole, presence or absence of stipules etc., leaves are characterized by certain diagnostic structures. Most of these diagnostic characters are microscopic one, such as stomata and trichomes, stomatal index palisade ratio, vein islet number etc. All these characteristics shall be referred in detail under microscopic characters of the leaves.

Collection of Leaves :

The procurement of leaves depend on several factors and varies from leaf to leaf. One should have thorough knowledge of chemical constituents of leaves and the chemical changes which might take place in normal atmospheric conditions. Medicinal leaves are collected during the flowering season of plants, when the plants reach maturity and they are photosynthetically most active. If the leaves contain volatile oil, irrespective of the other facts, they are generally collected when the plant is rich in volatile oil content. The

weather and time of collection is also very important for procurement of drugs. Dry weather with minimum humidity is ideal in most of the cases for plucking the leaves. Digitalis leaves are collected in dry weather, generally in the afternoon. Coca leaves are collected, when they are nearly ready to fall from the stems. The discoloration of leaves is undesirable, while the leaves of substandard quality fetch less value in the market.

Preparation of the Leaves for the Market :

The leaves after drying are graded as broken and entire leaves or depending upon their colour. Tossing and sieving are also done in many of the cases. The packaging of leaves is likely to affect quality of the drug. In order to maintain the quality and potency of leaves, wherever necessary, leaves should be packed in air-tight containers protected from light and moisture.

Diagnostic Characters of Leaves :

Apart from shape, size and colour, leaves are characterized by several microscopic structures which help in their proper identification. Following are few diagnostic characters of common occurrence.

[A] Stomata :

Epidermis of leaf shows different characteristics, e.g. cutical stomata, trichomes, water-pore, cell inclusions, etc. A Stoma is a minute epidermal opening with following characteristics.

(i) A central pore .

(ii) Two kidney shaped similar cells containing chloroplasts known as guard cells and varying number of subsidiary (epidermal) cells covering the guard cells.

Stomata perform two functions in the plant body. The primary and most important function of stomata is gaseous exchange and the secondary function is transpiration.

It is not essential that each plant must have stomata. The leaves of bryophytes and submerged leaves of aquatic parts do not contain stomata. Generally, stomata are present in green parts of the plant (mostly leaves), but absent in roots. Apart from the leaves, they are also present in the stems (ephedra), flowers (clove), and fruits (fennel). However, it is generally observed that stomata are abundantly present in dicot leaves. In some cases, they are present on the upper surface of leaves, while in others on lower surface only (coca and cherry). In some, the stomata are present on both surfaces of the leaves (senna, belladonna, datura etc.). The distribution of stomata between upper and lower epidermis in dicot leaves shows great variation.

Types of Stomata : Depending upon the type of the guard cells and arrangement of subsidiary cells, stomata are divided into four types.

1. Moss type.
2. Gymnospermous type.
3. Gramineous type.
4. Dicotyledonous type.

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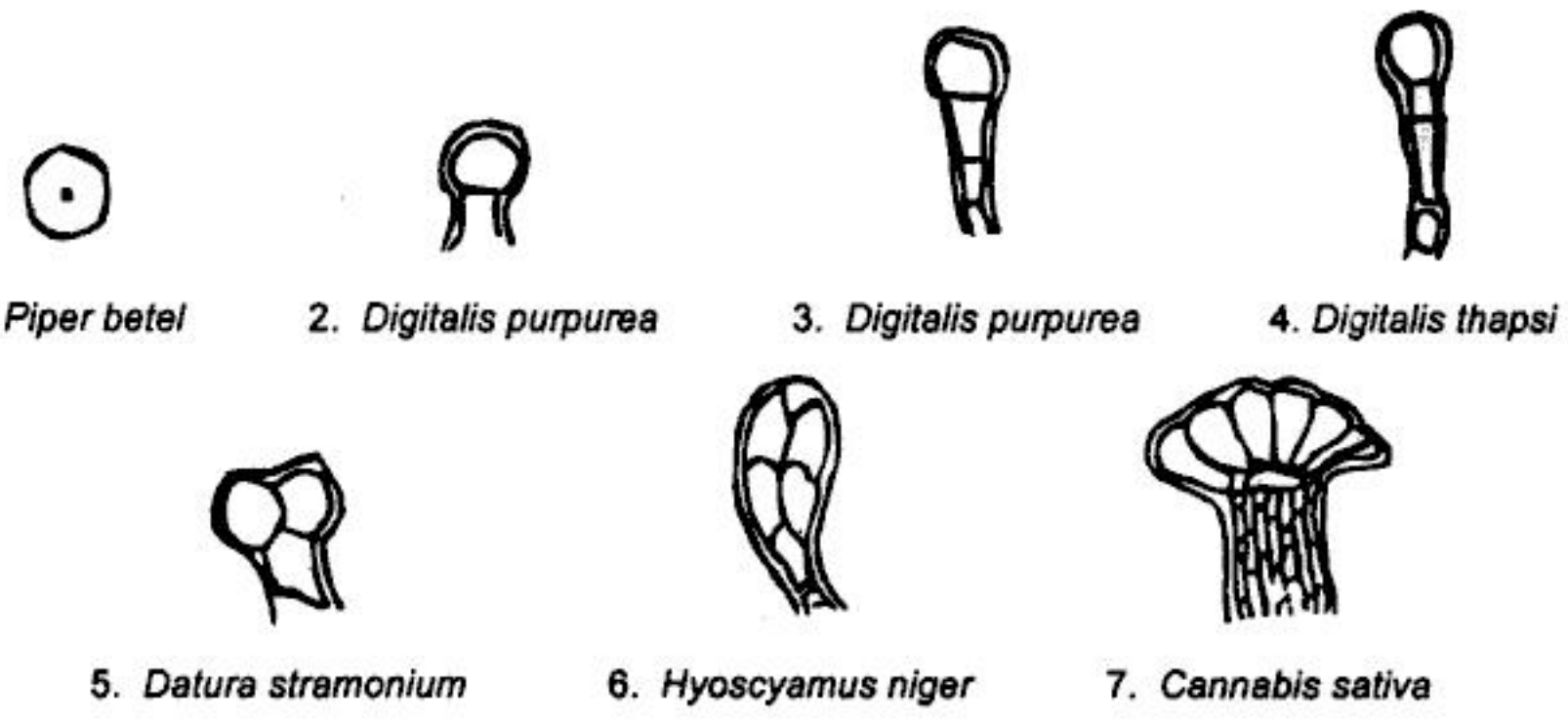

1. *Piper betel* 2. *Digitalis purpurea* 3. *Digitalis purpurea* 4. *Digitalis thapsi*

5. *Datura stramonium* 6. *Hyoscyamus niger* 7. *Cannabis sativa*

Fig. 4.4 (b) : Examples of Glandular Trichomes - Multicellular

2. Multicellular glandular trichomes :

1. Trichomes with unicellular head and unicellular stalk, e.g. *Digitalis purpurea.*
2. Unicellular head and uniseriate multicellular stalk, e.g. *Digitalis thapsi,* belladonna etc.
3. Multicellular head, multicellular, biseriate stalk, e.g. Santonica and plants of Compositae, such as sunflower etc.
4. Unicellular stalk and biseriate head, e.g. *Digitalis purpurea.*
5. Short stalk with secreting head formed of rosette or club shaped cells, e.g. *Mentha species.*
6. Trichomes with multicellular, multiseriate, cylindrical stalk and a rosette of secretary cells, e.g. *Cannabis sativa.*
7. Multicellular multisteriate head and multicellular uniseriate stalk, e.g. Indian hemp and tobacco.

[C] Hydathode or special types of trichomes :

These are the organs of absorption or secretion of water developed in certain plants e.g. *Piper betel,* London pride etc.

Emergences (Prickles) :

Emergences are also small outgrowths on the epidermal walls of the aerial parts of the plants. They are epidermal and sub-epidermal in origin. They may be present on the stems or fruits like trichomes. Emergences are not microscopic structures. They are hard many a times, stout in nature and meant for plant protection.

II. BARKS

The secondary external tissues lying outside the cambium in stem or root of dicotyledonous plants, are known as the bark.

Botanically, bark is also known as periderm. Periderm consists of three layers viz., cork (phellem) ; cork-cambium (phellogen) and secondary cortex (phelloderm). Commercially, barks consist of all the tissues outside the cambium. A young bark includes epidermis, cortex, pericycle and phloem. Barks are obtained from the plants by making longitudinal and transverse incisions through the outer layers followed by peeling. Barks may be obtained from stems or roots. Due to the excessive growth produced by the cambium and cork cambium, the external tissues get tangentially stretched or torn and hence, the epidermis is not found in the barks.

Characteristics of Barks :

Barks exhibit several morphological and microscopical characters. The morphological characters need special attention, as they help in identification of the barks.

Shapes in Barks :

The shape or form of the bark is dependent upon the method adopted for its preparation. It also depends on the type of incision made and the extent of any subsequent shrinkage of the tissues. When the bark is removed from the large trees and dried under pressure, the flats are produced, e.g. quillaia and arjuna. When the bark is removed from the small branches due to shrinkage of the soft tissues, it tends to curve forming concavity on the inner side, yielding *curved* pieces, e.g. wild cherry and cassia. If the concavity is on the outer side of the bark, it is described as recurved, e.g. kurchi. When the shrinkage of the tissues is to a greater extent and it forms deep trough or channel, it is called a *channelled bark*, e.g. ashoka, *Cinchona ledgeriana* and cassia. In some cases, one edge of a bark covers the other to form quill, e.g. cascara and cinnamon. If both the edges of the bark roll independently forming quill, it is described as *double quill* e.g. Java cinnamon. In some cases, one quill of a bark is put inside other quill to form a *compound quill*, e.g. cinnamon. Compound quill is a man-made shape of bark. It reduces the exposure of bark to atmospheric conditions and also saves the space in transport (Fig. 4.5).

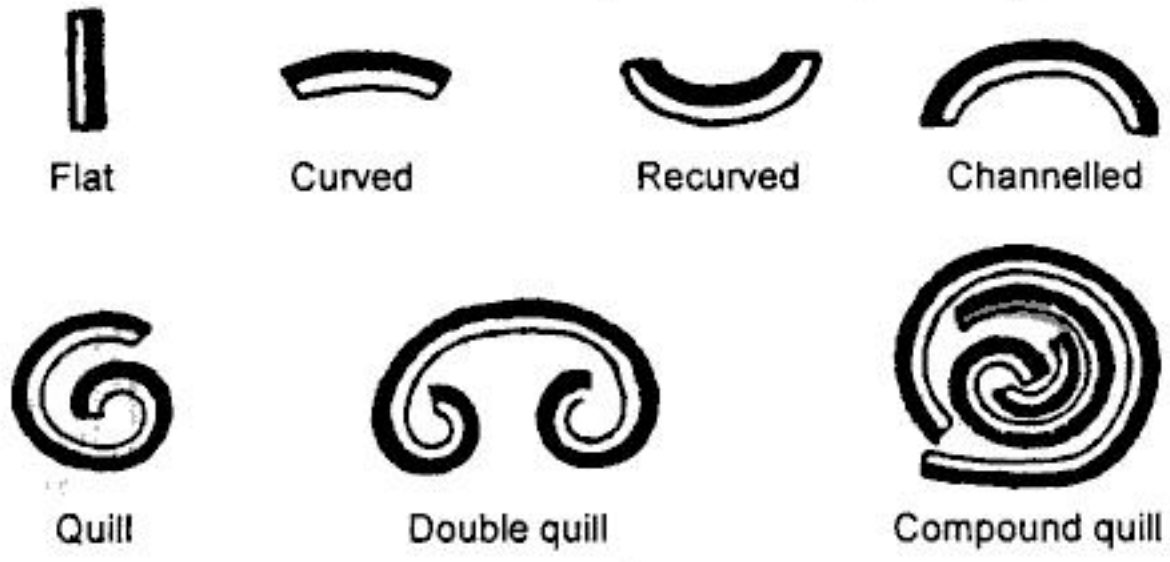

Fig. 4.5 : Shapes in Barks

Fractures in Bark :

The appearance shown by the transversely broken surfaces of the bark is known as *fracture*. It is, sometimes, useful in identification of barks. The types of the fractures are as follows.

When fractured surface is smooth, it is described as a short fracture (cinnamon and kurchi). If the exposed surface exhibits small rounded appearance, it is described as a *granular* fracture (wild cherry and cassia). If, the broken surface shows the presence of uneven projecting points, it is described as *splintery* fracture, as seen in cinnamon. The presence of numerous fibres on the transversely broken surface is described as a fibrous fracture (cinchona). If the exposed surface shows the arrangements of layers one over the other, it is described as a *laminated* fracture, as observed in quillaia.

The various characters shown by the barks on the outer, as well as inner surface are also diagnostically important. Amongst these, the colour, condition and presence of several growths like lichens, mosses etc., are characteristic to each bark. The presence of lenticels and development of cracks are additional characters of bark. Outer surface of the bark shows presence of cracks and fissures, which are due to lack of elasticity or due to increase in girth of the trees. *Fissures* are usually deep. *Wrinkles*, which are seen on outer surface of the bark, result due to shrinkage of inside soft tissues. *Furrows* are troughs between wrinkles. Inner surface of bark shows characteristics such as *striations*, which are longitudinal and parallel lines. Transverse wrinkles present on inner surface are described as *corrugations*.

Methods of Collecting Barks :

Barks are collected in a season when they contain maximum concentration of active constituent. Cinnamon is collected in rainy season, while wild cherry is collected in autumn. Following are the methods of collecting barks.

1. **Felling method :** This is a very old method of collecting barks. The tree is cut at base and bark is peeled out. This method is not used at present commercially, since it causes total destruction of trees.

2. **Uprooting method :** In this case, the roots of plant are dug out of soil and bark is stripped off from roots and branches. This method is applied for collection of root bark of cinchona in Java.

3. **Coppicing method :** In this method, the plant is allowed to grow for a definite period and then it is cut off at specific distance from soil. The stumps, which remain in ground are allowed to send shoots, which develop further independently yielding aerial parts. These new parts are cut off and bark is collected from shoots. As compared to other methods of collection of bark, this technique is more economical and less time-consuming. It is, therefore, the method of choice for collecting barks commercially. Cascara and cinnamon are collected by this method.

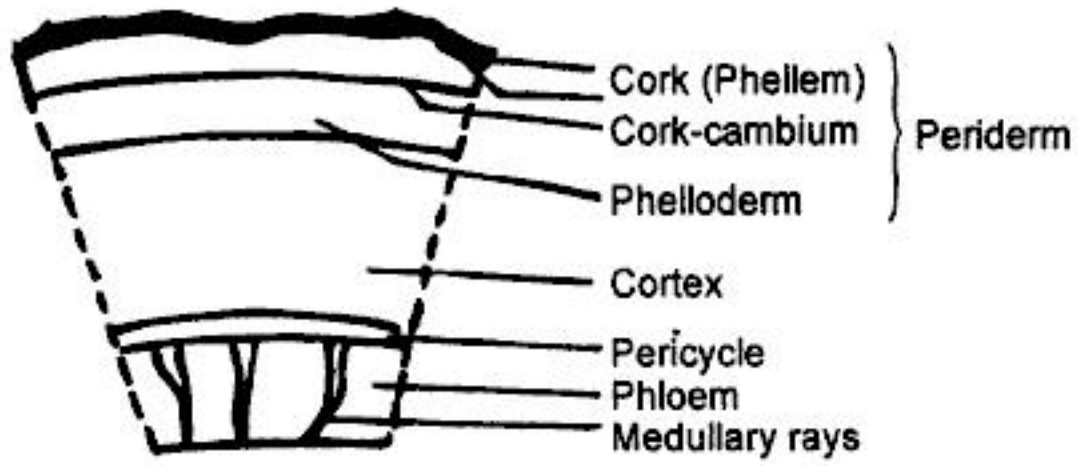

Fig. 4.6 : Microscopic Structure of Bark

Microscopic characters of Barks :

General microscopic characteristics of barks are represented in Fig. 4.6. Depending upon several factors such as exfoliation of bark or special technique of preparation of bark for market as in case of cinnamon, histological structures may vary from bark to bark.

