6

CARBOHYDRATES

The carbohydrates include simple sugars and polysaccharides. They are carbonyl alcohols containing the elements carbon, hydrogen and oxygen. The last two elements are usually present in the same proportions as in water. Carbohydrates are the primary products of photosynthesis and from them the plant synthesizes various chemical constituents by subsequent organic reactions. They are most abundant components of both plants (cellulose, starch, sugars) and animals (glycogen). Sugars are united with many compounds to form glycosides.

Generally carbohydrates are divided into two groups :

(1) monosaccharides or simple sugars, and

(2) polysaccharides.

Sugars are polyhydroxy-aldehydes or ketones and contain an unbroken chain of carbon atoms. Oligosaccharides are carbohydrates whose molecules consist of not more than a few monosaccharide units linked through oxygen. They are subdivided into disaccharides, trisaccharides, etc. They are hydrolyzed with water in the presence of catalysts or enzymes to produce monosaccharide molecules. On the basis of number of carbon atoms in the molecule monosaccharides are classified as trioses (with three carbon atoms), tetroses (four carbon atoms), pentoses (five carbon atoms), and hexoses (six carbon atoms). Sugars are soluble in water, crystalline compounds and sweet in taste. Monosaccharides like glucose possessing aldehydic group are called aldoses, ketone group containing sugars (fructose) are known as ketoses.

Polysaccharides are substances of very high molecular weight consisting of large number of monosaccharide units linked through oxygen. The hydrolysis of polysaccharide, by enzymes or reagents, yields in a succession of cleavage and the end products are monosaccharides. On the basis of these final products polysaccharides yielding hexose are called hexosans; starch yielding glucose is known as glucosan and inulin producing fructose is termed as fructosan. The fundamental unit of plants is made of a polysaccharide, cellulose, which consists of glucose units joined by β-1, 4-linkages. The other plant constituents of high molecular weight are hemicelluloses which are more soluble and more easily hydrolyzed. Gums and mucilages are related to hemicelluloses. Gums consist largely of pentose and hexose moeties and hydrolysis yields galactose and arabinose. Hemicellulose on hydrolysis produces another type of sugars like glucose, mannose and xylose, Gums are formed by decomposition of the cellulose or by injuring the plant and some of them constitute an important group of drugs as emulsifying agents, suspending agents for insoluble powders in mixtures, as adhesive in pills and tablets, and for the preparation of hand lotions and other cosmetic items. Pectins are also related to cellulose in structural skeleton. Polysaccharides are neither sweet nor crystallizable, insoluble in water and does not form colloidal solutions.

CHEMICAL TESTS

1. **Fehling's Solution Test** : The substance (0.5 g.) is heated with dilute hydrochloric acid to hydrolyse a polysaccharide. The reaction mixture is neutralized by addition of sodium hydroxide solution and then Fehling's solutions 1 and 2 are added. Red precipitate of cuprous oxide is produced on heating in case of reducing sugars (all monosaccharides, and many disaccharides like lactose, maltose, cellobiose and gentiobiose). Non-reducing sugars include some disaccharides (sucrose and trihalose) which on boiling with acids are converted into reducing sugars.
2. **Molisch Test** : A solution of carbohydrate is prepared in water containing α-naphthol. On addition of concentrated sulphuric acid along the side of test tube a purple ring is formed on the junction below aqueous layer. With insoluble carbohydrates (e.g. cellulose)

the colour will produce on shaking the reaction mixture.

3. **Osazone Formation** : A sugar on heating with phenylhydrazine hydrochloride, sodium acetate and acetic acid forms yellow crystals of osazone.
4. **Resorcinol Test for Ketoses *(Selivanoff's Test)*** : A crystal of resorcinol is added to the solution and heated with an equal volume of concentrated hydrochloric acid. Pink colour is produced in case of ketoses (e.g. fructose, honey or hydrolyzed inulin).
5. **Test for Pentoses** : A solution of the material is heated with equal volume of hydrochloric acid containing a little phloroglucinol. A red colour is formed in case of pentoses.
6. **Keller-Kiliani Test for Deoxysugars** : A deoxysugar (found in cardiac glycosides) is dissolved in acetic acid containing a trace of ferric chloride and transferred to the surface of concentrated H_2SO_4. A reddish-brown colour is formed at the junction which turns blue latter on.
7. **Furfural Test** : A carbohydrate sample is heated in a test tube with a drop of syrupy phosphoric acid to convert it into furfural. A disk of filter paper moistened with a drop of 10% solution of aniline in 10% acetic acid is placed over the mouth of the test tube. The bottom of the test tube is heated for 30-60 seconds. A pink or red stain appears on the reagent paper.