III. STEMS

The stem is an ascending axis of the plant developed from the plumule. It consists of nodes, internodes and buds and it gives rise to branches, leaves and flowers. The stem may be aerial, sub aerial and underground. Depending upon the presence of mechanical tissues, the stems may be weak, herbaceous or woody.

1. **Weak stems :** When the stems are thin and long, they are unable to stand erect and hence may be one of the following types.

   (a) **Creepers or prostate stems :** They grow flat on the ground without roots, e.g. grasses, gokharu etc.

   (b) **Climbers :** These are too weak to stand alone. They climb on the support with the help of tendrils, hooks, prickles or roots, e.g. *Piper betel, Piper longum*.

   (c) **Twinners :** These coil the support and grow further. They are thin and wiry, e.g. Ipomoea and Phaseolus.

2. **Herbaceous or woody stems :** These are the normal stems and may be soft or hard and woody, e.g. sunflower, sugarcane, ephedra etc.

IV. WOODS

In case of dicotyledonous plants, the tissues produced by cambium on inner side are collectively known as wood. Thus, it consists mainly of secondary xylem and smaller amount of other tissues. The cells forming these tissues are highly lignified. Commercially, two types of wood are available, heart wood or duramen and sap wood or alburnum.

1. **Heart wood :** It consists of the innermost central region of dicot stem or root, which is non-functioning, non-living and dark coloured part due to presence of several chemical substances like tannins, pigments, gums, resins etc. It gives mechanical support, e.g. sandal wood.

2. Sap wood : It is the outer region of the wood, which is the only functional wood conducting water and food material to plant and is lighter in colour, e.g. quassia.

The transverse section of wood shows, annual rings, which represent season's growth. The wood formed in spring is known as spring wood, while the wood formed in winter is known as autumn wood. In some cases annual rings are not marked due to absence of seasonal interruption and hence they are known as false annual rings.

The wood in which spring vessels are arranged more or less in a ring, is described as 'ring porous wood', e.g. oak. When spring vessels are distributed uniformly throughout 'whole spring wood', the wood is described as 'diffuse porous wood' e.g. quassia. The arrangement of fibres in wood also decides nature of the wood. When the fibres are straight and arranged parallel, resulting in a smooth and uniform fracture, the wood is described as 'straight grained-wood'. If fibres in the wood are arranged at an angle roughly 30°, the wood shall not break easily and result in an irregular and splintery fracture. It is, then, described to possess inter-locked grain as in guaiacum.

V. FLOWERS

The flower is a modified shoot meant for production of seeds.

A typical flower consists of four different circles (whorls) arranged in a definite manner. A flower is built upon stem or pedicel with the enlarged end known as thalamus or receptacle. The four whorls of the flowers can be described as under :

1. Calyx : It is the outermost whorl of flower and is generally green in colour. The individual member of calyx is called sepal.

2. Corolla : It is the second whorl of flower and is either white or bright coloured. Each member of corolla is known as petal. The number of petals varies with the type of flower.

3. Androecium : It is the third circle of flower and constitutes the male part. The individual component is called as stamen and each stamen consists of filament, anther and connective.

4. Gynoecium : This is the fourth circle of the flower and constitutes the female part. Each component is known as carpel or pistil and is made of stigma, style and ovary.

In pharmacognosy, the drugs to be studied as flowers are either entire flowers in botanical sense or the inflorescence or single part of the flower, used medicinally. The following are few examples of different parts of flowers.

1. Inflorescence

(a)	Raceme	Digitalis, mustard.
(b)	Panicle (compound raceme)	Goldmohar.
(c)	Capitula (Head)	Chamomile, arnica, artemisia, sunflower, pyrethrum.
(d)	Umbel	Caraway, fennel.
(e)	Cymose	Jasmine
(f)	Hypanthodium	Fig

2.	Stigmas	Saffron
3.	Corolla and stamens	Elder flowers.
4.	Petals	Rose, red poppy.
5.	Flower buds	Cloves.

Collection and Drying of Flowers :

For pharmaceutical purposes, flowers are dried in shade, so as to retain their colour and volatile oil content, if any. They are collected in dry weather and preferably during morning hours.

VI. FRUITS

The phanerogams are said to be matured, when they reach the flowering stage. The ovules of the flowers, after fertilization, get converted into seeds, whereas the ovary wall develops further to form the protective covering over the seeds, which is known as *fruit*. In botany, this particular coating is also called *pericarp*.

Pericarp consists of three different layers.

1. **Epicarp :** It is the outermost coating of the pericarp and may be thin, thick or woody.
2. **Mesocarp :** A layer in-between epicarp and endocarp, may be pulpy or made up of spongy parenchymatous tissue.
3. **Endocarp :** The innermost layer of the pericarp, may be thin, thick or even woody.

It is not necessary that the fruits should have seeds. If the ovules do not fertilize, the seedless fruits are formed. Depending upon the number of carpels present in the flowers and other structure, the fruits fall into following categories :

1. Simple fruits,
2. Aggregate fruits, and
3. Compound fruits.

1. Simple fruits : These are formed from the single carpel or from syncarpous gynaecium. Depending upon the mesocarp, whether it is dry or fleshy, they are classified as dry fruits and fleshy fruits. Dry fruits are further classified into dehiscent and indehiscent fruits.

2. Aggregate fruits : These fruits are formed from many carpels or apocarpous gynaecium.

3. Compound fruits : In this particular case, many more flowers come together and form the fruits.

False Fruits : Sometimes, apart from the ovary the other floral parts like thalamus, receptacle or calyx grow and form the part of the fruit and such a fruit is known as false

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7

ADULTERATION, DRUG EVALUATION AND SIGNIFICANCE OF PHARMACOPOEIAL STANDARDS

INTRODUCTION

Adulteration is the debasement of an article. An adulterant resembles the genuine drug in respect to its morphological appearance.

METHODS OF ADULTERATING THE DRUGS

The extent of adulteration depends upon whether the drug is indigenous or obtained from other countries. The reasons for adulteration are either scarcity or the high price of drug in the market. An adulteration of a drug may be deliberate or accidental. Adulteration is very common with drugs, which are sold illegally. Adulteration involves different conditions such as inferiority, spoilage deterioration, admixture, sophistication and substitution. Inferiority refers to any sub-standard drug, whereas spoilage could be due to attack of micro-organisms. Deterioration means impairment in quality of the drug, whereas admixture is the addition of one article to other through ignorance, carelessness or an accident. Sophistication means intentional or deliberate kind of adulteration. Substitution occurs when an entirely different article is sold or used in place of one required.

The different means for adulterating drugs are as follows :

1. **Replacement by exhausted drugs :** Particularly, this is observed in case of costly drugs such as cloves, saffron, tea, fennel, ginger etc. These drugs are exhausted for their active constituents and reused with genuine drugs after proper treatment. Exhausted saffron is coloured artificially, while ginger is mixed with starch and coloured to produce proper shade. The fictitious nutmegs are made from mineral matter pressed into moulds and flavoured.

2. Substitution with superficially similar but inferior drugs : The harvesting of cultivated drug, when it has not reached minimum standard of quality, yields inferior drug. The common example of substitution is adulteration of cloves by mother cloves. Saffron is adulterated with dried flowers of Carthamus tinctorius (Safflower). Digitalis containing very less amount of glycosides is used as diluent in preparation of prepared digitalis leaves, containing higher percentage of glycosides.

3. Substitution by artificially manufactured substitutes : This type of adulteration is observed in case of drugs which are costly. Paraffin wax is tinged yellow and substituted for yellow bees wax, while artificial invert sugar is mixed with honey.

4. Substitution by sub-standard commercial varieties : Red chillies i.e. *Capsicum frutescens (Capsicum minimum)* are substituted by *Capsicum annum*, while *Gentiana lutea* is substituted by *Picrorrhiza kurroa*. The substitution of Alexandrian senna with Arabian senna, and substitution of rhubarb with many species of Rumex are other examples. Nux-vomica seed (*Strychnos nux-vomica*) are adulterated with *Strychnos nux-blanda* or *Strychnos potatorum* seed.

5. Presence of organic matter obtained from the same plant : In this case, advantage of similar colour, odour and constituents is taken into consideration and other parts of the same plant are added to genuine drug; e.g., cloves are mixed with clove stalks, while caraway and anethum fruits are mixed with other parts of inflorescence.

6. Many a times a synthetic chemical which constitutes one of the chemical constituents of the drug is added to the genuine drugs, e.g. benzyl benzoate to balsam of peru and citral to oil of lemongrass, and camphor oil and eucalyptus oil in oil of rosemary.

Several times, wastes from the market are collected and admixed with drugs. This is observed in case of unorganised or liquid drug. The pieces of amber coloured glass in colophony, limestones in asafoetida, white oil in oil of coconut and stearin or paraffin in cocoa butter are deliberate kind of adulterations.

(B) DRUG EVALUATION

Evaluation of a drug means confirmation of its identity and determination of its quality and purity. If adulterated, it also includes the detection of the nature of adulteration in the crude drug.

Several methods are employed in detecting adulteration in genuine drugs. The form of drug provides a clue for the method of detection of adulteration to be followed. In ordinary course of study, the morphological characters may suffice the need of detection. But in case of powdered drugs, the microscopic characters, while in case of liquid drug chemical tests and one of the physical standards such as specific gravity, optical rotation, solubility etc., may be helpful in detection of adulteration.

Over the years, the nature and degree of evaluation of crude drugs has undergone a systematic change. Initially, the crude drugs were identified by comparison with standard description available. Due to advancement in chemical knowledge of crude drugs, at

present, evaluation also includes the method of estimating the active constituent present in crude drug, in addition to its morphological and microscopic analysis.

Taking into consideration variation in source of crude drugs and their chemical nature, they are standardized by different techniques. Since methods of estimation of chief active principles of various crude drugs fall within the purview of pharmaceutical analysis, we shall only outline different methods of estimation. The crude drugs can be identified on the basis of their morphological, histological and chemical studies. The different techniques involved in standardization of crude drugs are as follows.

1. ORGANOLEPTIC (MORPHOLOGICAL) EVALUATION

It refers to evaluation of drugs by colour, odour, taste, size, shape and special features, like touch, texture, sound etc. Aromatic odour of umbelliferous fruits and sweet taste of liquorice are the examples of this type of evaluation. The study of form of a crude drug is **Morphology**, while description of the form is **Morphography**.

However, it should be noted that colour, shape and size of crude drugs as described in official books should only be considered as guidelines and may vary depending upon several factors. For example, colour of the crude drug may fade if it gets exposed to sunlight for very long duration or if, the drug is not stored properly. Depending upon the condition under which the drug is growing or cultivated, i.e., availability of proper irrigation, fertilizers or even, high temperature may influence the size of the drug. If it gets favourable conditions, leaf, seed and fruit drugs of maximum size may be available and the crude drugs if grown in adverse conditions, size may get reduced.

The adulteration of seed of Strychnos nux-vomica with the seed of Strychnos nux-blanda or Strychnos potatorum, caraway with Indian dill, Alexandrian senna with dog senna or palthe senna are identified by morphological technique.

In case of acellular products (unorganised drugs), form of the drug depends totally on the method of preparation of the drug. Thus, gum acacia is found in the form of ovoid tears, while tragacanth is marketed as vermiform ribbon with longitudinal striations.

2. MICROSCOPIC EVALUATION

This method allows more detailed examination of a drug and it can be used to identify organised drugs by their known histological characters.

Microscope, by virtue of its property to magnify, permits the minute structure under study to be enlarged and can be used to confirm the structural details of the drugs from plant origin. For the effective results, various reagents or stains can be used to distinguish the cellular structure. The microscopic evaluation also covers study of constituents by application of chemical tests to small quantities of drugs in powdered form or to histological sections of the drug (Microchemistry). Histological studies are made from very thin sections of the drugs. The characteristics of cell wall, cell contents, trichomes, fibres, vessels etc., can be studied in details, e.g. Signified trichomes in nux-vomica. The

microscopic linear measurement and quantitative microscopy are also covered under this technique of evaluation.

The following few constants illustrate the importance of microscopic measurements.

(a) Stomatal number : It is the average number of stomata present per square mm of the epidermis.

The actual number of stomata per sq. mm of leaf preparation may vary for leaves of the same plant grown in different environmental conditions. Stomatal number is relatively a constant for particular species of same age and hence, it is taken into consideration as a diagnostic character for identification of a leaf drug. The adulteration can also be detected by stomatal number. It can be further illustrated by following examples.

Table 7.1 : Stomatal Number of Few Leaf Drugs

Species	Stomatal number
1. *Datura stramonium*	087 (upper epidermis)
2. *Datura innoxia*	141 (upper epidermis)
3. *Hyoscyamus niger*	125 (upper epidermis)

(b) Stomatal index : It is the percentage which the number of stomata form to the total number of epidermal cells, each stoma being counted as one cell. It can be calculated by a formula :

$$I = \frac{S \times 100}{(E + S)}$$

where I - Stomatal index;

S - Number of stoma per unit area;

E - Epidermal cells in the same area.

Whilst, stomatal number varies considerably with the age of leaf and due to changes in climatic conditions, stomatal index is relatively constant and therefore, of diagnostic significance for a given species. It is useful in differentiation of closely related species and also for detection of adulterants (Table 7.2).

Table 7.2 : Stomatal Index of Few Leaf Drugs

Species	Stomatal index (lower surface)
1. *Atropa belladonna*	20.2 to 23.0
2. *Atropa acuminata*	16.2 to 18.3
3. *Indian senna*	17.0 to 20.0
4. Alexandrian senna	10.8 to 12.6

(c) Vein islet number : It is the number of vein islets per sq. mm of leaf surface.

It is a constant for a given species of the plant. It usually does not alter with the age of plant and is independent of the size of the leaf (Table 7.3).

Table 7.3 : Vein Islet Number of Few Leaf Drugs

Species	Vein islet number
Erythroxylon coca	08 -12
Erythroxylon truxillense	15 - 26
Digitalis purpurea	02 - 5.5
Digitalis thapsi	8.5 - 16
Cassia angustifolia	19 - 23
Cassia acutifolia	25 - 30

(d) Palisade Ratio : It is the average number of palisade cells, beneath one epidermal cell, using four continuous epidermal cells for the count.

Since the palisade cells in the mesophyll of the leaves bear a definite relation to the epidermal cell, the palisade ratio as defined above, is constant for a species of a genus (Table 7.4).

Table 7.4 : Palisade Ratio of Some Leaf Drugs

Species	Palisade ratio
1. *Atropa belladonna*	06 -10
2. *Datura stramonium*	04 - 07
3. *Digitalis purpurea*	3.7 - 4.2

(e) Quantitative Microscopy (Lycopodium Spore Method) : It is an important analytical technique for powdered drugs, especially when chemical and other methods of evaluation of crude drugs fail as accurate measures of quality. Lycopodium spores are very characteristic in shape and appearance and exceptionally uniform in size (25 μm). On an average, 94000 spores per mg of powdered lycopodium are present.

A powdered drug is evaluated by this technique, if it contains :

(i) well defined particles which may be counted, e.g. starch grains or pollen grains,

(ii) single layered cells or tissues, the area of which may be traced under suitable magnification and actual area calculated or

(iii) the objects of uniform thickness, the length of which can be measured under suitable magnification and actual area calculated.

The percentage purity of an authentic powdered ginger is calculated using the following equation,

$$\textbf{Percentage purity} = \frac{N \times W \times 94000 \times 100}{S \times M \times P}$$

where, N - number of characteristic structures (e.g. starch grains) in 25 fields.

W - weight in mg of lycopodium taken.

S - number of lycopodium spores in the same 25 fields.

M - weight in mg of the sample, calculated on the basis of sample dried at 105°C.

P - 2,86,000 in case of ginger starch grains powder.

Lycopodium spore method can be used for evaluation of powdered clove, ginger, cardamom, nutmeg and umbelliferous fruits.

The study of microscopical or histological characteristics is useful in detection of adulterants in both entire and powdered forms of crude drugs. Apart from variations in cellular arrangement, many a times, the type of cuticle of epidermis and cell inclusion also help in detection of the adulterants. The common adulterant of *Digitalis purpurea* is *Verbascum thapsus,* containing candelabra trichomes, while digitalis contains either multicellular uniseriate trichomes or glandular trichomes. The powdered cloves contain neither prisms of calcium oxalate nor the sclereids, but in case of powdered clove stalks both are present. Starch is absent in clove, but is present in the powdered clove fruits. The leaves of *Digitalis purpurea* do not contain calcium oxalate crystals, while they are present in all other varieties of Digitalis. Surinam quassia does not contain calcium oxalate, but Jamaica quassia contains prismatic crystals of calcium oxalate.

The size of a starch grain is also important in detection of adulterants. In case of *Cinnamomum cassia,* the diameter of starch grains is usually more than 10 microns. The dimension of fibres also helps in detecting adulteration in case of cinnamon. The number of sclerenchymatous cells per square cm in cardamom is one of the criteria for detection of varieties of cardamom seed in powdered form.

3. PHYSICAL EVALUATION

Physical standards are to be determined for drugs, wherever possible. They may help in evaluation, specifically with reference to specific gravity, density, optical rotation, refractive index, melting point, viscosity and solubility in different solvents. A few of them are described below.

(i) Moisture content : The percentage of active chemical constituents in crude drugs is mentioned on air-dried basis. Hence, the moisture content of a drug should be determined and also be controlled to make the solution of definite strength. The moisture content of a drug should be minimised in order to prevent decomposition of crude drug either due to chemical change or due to microbial contamination.

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Aloe spicata Baker (Cape aloes), belonging to family Liliaceae. Indian aloe is obtained from wild plants of Aloe Vera (Fig. 9.1).

Geographical Distribution :

Most of the species of aloe are indigenous to Africa, but now introduced into West Indies and Europe. In Africa, it grows in Cape colony (South Africa) and on the islands of Socotra and Zanzibar. It is cultivated throughout India, but especially in North West Himalayas.

Preparation :

Various methods are used to prepare aloes commercially in Africa, as well as, in West Indies. Following is the general method of preparation.

The fleshy and sessile leaves of aloe are cut near the bases and are arranged in wooden trough or kerosene tin or vessels of goat skin as to form the V shaped cavity by placing the cut-end downwards. The leaves are allowed to drain fully. The juice is taken to evaporating pans and concentrated. Method of its concentration and cooling results in physical variations in aloes. Vigorous concentration followed by quick cooling results in transparent and brittle product known as *Vitreous* or *Lucid* aloes. Slow concentration with gradual cooling produces *Hepatic* or *Livery* aloes.

Organoleptic Characters :

Colour : Depends upon the variety from which it is obtained. It is dark brown, brownish black or black in colour.

Odour : Characteristic.

Taste : Intensely bitter and nauseating.

Size : It is found in the form of masses of various sizes.

Extra Features :

Three varieties of aloes can be distinguished from each other by their morphological characters (Table 9.1).

Table 9.1 : Morphological Characters of Aloe Varieties

Cape aloes	Curacao aloes	Socotrine aloes
Dark brown or greenish brown or glossy mass; masses are transparent, when mounted in glycerin, the crystal particles are observed. Fracture is glossy.	Dark chocolate-brown, usually opaque fracture is waxy.	Reddish-black to brownish black; opaque smooth and conchoidal.

Solubility :

It is entirely soluble in 60 % alcohol, and is partly soluble in water.

Standards :

1.	Water soluble substances	:	Not less than 25 %.
2.	Alcohol insoluble substances	:	Not more than 10 %.
3.	Loss on drying	:	Not more than 10 %.
4.	Ash	:	Not more than 5 %.

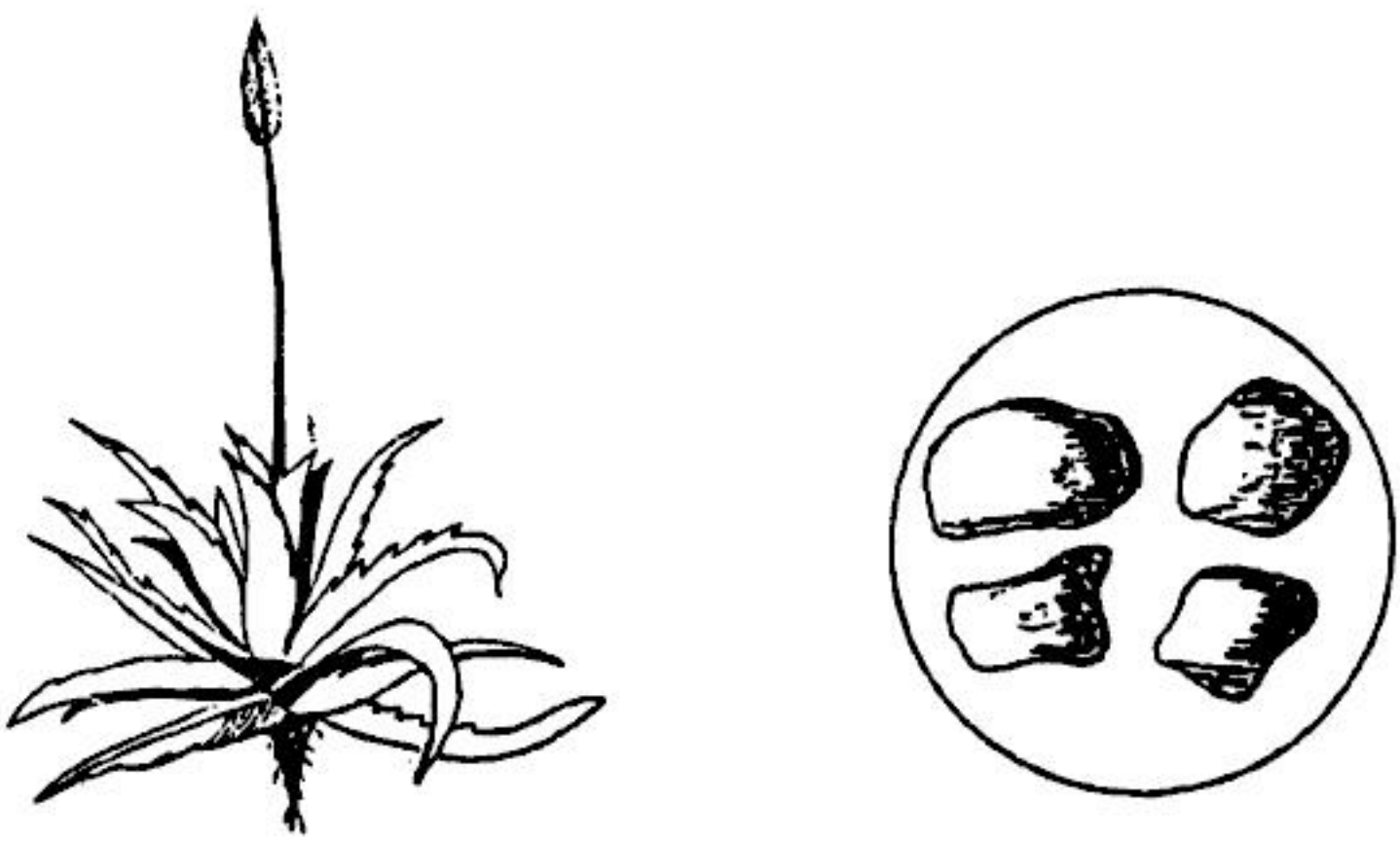
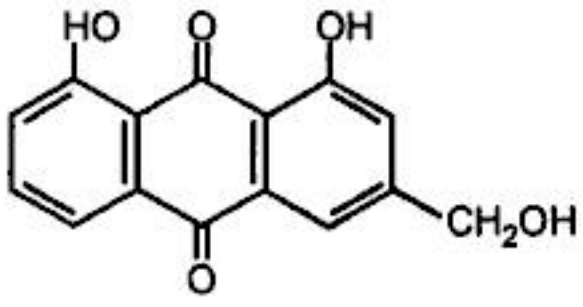


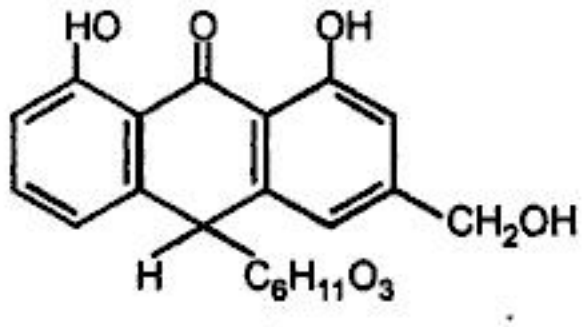
Fig. 9.1 : Aloe Plant and Aloe Sample

Chemical Constituents :

All varieties of aloes contain a yellow coloured crystalline substance known as barbaloin (C-glycoside), resin and aloe-emodin. Isobarbalion is present in Curacao and Cape aloes. Cape aloes are characterized by the presence of an amorphous compound, β-barbalion, aloinosides A and B and capaloresinotannol with p-coumaric acid. The resin of curacao variety contains barbaloresinotannol with cinnamic acid.



Aloe-emodin



Barbaloin

Identification :

Prepare 1 % solution of aloes by boiling with water, add 0.5 % of kieselguhr to it and filter. With the filtrate, perform following tests.

1. Heat 5 ml of above test solution with 0.2 g of borax; add this solution to the test-tube containing water. A green fluorescence is produced (due to aloe-emodin) **(Schoenteten's reaction)**.
2. To 2 ml of test solution, add equal quantity of freshly prepared bromine water. A pale yellow precipitate of tetrabromalion is observed.
3. To 5 ml of test solution, add 2 ml of nitric acid. Different varieties of aloes produce different colours mentioned as under :

(a)	Cape aloes	:	Yellowish-brown to green.
(b)	Curacao aloes	:	Reddish-orange.
(c)	Socotrine aloes	:	Pale brownish-yellow.
(d)	Zanzibar aloes	:	Yellowish-brown.

4. **Klunge's test :** To aqueous solution (2 ml), add a drop of saturated copper sulphate solution, followed by sodium chloride (0.5 g) and alcohol 90 % (2 ml).

1.	Curacao aloes	:	Wine red colour.
2.	Cape aloes	:	A faint colouration is developed.
3.	Zanzibar and socotrine aloes	:	Do not respond to the test.

5. **Modified Borntrager's test :** To 0.1 g of the drug, and 5% solution of ferric chloride (2ml), and dilute hydrochloric acid (2ml), heat on boiling waterbath for 5 minutes, cool and shake gently with benzene. Separate benzene layer and add equal volume of dilute ammonia. A pinkish-red colour is produced with all varieties of aloes.

Uses :

Due to aloin (anthraquinone-derivative), it is used as irritant purgative. It is slow and uncertain in action. Now-a-days, aloin is preferred instead of crude drug. It acts on colon; to counter effect the gripping action of aloe it is given with carminatives.

Aloe-gel, a mucilaginous colourless viscid juice of aloe, now-a-days, is used in cosmetics as a protective i.e. it prevents wrinkles (due to aging) on face and also in the treatment of radiation burns. It clears skin blemishes and grows new and healthy tissues. It stimulates the growth of hairs. Externally, it is applied for painful inflammations.

RHUBARB

Synonyms : Rheum; Rhizome-Rhei; Rhubarb-Rhizome

Biological Source :

Rhubarb consists of rhizome of Rheum palmatum Linn. and other species of *Rheum*, excepting *R. rhaponticum*, belonging to family Polygonaceae. Indian Rhubarb consists of the dried rhizomes of *Rheum emodi*. Wall or *Rheum webbianum* Royle. It is collected from six to eight year old plants, just before the flowering season and sold with cortex or in partially decorticated form.

Geographical Distribution :

Rhubarb is collected and cultivated in China, Tibet, India, Germany and other European countries.

Indian rhubarb is a stout herb (Fig. 9.2), about 1.5 to 3 m in height distributed in Kashmir and Sikkim at an altitude of 3600 to 5000 m. It is reported to be cultivated in Assam, but it is collected mainly from wild plants found in Nepal, Sikkim, Kulu and Kulaman.

Organoleptic Characters :

Colour	:	Brown or yellow.
Odour	:	Fragrant.
Taste	:	Bitter and astringent.
Size	:	Pieces of rhubarb are 2 to 20 cm in length and 1.5 to 2 cm in diameter.
Shape	:	Rhizomes are sub-cylindrical, barrel-shaped, conical or in planoconvex pieces.

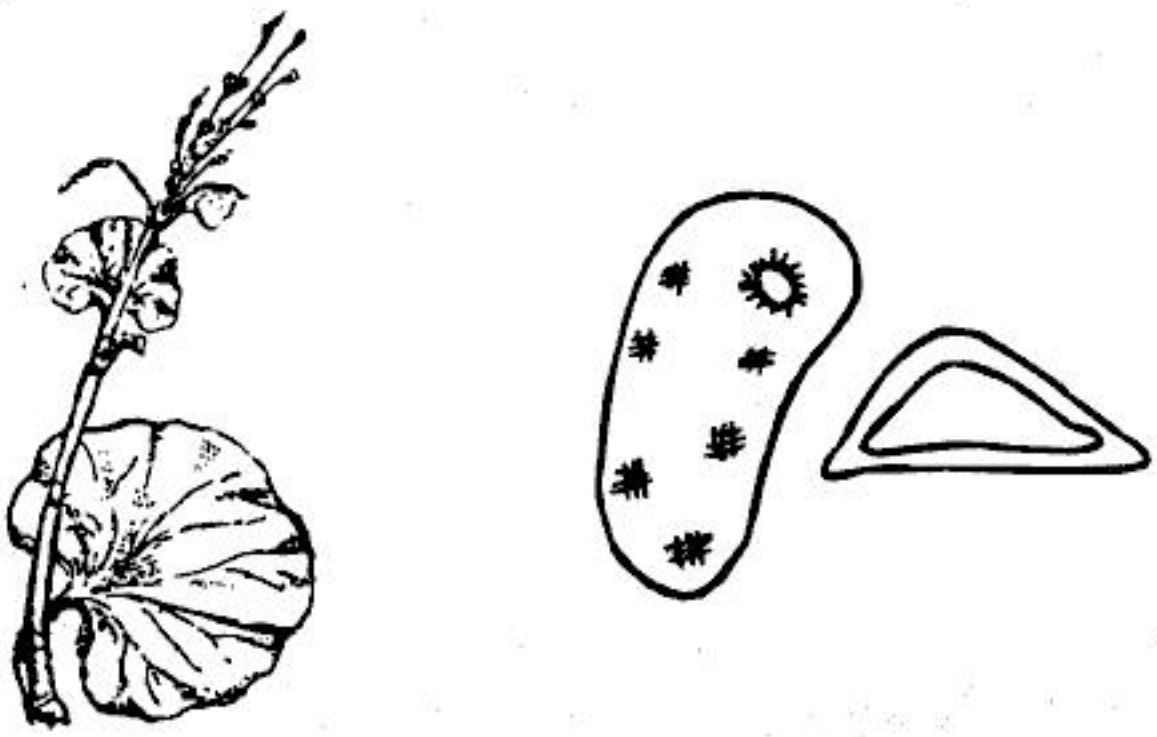


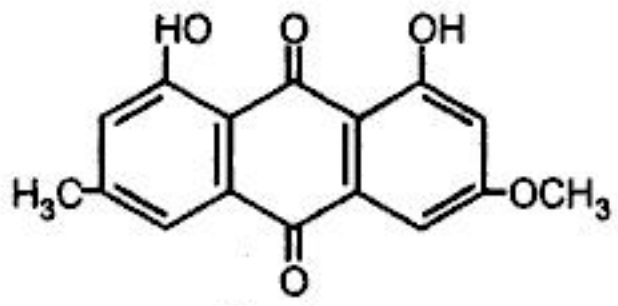
Fig. 9.2 : Rhubarb (*Rheum emodi*) *Twig* and *Rhizome*

Extra Features :

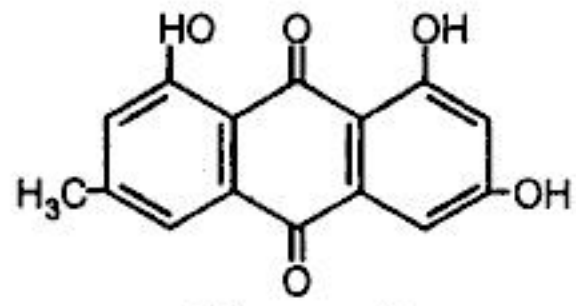
The rhubarb rhizomes are compact and firm with irregularly longitudinal wrinkles, furrows or ridges, while some pieces show transverse wrinkles or annulations. Fracture is granular, uneven and shows the presence of dark cambium lines.