HONEY

Synonyms : Purified Honey, Mel, Clarified Honey, Strained Honey; Madhu (Hindi).

Biological Source : Honey is a sugary secretion deposited by the honeybees, *Apis mellifera* Linn. and other species of *Apis* in the honeycomb. It must be free from foreign substances such as parts of insects, leaves, etc., but may contain pollen grains.

Order : Hymenoptera.

Family : Apidae.

Habitat : Honey is produced mainly in England, West Indies, California, Canada, Chile and in some parts of Africa, Australia and New Zealand.

Collection : Honeybees live in swarms which are gathered into hives. A hive contains :

1. a single queen bee,
2. the males or drones, and
3. the worker bees which are undeveloped females.

The worker bees possess a long, hollow tube to insert into the nectaries of the flowers. The tube is formed from the maxillae and labium. They take nectar from the flowers and pass it through the oesophagus into the honey-sac or crop. The nectar, which is an aqueous solution of sucrose (25%), is mixed with salivary secretion containing the enzyme invertase and then is hydrolyzed into the invert sugar. On returning at the hive the worker bees deposit the contents of the honey sac in the previously prepared cell of the honeycomb. The filled cell is sealed by wax. For collecting the honey, the honeycomb is smoked to remove bees, the comb is cut and honey is collected either by drainage or by expression. The honey obtained by latter procedure is contaminated with the wax. For getting purified honey, it is heated at 80°C when the impurities float on the surface which are removed.

Characters : Honey is thick, syrupy, translucent liquid when fresh. The colour is pale yellow or reddish-brown and it possesses pleasant odour and sweet taste which are dependent upon the floral source of the product. The honey obtained form *Eucalyptus* and *Banksia* species has somewhat unpleasant odour and taste and the honey collected from *Datura stramonium* is poisonous. On storage it becomes opaque and granular due to the crystallization of dextrose.

Chemical Constituents : Honey consists chiefly of glucose (30-40%), fructose (40-50%) and small amounts of sucrose (0.1-10%), dextrin, formic acid, volatile oil and pollen grains. In addition to these, traces of enzymes, vitamins, proteins, maltose, melezitose, pentosans, gums, trace elements, amino acids and colouring matter are also present in honey.

Uses : Honey shows mild laxative, bactericidal, sedative, antiseptic and alkaline characters. It is used for cold, cough, fever, sore eye and throat, tongue and duodenal ulcers, liver disorders, constipation, diarrhoea, kidney and other urinary disorders, pulmonary tuberculosis, marasmus, rickets, scurvy and insomnia. It is applied as a remedy on open wounds after surgery. It prevents infection and promotes

healing. Honey works quicker than many antibiotics because it is easily absorbed into the blood stream. It is also useful in healing of carbuncles, chaps, scalds, whitlows and skin inflammation; as vermicide; locally as an excipient, in the treatment of aphthae and other infection of the oral mucous membrane. It is recommended in the treatment of pre-operative cancer. Honey, mixed with onion juice, is a good remedy for arteriosclerosis in brain. Diet rich in honey is recommended for infants, convalescents, diabetic patients and invalids.

Honey is an important ingredient of certain lotions, cosmetics, soaps, creams, balms, toilet-waters and inhalations. It is used as a medium in preservation of cornea.

Adulterants : Honey is adulterated with cane sugar, corn syrup and artificial invert sugar which is obtained by acid hydrolysis of sucrose. The sugar contains furfural which gives red colour with resorcinol in the presence of hydrochloric acid. On prolonged heating or storage of the honey furfural may be formed in the genuine honey.

Chemical Tests : Adulteration in honey is determined by the following tests :

1. **Fiehe's Test for Artificial Invert Sugar** : Honey (10 ml) is shaken with petroleum or solvent ether (5 ml) for 5-10 minutes. The upper ethereal layer is separated and evaporated in a China dish. On addition of 1% solution of resorcinol in hydrochloric acid (1 ml) a transient red colour is formed in natural honey while in artificial honey the colour persists for sometime.
2. **Reduction of Fehling's Solution** : To an aqueous solution of honey (2 ml) Fehling's solutions 1 and 2 are added and the reaction mixture is heated on a steam bath for 5-10 minutes. A brick red colour is produced due to the presence of reducing sugars.
3. **Limit Tests** : The limit tests of chloride, sulphate and ash (0.5%) are compared with the pharmacopoeial specifications.