Chemical Constituents :

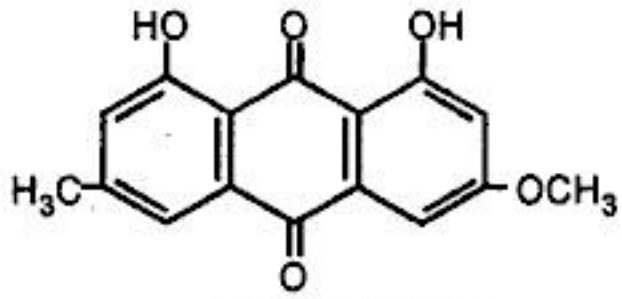
Rhubarb contains number of anthraquinone derivatives and their salts. The individual components of rhubarb are chrysophanol, aloeemodin, rhein and physicon. These occur in free form, as well as, in the form of glycosides of quinone, anthrone and dianthrone. Rhubarb also contains cinnamic acid, gallic acid, rhein acids, and calcium oxalate. Rhubarb yields to alcohol about 40 % of extractives.



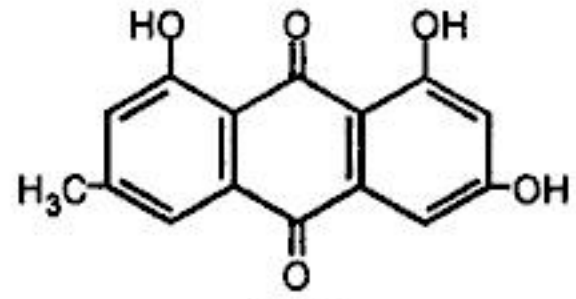
Physicon



Aloe-emodin



Chrysophanol



Rhein

Chemical Tests :

1. By addition of ammonia, it acquires pink colour.
2. With 5 % potassium hydroxide, blood red colouration is produced.
3. Under Ultra violet radiation Rheum-emodi gives brown colouration.
4. Borntrager's test for anthraquinone is given positive with rhubarb.

Uses :

Rhubarb is a mild purgative. Its action is like that of cascara. It contains tannins and hence, is associated with the astringent effect after purgation. It is also stomachic in smaller doses.

Adulterants :

Rhapontic rhubarb, obtained from Rheum rhaponticum is a common substitute for rhubarb. It is known as Chinese rhapontica in the market, as it comes from China. It has a distinctive odour and occurs as untrimmed pieces. Chinese rhubarb when examined under ultraviolet radiation flouresces bright blue (not observed in case of genuine drug).

CASTOR OIL

Synonym : Oleum Ricini

Biological Source : (Fig. 9.3)

Caster oil is the fixed oil obtained by the cold expression of the seeds of Ricinus communis.

Family : Euphorbiaceae

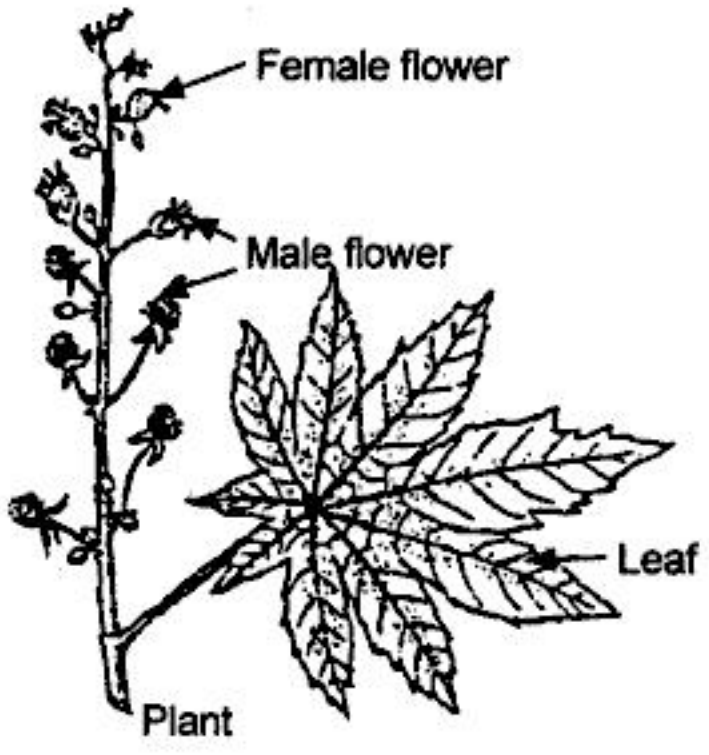


Fig. 9.3 : Castor Plant (Flowering)

Geographical Distribution :

Castor seeds are produced in almost all tropical and sub-tropical countries. In India, castor is one of the major oil seed crops and India is the second largest producer of castor seeds in the world, producing about 2.8 lakhs tonnes per annum. Brazil, U.S.S.R. Thailand, U.S.A., and Rummnia are other countries producing drug on large scale. In India, it is largely grown in Andhra Pradesh, Gujarat and Karnataka. Andhra Pradesh is producing about 60 % of the total crop in India.

Castor seeds are rich in phosphorous contents and most of it is in thesphytin. Hull is rich in mineral and also contains an alkaloid ricinine, resin, pigment etc. The oil content of the kernel varies from 36 to 60 %. Amongst different varieties, Hyderabad muggelai variety is supposed to be the richest (about 48 %) in oil content. Castor seeds contain several enzymes including lipase, maltase and invertase. The toxic principle ricin, constituting about 3 % of the whole seeds, is poisonous.

Preparation of Castor Oil :

Castor oil can be prepared by two different methods : the first being the crushing of whole or decorticated seeds in power driven hydraulic presses and the second one known as *Chani*, which consists of manually operated screw press driven by bullocks. For commercial scale of extraction, the first method is adopted. The oil, thus produced, is a non-medicinal castor oil.

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B. Drugs affecting mental activity :

(i) Stimulants : Caffeine from tea, coffee, kola.

(ii) Depressants : Reserpine from the roots and rhizomes of various *Rauwolfia* species.

(iii) Hallucinogenics : Tetrahydrocannabinol from leaves of *Cannabis sativa*

C. Centra ldepressants of motor functions :

Tropane alkaloids like hyoscine atropine from belladonna, hyoscyamus and datura

D. Analgesics :

Morphine and codeine from Papaver somniferum .

HYOSCYAMUS

Synonyms : Hyoscyamus herb, Hyoscymus leaves, Henbane

Biological Source :

It consists of dried leaves and flowering tops of the plant known as *Hyoscymus niger* Linn., (Family : Solanaceae). It should contain not less than 0.05 % of total alkaloids calculated as hyoscyamine.

Geographical Distribution :

It is found in England, Germany, Hungary, Russia and India.

It is an annual or a biennial plant. Though, mostly found in wild state, it is being cultivated at present in India.

Cultivation and Collection :

The cultivation is done in temperate region at an altitude of 2000 m. The drug is cultivated on commercial scale in Europe, Egypt, Russia and Hungary. In India, it is cultivated in Kashmir to a limited extent. The method of propagation is from seeds. The small seed-beds are raised and seeds are sown, which take about two weeks for germination. The seedlings are transplanted in field in the month of May, by keeping the distance of half a metre in-between them and about 75 cm in-between two rows. The plants are kept free of weeds and occassional hoeing is also done. The crop is harvested when it reaches maturity. Under all favourable conditions, the yield of the drug per hectare is 1000 to 1500 kg.

Organoleptic Characters (Fig. 9.32) :

Colour : The leaves are greyish-green or pale green in colour.

Odour : None.

Taste : Intensely bitter.

Size : Generally, the hyoscyamus leaves are petiolate, 20 to 30 cm in length and 4 to 10 cm broad. The petiole is flat and about 5 cm in length. The leaves are ovate to lanceolate in shape with dentate or serrate margin.

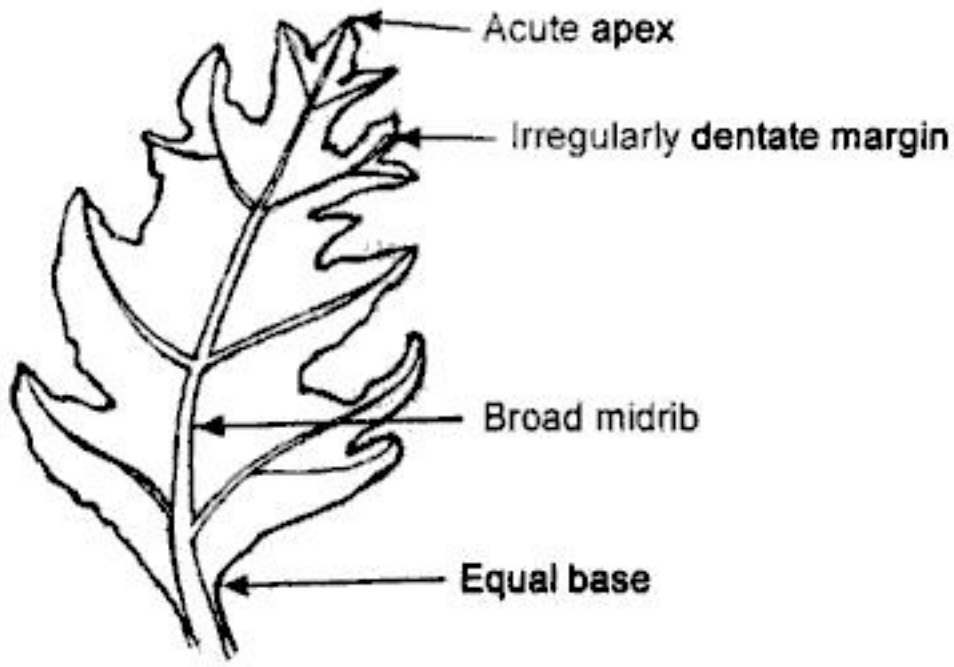
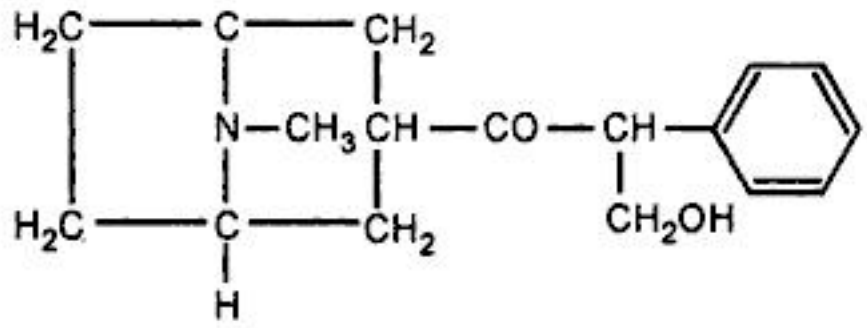


Fig. 9.32 : Hyoscyamus Leaf

Chemical Constituents :

Hyoscyamus leaves contain about 0.05 to 0.15 % of alkaloids, viz., *l* - hyoscyamine, hyoscine (scopolamine) and atropine. Hyoscyamine is the chief active constituent. The petiole appears to contain more alkaloid than the stem or lamina. *l* - hyoscyamine or atropine is an ester of tropic acid and tropine. The racemic form of *l* - hyoscyamine is atropine. Optically active alkaloids are more active than their corresponding racemic forms.



***l*- Hyoscyamine, Atropine**

Uses :

It is used to counteract gripping due to purgatives and also to relieve the spasms of urinary tract. It is also sedative and used to check salivary secretions. It is an expectorant too. It is an antispasmodic and anti-asthmatic .

Substitutes :

Egyptian henbane consists of dried leaves and flowering tops of *Hyoscyamus muticus* (Solanaceae). The plant is grown in sandy districts of Egypt. It contains 0.7 to 1.5% of total alkaloids, mainly *l*-hyoscyamine (75 %). The other alkaloids are apoatropine (15%) and small quantities of noratropine and norhyoscine.

DATURA

Synonym : Datura herb

Biological Source :

Datura consists of dried leaves and flowering tops of *Datura metel* variety *fastuosa* Safford (Family : Solanaceae). It contains not less than 0.5 % of total alkaloids, calculated as hyoscyamine.

Geographical Distribution :

Datura is a genus of poisonous shrubs of tropical and sub-tropical parts. It is also found in India. It is cultivated in Europe.

Cultivation and Collection :

The drug is cultivated by sowing the seeds. The germination rate of the seeds is poor. If the seeds are soaked in water and kept overnight, the rate of germination increases. About 7 to 8 kg of the seeds per hectare are required for sowing. The seeds take about 15 to 20 days for germination. Weeding and thining are necessary and performed when the plants reach about 10 to 15 cm in height. The distance kept in between two plants is about 75 to 100 cm. The drug is collected after four months of its cultivation. The leaves and branches are removed, the drug is dried in the sun, and marketed by packing in gunny bags.

Organoleptic Characters (Fig. 9.33) :

Colour : Pale green.

Odour : Characteristic.

Taste : Bitter.

Fig. 9.33 : Datura Metel in Fruiting Stage

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Cultivation and Collection :

The cultivation of drug at an altitude of 1400 m from sea level is found to be satisfactory, if provided with proper irrigation. It is observed that the yield per hectare can be increased appreciably by proper cultivation technology. The experimental trials of applications of several fungicides and insecticides right from the treatment of the seeds to the foliar sprays were very encouraging. Its cultivation in Jammu and Kashmir is found to be successful.

Belladonna berries are crushed to get the seeds for cultivation. Proper processing like washing and sieving is performed and only healthy seeds are used for cultivation. Seeds are sown by broadcasting method in well prepared beds with the application of fungicide like diathion. Sowing is done in May or July. The seedlings are ready for transplantation by the end of September. Transplanting is done by keeping the specific distance between two plants sand the seedlings are irrigated carefully. Fertilizers like urea, potash and superphosphate are given as per the needs. Insecticidal sprays like sevin are also tried when the plant reaches maturity. The leaves, as well as, the flowering tops are cut and sun-dried. While drying, care is taken so that the dried leaves retain their green colour. While grading and packing for market, woolly stems and foreign organic matter are rejected. The yield per hectare is found to be 200 to 600 kg.

Organoleptic Characters :

Colour : Leaves – green to brownish-green.
Flowers - purple to yellowish-brown.
Fruits - green to brown.

Odour : Slight and characteristic.

Taste : Bitter and acrid.

Size : Leaves - 5 to 25 cm long and 2.5 to 12 cm wide.
Flowers - corolla 2.5 cm long and 1.5 cm wide.
Fruits - about 10 cm.

Shape : Leaves - ovate lanceolate to broadly ovate, with acuminate apex, decurrent lamina, entire margin, petiolate, brittle and transversely broken.
Flowers - campanulate, 5, small reflexed lobes of corolla.
Fruits - sub-globular in shape with numerous flat seeds.

Extra Features :

In general, the entire drug is seen as crumpled and twisted. The drooping flowers are associated with as many pairs of leaves. The flowers are with 5 stamens, superior bilocular ovary and numerous seeds.

Microscopic Characters :

Epidermal cells with slightly sinuous anticlinal wall and striated cuticle, anisocytic stomata and occasionally uniseriate covering trichomes are present. There are glandular trichomes which are uniseriate and with unicellular heads. The palisade ratio is 5 to 7.

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Organoleptic Characters :

Colour : Greenish-brown.

Odour : None.

Taste : Intensely bitter.

Size : Seeds are 10 to 30 mm in diameter and 4 to 6 mm in thickness.

Shape : The seeds are disc shaped, somewhat flat of irregularly bent and concavo-convex. The margin of the seeds is rounded.

Fig. 9.41 : Nux-vomica Plant

Extra Features :

Surface of the seeds is silky due to radially arranged, densel covered and closely appressed unicellular lignified covering trichomes. The presence of endosperm, embryo and cotyledons can be confirmed in the longitudinal section (L.S.) of the seed (Fig. 9.42).

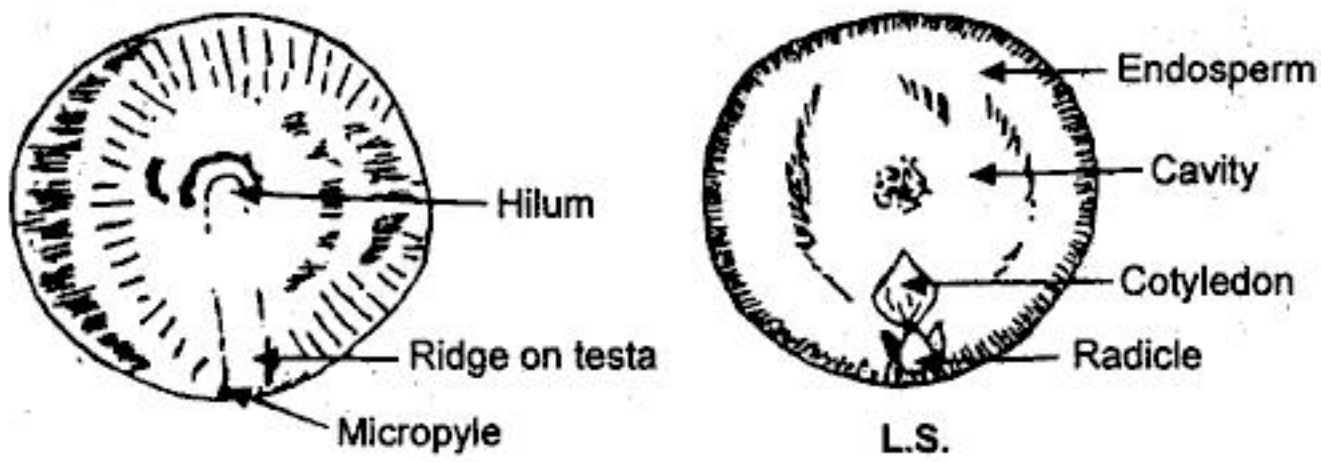

Fig. 9.42 : Nux-vomica Seed

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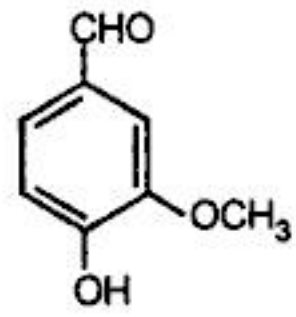
Chemical Constituents :



Vanillin

Balsam of tolu contains 12 % to 15 % of free cinnamic acid, about 8 % of free benzoic acid, 7.5 % of oily liquid (cinnamein) containing benzyl benzoate and benzyl cinnamate. The resinous matter, which constitutes about 80 % of the drug contains, chiefly ester of toluresinotannol. Small quantities of vanillin and styrol are also reported in the drug. The volatile oil obtained by distillation from balsam does not exceed 3 %. The tolu oil is yellow liquid with highly fragrant flavour.

Identification :

1. When heated and pressed inbetween two glass slides and examined under microscope, it exhibits crystals of cinnamic acid.

2. To alcoholic solution of balsam of tolu, add solution of ferric chloride; green colour is produced.

3. Warm gently about 1 g of the drug with 5 ml of potassium permanganate solution; odour of benzaldehyde is produced.

Uses :

Balsam of tolu is used as an expectorant and as flavouring agent. It is also an antiseptic. It is a common ingredient of cough mixture. It is used in the preparation of confectionary, chewing gums and perfumery.

Adulterants :

Many a times, exhausted balsam of tolu is added to the drug. Fictitious tolu balsam prepared by adding benzoin and cinnamic acids to the exhausted balsam can be detected by lack of its natural flavour and volatile oil content. Colophony is also added to balsam of tolu. Its presence can be detected by the test for abietic acid, the active constituent of colophony.

Peru balsam is obtained from stems of Myroxylon pereirae (Leguminosae) grown in Central America, Peru and Guatemala. It contains 60 % mixture of balsamic esters (Cinnamein), 35 % esters of balsamic acids with peruresinotannol and vanillin. It is used as an antiseptic, expectorant and in treatment of scabies.

(H) ANTIRHEUMATICS

The drugs used to relieve or used in the treatment of rheumatism are known as antirheumatics. Rheumatism (Greek : *Rheuma* : flowing and *ismos* - condition) is characterised by soreness, stiffness of muscles, and pain in joints and associated structures, including arthritis.

The modern analgesics and anti-inflammatory agents (like analgin, oxyphenbutazone etc.) used to treat the rheumatism are from synthetic sources. However, the salicylic acid derivatives or salicylates commonly used for the purpose were originally obtained from the plant source i.e. white willow (*Salix alba* Vulgaris) in the form of salicin, a bitter glycoside.

The herbal antirheumatics which are effectively used in rheumatism, now-a-days, are as follows :

Guggul (*Commiphora mukul*)
Salai (*Boswelia seratta*)
Nirgundo (*Vitex-nirgundo*)
Jatamansi (*Nardostachys jatamansi*)
Colchicum (*Colchicum luteum*)

INDIAN BDELLIUM

Synonyms : Guggul, Scented bdellium, Gum guggul

Biological Source :

Guggul is the oleo-gum-resin obtained by the incision of the bark of the plant *Commiphora weightii* (*Arn*) *Bhand*, (*Commiphora mukul* Engl; *Balsamodendron, mukul* Hook), (Family : Burseraceae).

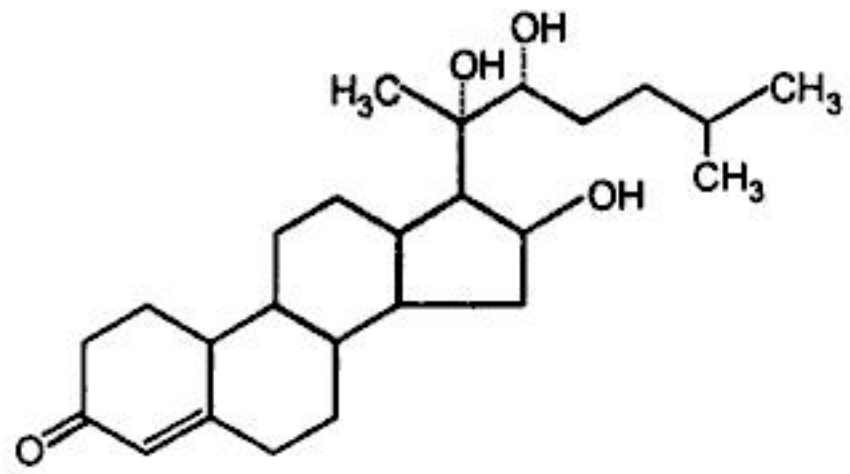
Geographical Distribution :

The plant guggul (shrub) is found well distributed in India, Pakistan Baluchistan and Arabia.

The guggul plant is an inhabitant of dry areas of Rajasthan, Karnataka, Gujarat and Maharashtra. It grows to the height of 2 - 3 metres, much branched with characteristic silvery and paper like bark-peelings. Each plant produces about 0.5 to 1 kg of oleo-gum resin which is collected from January to March every year.

Organoleptic Characters :

Colour : Brown to pale yellow or dull green.
Odour : Agreeable, aromatic and balsamic.
Taste : Characteristic bitter.
Size : 0.5 to 1.00 to 2.5 cm in diameter.



Guggulosterol-I

Resin also contains sterols known as guggulosterol I, II and III.

Standards :

Water soluble extractive	:	Not more than 48 %.
Alcohol soluble extractive	:	Not more than 40 %.
Ash value	:	Not more than 5.5 %.
Acid - insoluble ash	:	Not more than 3.5 %.
Loss on drying	:	Not more than 11.8 %.

Chemical Test :

To the ethyl acetate extract of guggul add acetic anhydride, boil, cool and add 2 ml. of sulphuric acid, green colour develops at junction due to steroids.

Uses :

It is used as anti-inflammatory anti-rheumatic, hypolipidemic and hypo cholesteremic drug.

Substitutes :

Commiphora berryi, Commiphora caudata and *Commiphora roxburghii* also yield oleo-gum resin of commercial importance.

INDIAN COLCHICUM

Synonyms : Colchicum seeds

Biological Source (Fig. 9.51) :

Colchicum consists of dried seeds of the plant *Colchicum luteum*, Baker, (Family : Liliaceae).

Geographical Distribution :

It is found in Western Himalaya, Kashmir and Chamba.

Cultivation and Collection :

It is found at an altitude of 1000 to 3000 m growing extensively in open lands from Murre hills to Kashmir.

The plants are cultivated by sowing the seeds in boxes from May onwards. The seeds take a long time for germination. Seedlings are transferred in the field and placed one metre apart. After removing scales and coats, the corms which are also used in medicine, are sliced transversely and dried below 65°C. The collection of the seeds is done from capsular fruits. Colchicum plants flower in the month of August to October and start bearing the capsular fruits from May to July. Capsules are collected before their dehiscence from June to July. During ripening, the seeds become dark in colour and are separated by shifting from the fruits. Seeds are processed and graded accordingly.

Organoleptic Characters :

Colour : Dark reddish-brown pitted and sturdy.

Odour : None.

Taste : Bitter and acrid.

Size : 2 to 3 mm in diameter.

Shape : Seeds are globular with strophiole at one side and raphe on the other (Fig. 9.51).

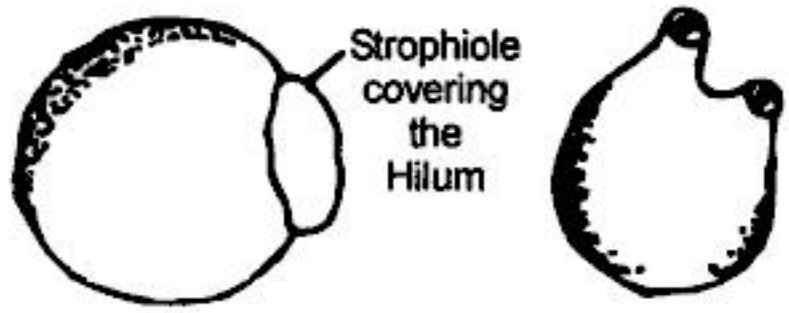
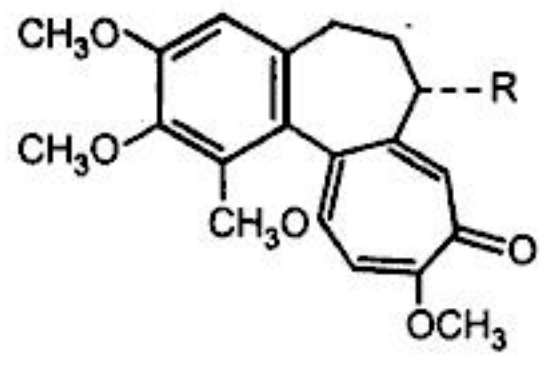


Fig. 9.51 : Colchicum Seeds

Chemical Constituents :

Colchicum seeds contain about 0.2 to 1 % of total alkaloids, calculated as colchicine. The alkaloids present in the drug are colchicine and demecolcine. The alkaloids have tropolone or cycloheptatrien-ol-one ring structure. Colchicoresin, starch and about 5 % of fixed oil are other contents of the drug.



R = $NHCOCH_3$ - **Colchicine**

R = NHCH - **Demecolcine**

Chemical Test :

With 70 % sulphuric acid, a yellow colour due to colchicine is produced.

Uses :

Colchicum seeds are used in gout and rheumatism. Colchicum seeds can control the malignant tumour, but are highly toxic. Colchicine is used to cause polyploidy. It is used in horticulture and in the cultivation of medicinal plants.

Note :

B.P. variety consists of dried seeds and corms of plant *Colchicum autumnale* Linn., a perennial herb and found growing in moist meadows (hence known as Meadow-saffron) in England and Europe. Commercial supplies to seed and corm come from Yugoslavia, Czechoslovakia, Poland and Holland.

COLCHICUM CORM

Synonyrns : Autumn Crocus corm, Meadow Saffron corm

Biological Source :

Colchicum corms are the corms of Meadow Saffron. i.e. *Colchicum autumnale* in the fresh or dried form, belonging to family Liliaceae.

Geographical Distribution :

It is found in England, Central and South Europe.

Cultivation and Collection :

In India, *Colchicum luteum* is used as a substitute for *Colchicum autumnale*. Hence, the Indian Colchicum differs from the B.P. variety. It is found in Western Himalayas. *Colchicum autumnale* corms are collected early in summer after the leaves have died. They are prepared by removing the scaly coats. Corms are then sliced transversely and dried at a temperature below 65°C. Indian Colchicum corms are collected from the plants which are two years old and are collected in June and July in Kashmir valley and in the hilly area of Kistwar, Uri and Damel.

Organoleptic Characters :

Colour : Yellowish-brown.

Odour : None.

Taste : Bitter and acrid.

Size : Slices are about 2 to 5 mm in thickness.

Shape : Sub-reniform or ovate in outline or plano-convex (Fig. 9.52).

(I) ANTILEPROTICS

Leprosy is an infectious disease caused by microorganism known as *Mycobacterium leprae*, affecting the skin and nerves resulting in disfigurement and deformity of the affected parts. The disease is characterized by glossy, corrugated, thickened skin with decreased sensation of touch.

The drugs used in the treatment of leprosy are known as antileprotics.