STARCH

Synonym : Amylum

Biological Source : Starch of pharmaceutical use consists of polysaccharide carbohydrate occurring as discrete granules

in the mature grain of corn, *Zea mays* Linn. (Fam: Gramineae) or of wheat, *Triticum aestivum* Linn. (Gramineae), or tubers of potato, *Solanum tuberosum* Linn. (Solanaceae) or rice, *Oriza sativa* Linn. (Gramineae), or arrowroot, *Maranta arundinacea* Linn. (Marantaceae). Commercial starch is also obtained from tapioca or cassava starch, *Manihot utilissima* Pohl. (Fam : Euphorbiaceae).

Geographical Source : Commercially the starch is produced in U.S.A., Argentina, India, China, Japan and other tropical and sub-tropical countries.

Preparation : Various procedures are used to prepare a particular starch. In cereal grains starch is present in the endosperm along with cell debris, oil, soluble and insoluble proteins (gluten). These substances are removed during the preparation of starch.

1. Preparation of Maize Starch

The grains are softened by soaking in an aqueous solution of sulphurous acid (0.2%) at 50°C for 2-3 days to free the starch from fibres. The softened grain is crushed in rollers to separate embryo or germs. The germs are used to prepare germ oils (fixed oils) which are source of vitamins and contain unsaturated fatty acids like linoleic and linolenic acids. The milky liquid is filtered through sieves to remove cell-debris and some of gluten as it is lighter than starch. The remaining proteins may be separated by repeated tabling method in which the suspension is allowed to flow slowly through toughs about 40 m long and 0.7 m wide shallow tables when the heavier starch deposits first. In a modified procedure the total mixture of starch and proteins is fractionated into gluten and starch by the use of special starch purification centrifuges. Traces of proteins are separated by treating starch with dilute alkali to dissolve the former. Then the starch is dried by flash dryers or a moving-belt dryer.

2. Preparation of Rice Starch

Broken rice pieces are softened by macerating in aqueous sodium hydroxide solution (0.4%) and then crushed. The ground material is mixed with water and the starch is separated by standing or by means of a centrifuge. It is washed, dried at 50-60°C and powdered.

3. Preparation of Wheat Starch

To the wheat flour water is added to prepare dough and then kept for one hour to allow gluten to swell. The balls of dough are shaken with water on grooved rollers. Liquid containing starch falls below from which it is separated by centrifugation, washed and dried.

4. Preparation of Potato Starch

Potatoes are washed, crushed in a rasping machine and the cell-debris is removed from the pulp by rotary sieves after addition of water. The liquid contains starch, soluble proteins, salts and some cellular tissues. On standing, the starch separates more rapidly. It may be purified by centrifugation. The washed starch is dried and pulverized.

Characters : Starch occurs in irregular, angular powder or a white mass, insoluble in cold water and forms a colloidal solution on boiling. On cooling the solution forms a translucent jelly. It produces deep blue colour with iodine solution. Starch granules undergo gelatinization on heating or by treating with sodium hydroxide solution or concentrated solution of calcium or zinc chlorides or chloral hydrate. Maize starch is almost neutral, rice starch is slightly alkaline and potato starch is slightly acidic.

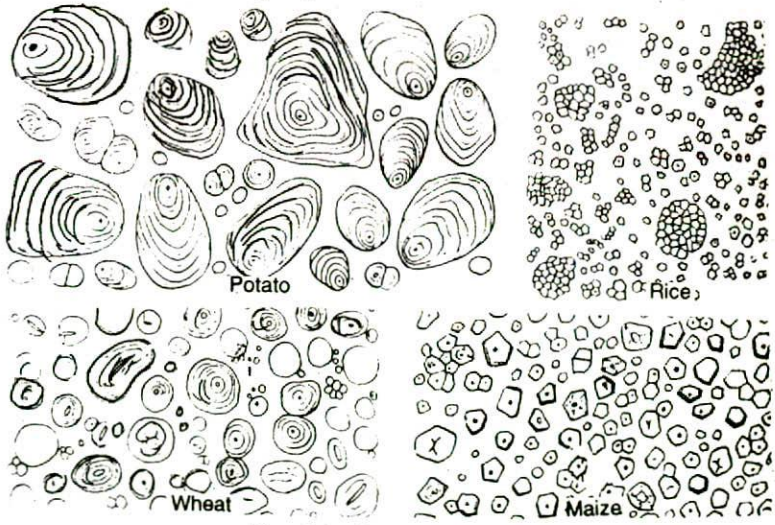


Fig. 6.1. Starch granules

Microscopically, starch granules contain central or eccentric hilum, concentric rings or striations and differ in