Leprosy is completely curable disease, but needs the treatment for long duration of time. Several chemotherapeutic agents including antibiotics are being used at present to treat lepers. Important amongst them are dapsone DDS (diamino diphenyl sulphone) sulfoxone sodium, rifampicin and clofozimine.

Brahmi (asiaticoside) and chaulmoogra oil are the drugs fron natural (herbal) origin available for treatment of leprosy.

CHAULMOOGRA OIL

Synonyms : Hydnocarpus oil, Gynocardia oil

Biological Source :

Hydnocarpus oil is fixed oil obtained from ripe seeds of the plants *Hydnocarpus anthelminitica* Pierre, Taraktogenos kurzil king. *Hydnocarpus heterophylla* Kurz and other species of the *Hydnocarpus*, (Family : Flacourtiaceae) prepared by cold expression method.

Geographical Distribution :

Chaulmoogra plant is native of Myanmar, Thailand and Eastern India. It is also found in Bangladesh. In India, it is grown in Assam and Tripura.

Method of Preparation :

Chaulmoogra seeds contain 40-45 % fixed oil. Seeds are decorticated by machine after grading. The kernels are pressed with hydraulic press and oil is filtered.

Organoleptic Characters :

Colour	:	Yellow to brownish-yellow coloured liquid.
Odour	:	Characteristic.
Taste	:	Somewhat acrid.
Solubility	:	Slightly soluble in alcohol, soluble in chloroform, ether, benzene and carbon disulphide.

It is white solid below 25°C and soft.

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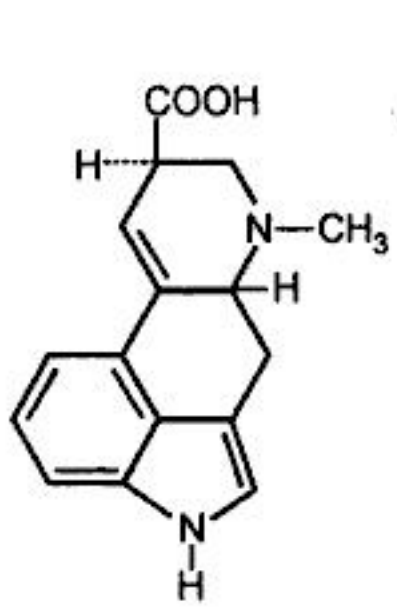
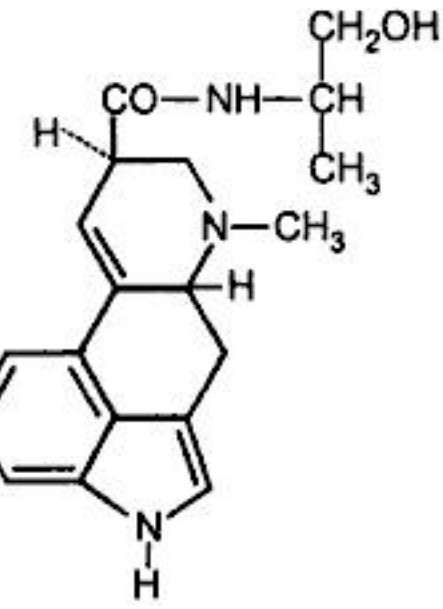


d-lysergic acid



ergometrine

Chemical Tests :

1. To defatted ergot powder, add 50 % potassium hydroxide solution and heat at 170° for one hour, cool, wash thoroughly with alcohol and to it add first iodine solution and then 20 % sulphuric acid; violet colour is produced.

2. Extract about 1 g of powdered ergot with 10 ml of solvent ether alongwith 0.5 ml of dilute sulphuric acid. Filter the extract and to the filtrate add approximately 1 ml of cold saturated solution of sodium bicarbonate. The aqueous layer becomes red or violet (due to sclererythrin).

3. In ultra-violet light, ergot powder shows red fluorescence.

4. Extract ergot with chloroform and sodium carbonate and to extract add paradimethylaminobenzaldehyde, 35 % sulphuric acid and 0.5 % ferric chloride solution. A blue colour is produced (ergotoxine test).

Uses :

Ergot is used in labour to assist delivery and to reduce post-partum haemorrhage. Ergotamine is used in the treatment of migraine. Ergometrine is also known as ergonovine in U.S.A. It is oxytocic and produces much faster uterine stimulation than other alkaloids. The activity of ergometrine increases with methyl group. Ergotamine and semi-synthetic dihydroergotamine salts are employed as analgesics in the treatment of migraine. Lysergic acid diethylamide (LSD - 25) prepared from lysergic acid possesses hallucinogenic properties.

Storage :

Ergot should be dried thoroughly and kept in entire form in cool place. It should be stored in well closed containers. Ergot alkaloids are very sensitive to moisture and hence thorough drying of ergot is necessary. The broken sclerotia are very susceptible to the fungal growth and hence broken pieces should not be stored at low temperature in cool place away from light. If powdered ergot is required to be stored, it should be defatted first and then stored or, otherwise, decomposition of active constituents takes place.

(Q) VITAMINS

These are the substances which are considered to be essential for the maintenance of normal metabolic functions, but are not synthesized by human body on its own, and hence to be supplied from outside sources. It must be noted that the vitamins received through the normal, well balanced diet are not treated as drugs for a healthy person. But, certain conditions like inadequate intake, increased tissue requirements, disturbances in adsorption or utilization of vitamins reduce their concentration in the body. This leads to certain deficiency symptoms and in such situation vitamins need to be supplied in chemically pure form or their active concentrates. In such conditions, they are treated as drugs of therapeutic nature. Sometimes, they are also given in prophylactic forms.

The excessive use of many vitamins, especially vitamin D, causes toxic effects.

The vitamins are normally not associated with energy formation. They have an important role in several energy transformation reaction in the body. Sometimes, they resemble hormones in their functions and are required in small quantities. The adults, infants, children, pregnant and lactating mothers require a certain minimum level of vitamins in the food called as Recommended Daily Allowances. Chemically, the vitamins largely differ from each other and are grouped as water soluble and fat-soluble vitamins. The water-soluble vitamins are easily absorbed, highly excreted through urine and not stored in body except vitamin B_{12}. On the other hand, fat-soluble vitamins need bile salts and fats for their absorption, normally not excreted in urine and are generally stored in liver.

Cod liver oil, Halibut liver oil are the sources of vitamin A and D, **shark liver oil** and **carrots**, in the form of carotene are richest source of vitamin A, while **amla** contains vitamin C and **yeast** contains vitamin B complex.

SHARK LIVER OIL

Synonyms : Oleum Selachoids

Biological Source :

Shark liver oil is the fixed oil obtained from the fresh and carefully preserved livers of various species of the shark, mainly *Hypoprion brevirostris*. In India, *Scoliodon, Carcharias* and *Sphyrna* are abundant among the species, and are generally utilised for the extraction purpose. According to I. P., one gram of oil should not contain less than 6000 International Units of vitamin A activity.

Geographical Source :

In India, the sharks (Fig. 9.72) are processed and oil is obtained on commercial scale in Tamil Nadu, Maharashtra and Kerala. Most of the European countries are also producing shark liver oil on large scale.

Method of Preparation :

With a little variation, the principle involved in extraction of the oil from the livers is uniform in almost all cases. Government factories in Tamil Nadu and Maharashtra process livers for extracting the oil. The livers are cleaned and minced. The minced mass is taken to a boiling pot, where the temperature of 80°C is maintained. The oil extracted is treated with dehydrating agent to remove traces of water.

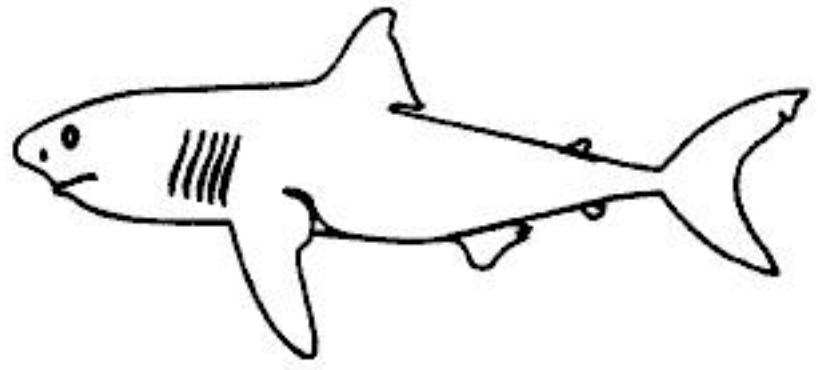


Fig. 9.72 : Shark Fish (Carcharias Species)

The oil is then taken to a vacuum still for dehydration and chilled to separate stearin. Centrifuges are used to separate the suspended materials in oil. The clear oil is manipulated to adjust the desired strength. The oil being sensitive to light and air, all the while, care is taken to minimize its exposure to sunlight and air. Many a times, the livers are stored at very low temperature, until they are taken for processing.

Description :

Colour : Pale yellow to brownish-yellow.

Odour : Characteristic fishy, but not rancid.

Taste : Bland or fishy.

Solubility :

Shark liver oil is soluble in solvent ether, chloroform and light petroleum. However, it is insoluble in water and slightly soluble in ethyl alcohol.

Standards :

The pharmaceutical grade of shark liver oil should comply with the following standards.

Specific gravity	:	0.912 to 0.916
Refractive index	:	1.459 to 1.477 at 40°
Acid value	:	Not more than 2
Iodine value	:	Not less than 90

Chemical Constituents :

Shark liver oil contains vitamin A. The concentration of vitamin A in the oil varies from 15000 to 30000 International Units of vit. A activity per gram. Other constituents of the oil are the glycerides of saturated and unsaturated fatty acids.

Organoleptic Characters :

Colour : Green changing to light yellow or brick red when matured.

Odour : None.

Taste : Sore and astringent.

Size : 1.5 to 2.5 cm in diameter.

Shape : The fruits are depressed, globose.

Fig. 9.73 : Amla Twig with Fruits

Extra Features :

Fruits are fleshy obscurely -6 lobed with 6-trygonus, seeds. They are very hard and smooth in appearance.

Chemical Constituents :

Amla fruit is a rich natural source of vitamin C and contains 600 to 750 mg per hundred gram of the fresh pulp. Apart from that, fruits also contain about 0.5 % fat, phyllemblin and 5 % tannin. Amla fruits are also rich in mineral matters like phosphorus, iron and calcium. It contains appreciable amount of pectin. The fresh fruits contain about 75 % moisture. The fruits are dehydrated and stored. It is found that vitamin content of dried fruits is not lost considerably. It may be due to the presence of tannins, which retards oxidation of vitamin C.

Chemical Test :

Test for Vit. C : To the aqueous solution of amla, add lead acetate or gelatin, remove the ppt. by filtration. To the filtrate add solution of 2, 6 dichlorophenol-indophenol colour disappears.

Uses :

Amla fruits are largely used in Indian medicine. It is used as an acrid, diuretic, refrigerant and laxative. Dried fruits are given in diarrhoea and dysentery. They are also administered in jaundice, dyspepsia and anaemia alongwith iron compound. Fruits are also used in preparation of inks, hair oils and shampoo. It is reported that fixed oil from fruits possesses the property of promoting hair growth. Seeds of the fruits are given in treatment of asthama and bronchitis. The leaves are used as fodder. Alcoholic extract of the fruit is anti-viral. It is a popular drug ingredient of ' Triphala ' and ' Chyavanprash '.

(R) ENZYMES

Enzymes are the protein substances, which serve a role of catalysing the biochemical reactions.

Although, they are an essential constituent of living cell, they can act independently. They are colloidal in nature, heat-labile, and highly specific in action. Enzymes are sensitive to pH and to particular substances which act as activators. They are classified according to the type of reaction they catalyse. Normally they are named by adding the suffix-ase to a specific substrate upon which they act. The enzymes are classified into following categories :

1. **Hydrolases** for catalysis of hydrolytic reactions.
2. **Transferases** for the transfer of chemical group from one molecule to another.
3. **Oxido-reductases** catalyse the oxidation-reduction reactions.
4. **Lyases** catalyse the addition of groups to double bonds or vice versa.
5. **Isomerases** are responsible for intramolecular rearrangements.
6. **Synthetases** catalyse the condensation of two molecules coupled with the cleavage of pyrophosphate bond of ATP or similar triphosphate.

Many of the enzymes also possess non-protein chemical groups. An enzyme moiety comprises of a protein component ' apoenzyme ' and a prosthetic group representing non-protein component. The latter is also called as cofactor or coenzyme. Certain metals and vitamins also act as coenzymes.

DIASTASE

Synonyms : Amylose, salivary diastase, malt diastase.

Biological Source :

It is one of the amylolytic enzymes present in saliva i.e. salivary diastase or *ptyalin* and pancreatic diastase or *amylopsin*, found in the digestive tract of the animals (Also known as *animal-diastase*).

It is also formed during the germination of barley grains and known as *Malt-diastase*.

Several amylolytic enzymes or carbohydrases of commercial importance are known, many of them are also used in therapeutics. Zymase, maltase, sucrase, cellulase, invertase, hyaluronidase, lysozyme are amongst the important amylolytic enzymes.

Description (Fig. 9.74) :

Colour : Whitish powder.

Odour : Characteristic.

Size : Unicellular micro-organism measuring less than 1.5 μ.

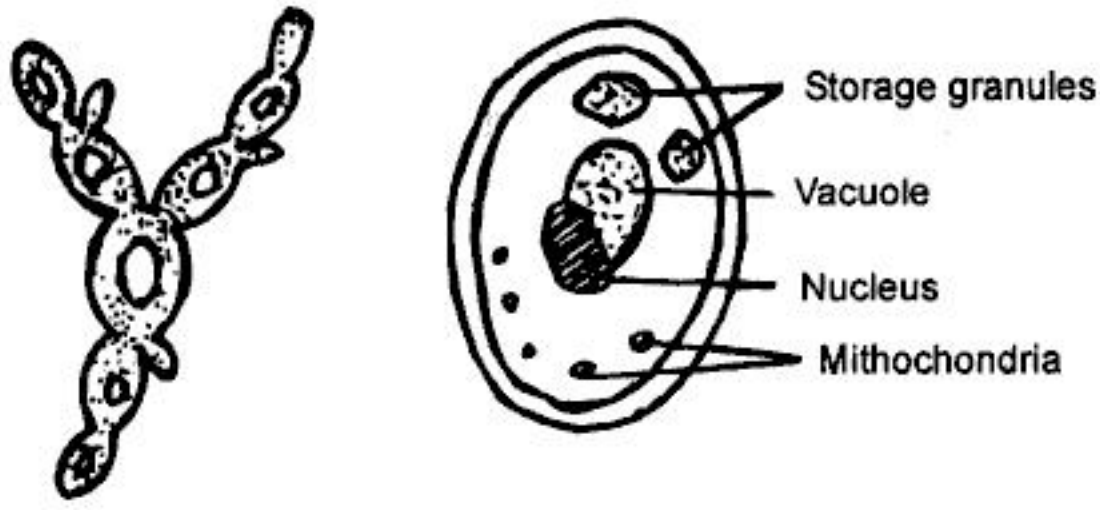


Fig. 9.74 : Budding Yeast

Manufacture of Yeast :

Various substrates are used for the commercial production of yeast as mentioned above. But, common and industrially used are beet and cane-mollasses. A suitable strain like *S. cerevisiae* is grown and it is transferred to sterilised substrate. The equipment is sterilised to get rid of bacteria and other micro-organisms. The nutrient medium on which the yeast is grown is continuously added to the culture medium. It is confirmed that the sugar content of nutrient medium is not more than 1%. The pH is kept in-between 4 to 4.5 and temperature at 25 to 30°C. Nitrogenous nutrients like ammonium sulphate and sugar phosphate are added to the nutrient medium and fermentation is allowed to take place for about 11 hours. Yeast is separated in centrifuge, washed with sterilised cold water, press filtered and finally dried. The moisture content of the final product is maintained at 75 % and it is filled in containers and stored at low temperature.

Chemical Constituents :

The yeast contains about 65 to 85 % of moisture, nitrogenous compounds (proteins), glycogen, fat and vitamins. Vitamins reported are thiamine, riboflavine, nicotinic acid, pantothenic acid, folic acid, biotin etc. The enzymes invertase, diastase, zymase and maltase are present in yeast.

Uses :

The yeast is used in manufacture of alcohol, beer and various wines and in the bread industry, to raise dough. Irradiated yeast has been used as a source of vitamin D. Glutathion and invertase are also manufactured from yeast. It is a good source of protein.

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Fig. 9.88 : Honey-bee

Extra Features :

Yellow bees-wax is non-crystalline solid. It is soft to touch and crumbles under the pressure of fingers to plastic mass. Under molten condition, it can be given any desired shape. It breaks with a granular fracture.

Solubility :

It is insoluble in water, soluble in hot alcohol, ether, chloroform, carbon tetrachloride, fixed and volatile oils.

Standards :

Melting point	:	60 to 65° C
Specific gravity	:	0.958 to 0.967
Acid value	:	5 to 8
Sap. value	:	90 to 103
Ester value	:	80 to 95

Chemical Constituents :

The chief constituent of beeswax is myricin i.e. myricyl palmitate (about 80 %). Free cerotic acid (about 15 %), small quantities of melissic acid and aromatic substance cerolein are the other constituents. Indian beeswax has the acid value of 17 to 22.

Uses :

Beeswax is used in preparation of ointments, plasters and polishes. It is used in ointment for hardening purposes in the manufacture of the candles, moulds and in dental and electronic industries. It is also used in the cosmetics for the preparation of lipsticks and face creams. Pharmaceutically, it is an ingredient of paraffin ointment I.P.

White bees wax : Obtained by bleaching yellow bees wax, should not be used for ophthalmic purposes.

Adulterants :

Very frequently, beeswax is adulterated with colophony, hard paraffin, stearic acid, Japan wax, spermaceti, carnauba wax and several other substances. Adulteration can be detected on the basis of solubility and melting points. The genuine wax should not give turbidity when 0.5 g of wax is boiled with 20 ml of aqueous caustic soda for 10 minutes and cooled.

PECTIN

Pectin is a complex carbohydrate component found in nature in the middle lamella of plant cells, forming colloidal solution in water. Chemically, pectin is a neutral methoxy ester of pectic acid. Pectins are polyuronides and consist of mixtures of pectic substances like proto-pectin, pectin, pectinic acid and calcium pectate. They are obtained from inner portion of rind of citrus fruits or other vegetative matter such as sun-flower, papaya etc. Pectin is a reversible colloid i.e. it may be dissolved in water, precipitated, dried and redissolved without altering its physical properties. Pectin, by addition of water, forms the lumps which on heating goes into solution. The solution is clear to transmitted light and cloudy to reflected light. Under certain conditions, in presence of sugar and acid, it forms jelly like mass.

Pectin is available in number of plants, belonging to different families. Following are few important sources of pectin.

Lemon peel	:	10 - 15 %
Orange peel	:	10 - 12 %
Apple pomace	:	10 - 15 %
Carrots	:	10.0 %
Sunflower-heads	:	5.0 %

Papaya, guavas and mangoes are also rich sources of pectin. Pectin has several industrial and pharmaceutical applications. Most of the Indian needs are met by import. In India, very few units are manufacturing pectin on commercial scale. U.S.A., Switzerland and other European countries are producing pectin either from citrus peels or from apple pomace. Pectin is standardized on 'gelly-grade' i.e. its 'setting power' by the addition of sugar (100, 150 and 200 gelly grades are supposed to be standard grades for food and medicinal use).

Biological Source :

Pectin is the purified carbohydrate product obtained by acid hydrolysis from inner portion of the rind of citrus peels i.e. *Citrus limonis* or *Citrus aurantium*, (Family : Rutaceae).

Method of Manufacture :

Depending upon the raw material from which it is to be isolated, process of manufacture needs suitable modification. The type of pectin (i.e. low methoxy group or high methoxy group) needed should also be considered. Following is the general process for isolation of pectin from citrus peels.

material is then washed with water, put into a cloth bag and extracted with water for few hours by heating on a water-bath at a temperature not exceeding 85°C, as higher temperature and direct heating affect the quality of gelatin. The extraction process is repeated, solution is sedimented and treated with alum, egg-albumin or animal blood to remove impurities like albumin, mucin, mineral matter etc. The purified solution is decolourised with animal charcoal, concentrated in multiple effect evaporator and chilled. Solid mass is cut into strips and dried in vacuum. When the bones are used as the raw materials, they are required to be crushed, extracted with lipid solvent like ether or benzene to remove fatty material and their inorganic phosphates and removed by treating them with dilute hydrochloric acid. The osses in is left in acid solution as residue. This is further limed when collagen gets converted into gelatin. The pH maintained during preparation should be below 7.7. The digested solution is filtered and evaporated under reduced pressure. The gelatin is dried at low temperature.

Description (Fig. 9.89) :

Colour : It is colourless or pale yellow.

Odour : Characteristic.

Taste : Slight and broth-like.

Size : It is obtained in the form of shreds, sheets, flakes, and coarse or fine powder. The sheets and flakes are transluscent. It is quite stable in air when dried, but is subject to microbial contamination, when moist or in the form of solution.

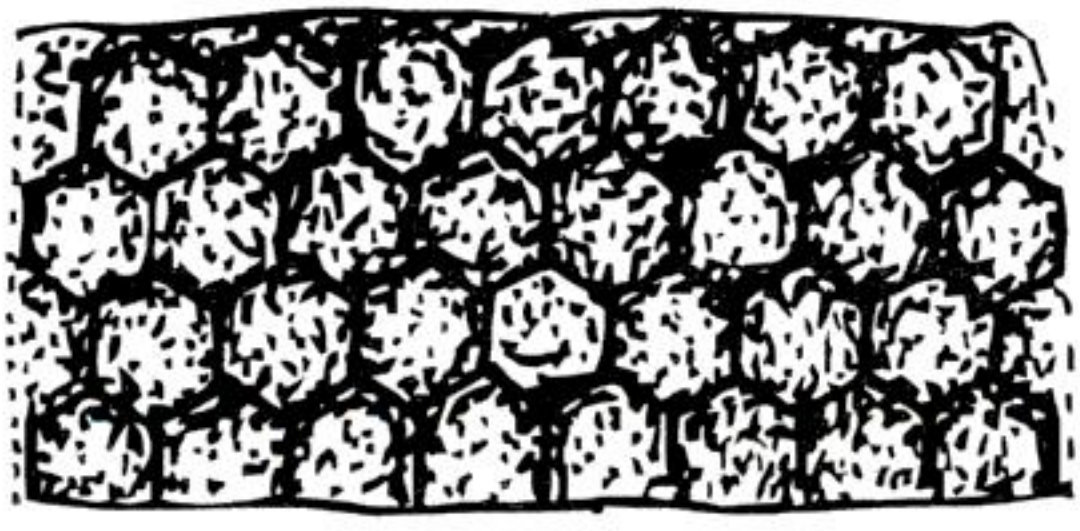

Fig. 9. 99 : Gelatin Sheet

It is practically insoluble in cold water, but swells and softens when immersed. It gradually absorbs 5 to 10 times its own weight of water. It is soluble in hot water, in the mixture of glycerin and water and also in acetic acid. It is insoluble in alcohol, chloroform and solvent ether.

Geographical Source :

Sea-weeds are found in Atlantic and Pacific Oceans, particularly in coastal lines of Japan, U.S.A., Canada, Australia and Scotland. In India, it is found on the coast of Saurashtra. The largest quantity of world production of algin is in U.S. and U. K.

Preparation of Sodium Alginate :

The brown coloured algae is used for extraction of alginic acid. The colour is due to carotenoid pigment present in it.

M. pyrifera, the principal source for global supply, is a perennial plant that lives from 8 to 12 years, and grows, as much as, 30 cm per day. This giant kelp is found mainly in Pacific ocean. It grows on stands from 15 metre to 1.5 km in width and several km in length. The mechanical harvesting is done, about four times a year.

Alginic acid is present in the cell wall. First of all, the sea-weed is harvested and dried. The dried sea-weed is then milled and extracted with dilute sodium carbonate solution which results in a pasty mass. It is then diluted to separate the insoluble matter. Soft water is only used for extraction purposes, so as to avoid the incompatibilities. It is treated with calcium chloride or sulphuric acid for conversion into either calcium alginate or insoluble alginic acid, which is collected and purified by thorough washing. If calcium is used, it is treated with hydrochloric acid. Alginic acid so collected, is treated with sodium carbonate for neutralisation and conversion into sodium salt. The alginic acid content on dry solid basis varies from 22 to 35 % in all the varieties of brown algae.

Description :

Colour : White to buff coloured powder.

Odour : Odourless.

Taste : Tasteless.

Solubility :

It is readily soluble in water forming viscous colloidal solution and insoluble in alcohol, ether, chloroform and strong acids. 1 % solution of gum at 20°C may have a viscosity in the range of 20 to 400 Centipoises.

Properties :

It loses about 20 % of its weight on drying. Sodium alginate is incompatible with calcium salts, phenyl mercuric acetate and nitrate, crystal violet, alcohol in the concentrations above 5 % and heavy metals. It is also precipitated below pH 3.0.

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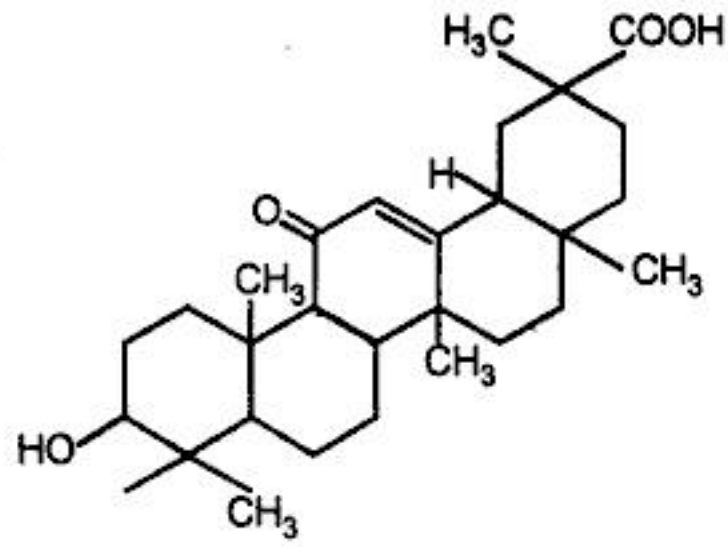


Glycyrrhetinic acid (Glycyrrhetic acid)

Uses :

Glycyrrhiza is used as demulcent and mild expectorant. It is used as a sweetening agent, an antispasmodic, anti-inflammatory and antiulcer drug. It is used as a flavouring agent and for improving taste of bitter medicines like quinine, cascara etc. It is also used in cough-lozenges, cough-pastilles and also as an absorbent pill excipient in the form of powder. Glycyrrhiza does not exhibit laxative property as described many a time, but it potentiates laxative action of senna. One of the constituents of glycyrrhizin, i.e. Glycyrrhetinic acid in the form of disodium salt is used as an anti-inflammatory agent in gastric ulcers. Glycyrrhetinic acid is used in the treatment of Addison's disease. Residual matter produced in the preparation of liquorice extract is reported to have been used as a foam stabilizer in foam type of fire extinguisher. Liquorice is used as a flavouring agent. Ammoniated glycyrrhiza is used as a flavouring agent in beverages, confectionary and pharmaceuticals. Ammoniated Glycyrrhiza is 50 times sweeter than sucrose. However, it cannot be used as a flavouring agent in acidic medium. Liquorice in the form of sticks or rolls is used for manufacture of confectionaries. Liquid extract of liquorice, granulated and spray dried liquid are supposed to be ideal for this purpose.

PICRORRHIZA

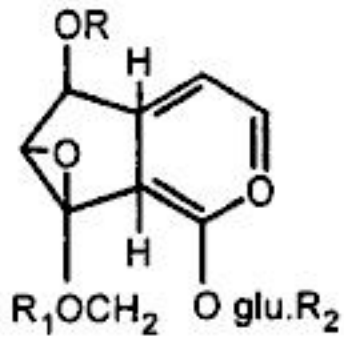
Synonyms : Indian gentian, kutki

Biological Source :

Picrorrhiza consists of dried rhizomes of the plant *Picrorrhiza kurroa* (Scrophulariaceae), cut in small pieces and freed from attached root-lets.

Geographical Source :

Picrorrhiza is a perennial herb well distributed in upper Himalayas and also in China. It is found growing naturally in Kashmir and Sikkim. It is also reported in Punjab, Uttar Pradesh and Himachal Pradesh. The drug is collected from naturally growing plants and may be cultivated at higher altitudes (2700 - 4500 m) in Himalayas. It is propagated by seeds and also from rhizomes (Fig. 9.92).



The drug is found to contain irridoid bitter substances, picroside I, picroside II and kutkoside. Picrosides and kutkoside are monoterpene glycosides with an epoxy oxide in ring.

Uses :

Picrorrhiza is used as a valuable bitter tonic, antiperiodic, febrifuge and stomachic. It is laxative in large doses. Alcoholic extract of the root is found to have antibacterial effect. The drug is found useful in treatment of jaundice.

LINSEED OIL

Biological Source :

It consists of fixed oil obtained from the dried fully ripe seeds of *Linum usitatissimum*, Linn., (Family : Linaceae).

Geographical Source :

It's origin is uncertain, but it is regarded as indigenous to India. It is cultivated at present extensively as a source of fibres in Egypt, Algeria Spain, Italy and Greece, while as a source of oil in Turkey, Afghanistan and India. In Russia, it is cultivated for both oil and fibre. (Fig. 9.93).

Method of Preparation :

The variety yielding high percentage of oil is selected for extraction of oil. Seeds are sieved to make free of earthy matter and other mat

Commercially, linseed oil is produced by use of expellers. Before the seeds are subjected to the expellers, they are rolled into meal, then moistened and heated by means of steam-jacketed troughs filled over the expellers. An average yield of oil is 30 - 35 %. The expressed oil is tanked for a long period to settle colouring matter and mucilage. The oil is then treated with alkali immediately after filtration. Alkali treatment helps to remove free fatty acids. Bleaching of the oil is done by using either charcoal or fueller's earth at elevated temperature. The refined oil produced as above, is chilled to separate wax.

Description (9.94) :

Colour : Yellow coloured clear liquid.

Odour : Characteristic.

Taste : Pleasant.

Linseed oil gradually thickens on exposure to air forming thin transparent film.

Caution :

To meet requirements of various industries, different grades and types of linseed oil are available in the market. Boiled linseed oil dries at a faster rate and forms smooth and lustrous film. Thus, linseed oil that has been boiled or treated in dryers such as linoleates or resinates of lead manganese, cobalt or zinc should not be used in medicine.

Adulterants :

Linseed oil is adulterated with boiled linseed oil, cotton seed oil, sunflower oil, rosin, mineral fish oils and mustard oil. Fish oil is detected by odour and rosin and mineral oils are detected by studying the composition of unsaponifiable matter.

SHANKHPUSHPI

Synonyms : Shankhwel, Shankhphuli

Biological Source :

This consists of the aerial parts of the plant known as *Canscora decussata*, (Family : Gentianaceae).

Geographical Source :

Shankhpushpi is found throughout India upto an altitude of 1300 m. It is also grown in Sri Lanka and Myanmar.

Organoleptic Characters :

It is much branched annual propagated by seeds. The flowering season of this plant is from October to December. The plant is cultivated in the gardens as ornamental plant for its flowers. This is an erect annual with four winged stems half a metre in length and decussate branches. It grows well in moist situations.

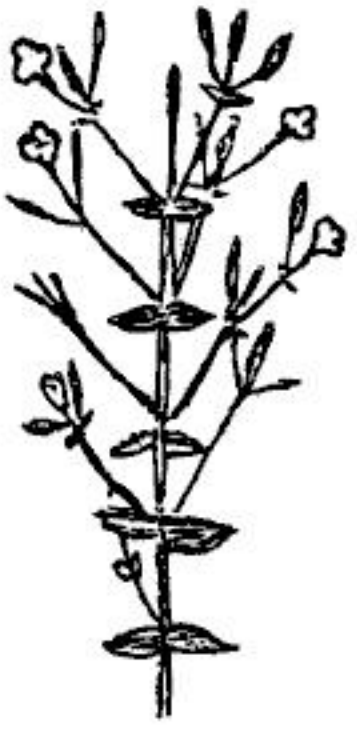


Fig. 9.95 : *Canscora decussata* Herb

Leaves, sessile, 2.5 to 4.0 cm in length, lanceolate decussate, three prominent verticle lines flowers, axilliary, solitary white or yellowish.

Chemical Constituents :

Drug is found to contain bitter substance and an oleo-resin. Two crystalline compounds have been isolated from the aqueous and alcoholic extracts of the plant. Shankhpushpi is found to contain triterpenes, alkaloids and xanthones.

Uses :

Entire plant, as well as, fresh juice are used in medicine. It is regarded as bitter, alternative and nervine tonic. The fresh juice of the plant is prescribed in insanity, epilepsy, and nervous debility. Alcoholic extract possesses anti-viral activity against Ranikhet disease virus (chicks).

Substitutes :

Canscora diffusa distributed throughout India is used as substitute for Shankhpushpi. In gardens, it is grown as an ornamental plant for its rosy flowers.

Note :

Some scientists have identified Shankhpushpi as *Evolvulus alsinoides* (Convolvulaceae). It is a procumbent or sub-erect shrub. Stems are woody at base. Leaves are about one inch long, linear, oblong or mucronate, obtuse, subsessile with tapering base. Flowers are auxiliary, solitary or 2 - 3 together, pedunculate bluish or white coloured, flowering season July or November. Roots are 5 to 15 cm in length, white with penetrating odour.

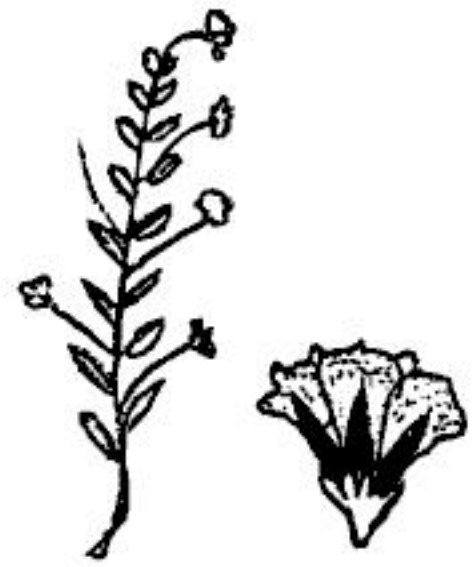


Fig. 9.96 : *Evolvulus alsinoides* Herb

The drug contains an alkaloid shankhpushpine and volatile oil, in addition to potassium chloride. It is used as brain tonic and sedative.

GARLIC (LAHSUN)

Synonyms : Allium

Biological Source :

This consists of bulbs of the plant known as *Allium sativum* Linn., (Family : Liliaceae).

Geographical Distribution :

Lahsun is cultivated in Central Asia, Southern Europe, U.S.A. and India. In India, it is found in almost all the states and cultivated as a spice or a condiment crop.

Cultivation and Collection :

Garlic is cultivated in well drained moderately clay loamy soil. It needs cool moist climatic conditions during the growth and dry period during maturity. Garlic is a hardy perennial herb with narrow flat leaves and bears white small flowers and bul-bils. The flat leaves of drug is done by planting bulbs generally, in the month of September to late in

October. It takes about four months for harvesting. It is also taken as an alternate crop with many other vegetables. For cultivation, about 300 kg of bulbs per hectare are required, and yield per hectare is about 8,000 kg.

India produced 2,86,700 tonnes of garlic in 1987 - 88 alone, in 80,000 hectares.

Organoleptic Characters (Fig. 9.97) :

Colour : Bulbs are white to pink in colour.
Odour : Characteristic and aromatic.
Taste : Aromatic and pungent.
Size : 1.5 to 2.5 cm.

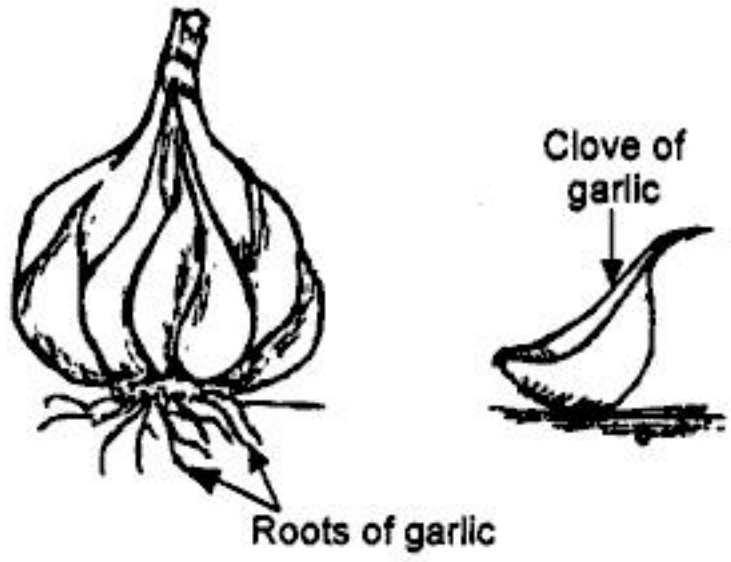
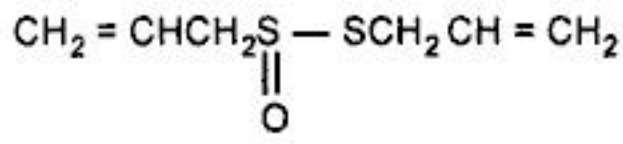


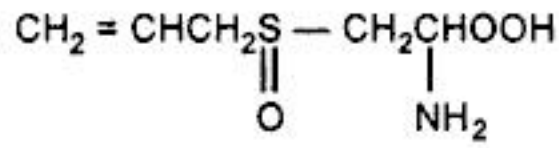
Fig. 9.97 : Garlic Bulb

Chemical Constituents :

Garlic bulbs contain 29 % carbohydrates, about 56 % proteins (albumin), 0.1 % fat, mucilage, and 0.06 to 0.1 % volatile oil. It also contains phosphorous, iron and copper. Volatile oil of the drug is the chief active constituent, and contains allyl propyl disulphide, diallyl disulphide, alliin and allicin. Alliin, by action of enzyme allinlyase, is converted into allicin. Garlic oil is yellow in colour and has specific gravity of 1.046. It is optically inactive.



Allicin



Alliin

Uses :

Garlic is used as carminative, aphrodiasiac, expectorant, stimulant, and disinfectant in the treatment of pulmonary conditions. It is largely used as condiment. Oil of garlic is used as anthelmintic and rubefacient. Allicin is antibacterial. Garlic oil is useful in high blood pressure and atherosclerosis. It is reported to possess cholesterol suppressing properties.

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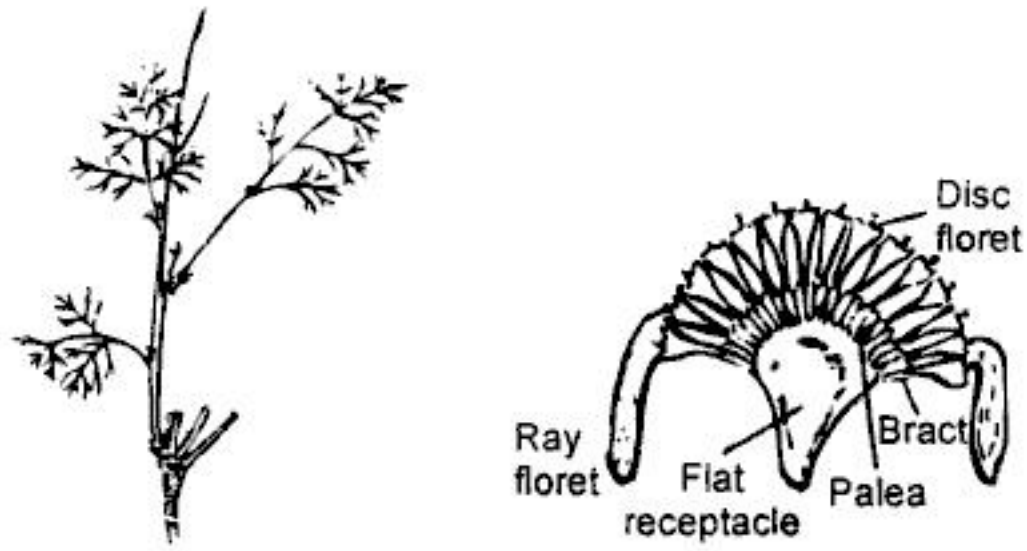

(a) Pyrethrum Herb **(b) Pyrethrum Flower**

Fig. 9.102

Extra Features :

Peduncle is short and longitudinally striated. Involucre of three yellowish green bracts and keel are pronounced. Ray-florets (female) are 15 - 23 in number. Disc-florets are 200 - 300 (hermaphrodite), each with 5 lobed yellow coloured tubular corolla.

Chemical Constituents :

The active constituents of pyrethrum flowers are collectively known as pyrethrins which are organic esters, chemically, made up of carboxylic acid and keto-alcohols. The constituents are known as pyrethrin-I, pyrethrin- II, cinerin-I, cinerin-II, jasmolin-I and jasmolin-II. Pyrethrin-I, cinerin-I and Jasmolin-I, are the esters of chrysanthemic acid, whilst pyrethrin-II, jasmolin-II and cinerin-II are esters of pyrethric acid.

Ester	Acid	Alcohol
Pyrethrin- I	Chrysanthemic acid	Pyrethrolone
Pyrethrin - II	Pyrethric acid	Pyrethrolone
Cinerin -I	Chrysanthemic acid	Cinerolone
Cinerin - II	Pyrethric acid	Cinerolone
Jasmolin - I	Chrysanthemic acid	Jasmololone
Jasmolin - II	Pyrethric acid	Jasmololone

Additionally it also contain pyrothrosin, pyrethrol sesquiterpene lactones.

Commercially available allethrins are the synthetic analogues of naturally occurring insecticides i.e. pyrethrin, cinerin and Jasmoline.

Uses :

It is a natural contact insecticide. It is used in the form of aerosols containing 0.2 to 1% extract. It is also used in preparation of mosquito coils and sticks and insect repellent formulations. The sprays of 'pyrethrum concentrates' are prepared in kerosene or other non-polar solvent.

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Mr. Asan, Dhorbenla
S. Honne
Tm. Vengai
T. Yeggi

PUNARNAVA

B. Sabunba
G. Lalsabuni
H. Lalsabunooch
K. Muchchu-joni
Mr. Pandhari-punernava
S. Punernavi
Tm. Sharunai
T. Galijeru

RAUWOLFIA

B. Chandra
G. Sarpagandho
H. Chhotachand
M. Sarpagandha
Mr. Sarpagandha
S. Punernavi
Tm. Govannamilpuri
T. Patala agandhi

RHUBARB

B. Bangal-arevanchini
G. Gamnir-eranchini
H. Revakinni
Mr. Ladaki-revanchini
S. Gandhini
Tm. Nettureval chini
T. Nethurewal chini

SANDAL-WOOD

B. Chandan
H. Safedchandan
K. Chandana
M. Chandnam
Mr. Chandan
Tm. Ingam
T. Chandunamu

SAUSSUREA

B. Kur
G. Kut
H. Kut, Pachak
M. Sepuddy
Mr. Ooplet
S. Kushtha
Tm. Koshtam
T. Koshtum

SENNA LEAF

B. Sonamukhi
G. Nat-kisana
H. Sena-ka-patta
K. Nilavaka
Mr. Sonamukhi
S. Swarnamukhi
Tm. Nilavarai
T. Sunamikhi

SHANKHAPUSHPI

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G. Shankhaphuli
Mr. Shankhvel
S. Shankhapushpi

SHATAVARI

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H. Satawar
M. Shatawali
Mr. Shatavari
S. Shatmuli, Tagar
Tm. Shimaishdavari
T. Challagadda

TOBACCO

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G. Tamaku
H. Tambaku
M. Pokala
Mr. Tambakhu
S. Tamakhu

Tm. Pugaivilay
T. Pogaku

TULSI

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G. Tulsi
H. Tulsi
K. Vishnu-tulsi
M. Trittaru
Mr. Tulsi
S. Manjiri
Tm. Thulasi
T. Thulasi

TURMERIC

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G. Halada
H. Haldi
K. Arishina
Mr. Halad
S. Haldi, Haridra
Tm. Manjal
T. Pasupu

VASAKA

B. Bakas
G. Adsoge
H. Arusha
K. Adusoge
M. Adalodagam
Mr. Adulsa
S. Vasa
Tm. Adatodai
T. Addasaramu

VINCA

B. Nayantara
H. Sadabahar
Mr. Sadaphuli
T. Billaganneru

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2. GLOSSARY

Most of the technical terms used for the macroscopic and microscopic descriptions of crude drugs and also to describe their pharmacological and pharmaceutical uses are included in this glossary.

1. BOTANICAL TERMS

Achene	:	A simple dry one-seeded, indehiscent fruit with unfused seed coat and fruit wall, but with no special method to liberate the seeds.
Adventitious	:	Arising from abnormal position.
Adventitious roots	:	Arising from stems or leaf cutting but not from primary root.
Adventitious buds	:	A bud which develops in some other place than the axils of leaves or stem apices.
Aerenchyma	:	Tissue comprising of thin walled cells with large airsacs found in different parts of plants.
Aleurone grains	:	Protein granules found in plants, quite often in seeds.
Algae	:	Simple lower plants capable of carrying out the photosynthesis and with unicellular organs or reproduction.
Androecium	:	Collective term, for the stamens of flower.
Angiosperm	:	Flowering plant.
Anther	:	Pollen bearing part of a stamen.
Anticlinal	:	Situated approximately at right angles to outer surface of plant part.
Annual	:	Plant that completes its life cycle from seed germination on seed production followed by death, in a single season.
Annual ring	:	The layer of xylem (wood) formed by one year's growth of cambium.
Annual thickening	:	Internal thickening of wall of xylem vessel so as to form rings at intervals alongwith its length.
Apical	:	Of the tip.
Apothecium	:	Cup-shaped fruit body of certain ascomycete fungi.
Aril (Arillus)	:	Succulent development of stalk or base of seeds of fungi (mycophyta).
Ascomycetes	:	Group of fungi (mycophyta).
Ascospore	:	A spore produced by sac (ascomycete).
Ascus	:	A sac-like structure within which ascospores are produced.
Auxins	:	Growth regulating substance or plant hormones.

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