size and aggregation. In maize starch granules are 10-35 μm in size, angular, polyhedral, hilum is central, distinct and contain a cavity or from 2 to 5 rayed cleft. The striations are absent. Rice starch is composed of 2-10 μm diameter compound and simple granules with an angular outline and aggregated from 2 to 150 components. The granules are polyhedral with sharp angles. Striations are absent and hilum is centric. Wheat starch contains larger granules lenticular, smaller ones globular, size is from 2 to 45 μm. Few compound granules are present. The hilum is central and unclaft. Concentratic and faint striations are observed. Potato starch contains most of simple granules, wedge or mussel-shaped. The diameter is from 2 to 110 μm. Hilum is in the form of α point, near the narrower point and eccentric. Concentric striations are well-marked. Few compound granules of 2 or 3 components are fused together.

Chemical Constituents : Starches are generally mixtures of two types of polymers :

(1) amylose, a linear (1-4)-α-D-glucan, and

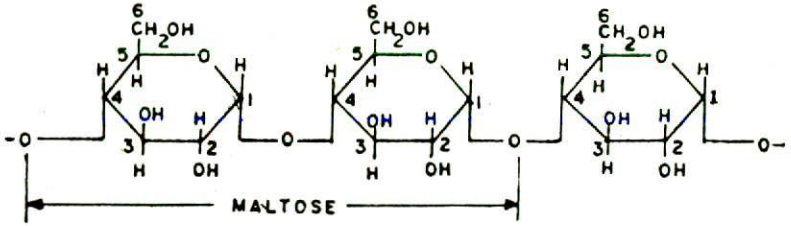
(2) amylopectin, a branched D-glucan with mostly α-D (1-4) and aproximately 4% α-D (1-6) linkages.

The strach in corn contains approximately 27% amylose and 73% amylopectin. These two polymers are so associated in the crystal lattice that they are practically insoluble in water or alcohol. In amylose from 250 to 300 D-glucopyranose units are uniformly linked and the molecule acquires a helix-like shape. The amylopectin consists of 1000 or more glucose units. Due to these structural differences amylose is more soluble in water than amylopectin. Amylose reacts with iodine to form a deep-blue complex while amylopectin gives a blue-violet or purple colour.

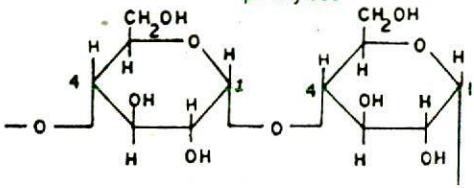
Hydrolysis of starch with mineral acids, (HCl, H_2SO_4) produces glucose in quantitative yield. The reaction may be brought by an enzyme (α-amylase, β-amylase or amyloglucosidase) and yields more specific products. β-Amylase, for example, breaks off mostly into maltose units and amyloglucosidase yields mainly D-glucose.

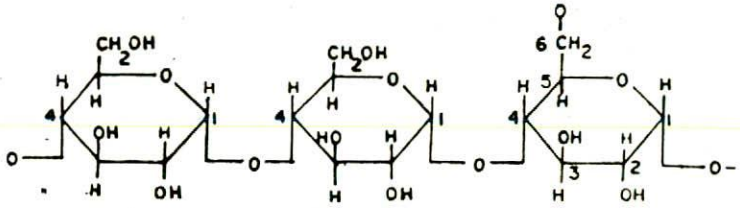
Uses : Starch is used internally as mild astringent, nutritive, demulcent, protective and absorbent. It is given as an antidote in iodine poisoning. It is employed as pharmaceutical aid, as tablet disintegrant, filler and binder. Externally it is used as an absorbent, emollient, in dusting powders and in ointments. Starch is the starting material for the preparation

of glucose, dextrose, and dextrin. Some official preparations of starch are Mucilage of Starch B.P.C., Zinc Starch Dusting powder B.P.C., and Zinc oxide paste, I.P.



β-Amylose





Amylopectin

Tests for Identification

1. Dissolve starch (1 g) in water (15 ml) by heating on a water bath. A viscous transluscent jelly is formed on cooling.
2. Fehling's solution test is positive.
3. It shows Molisch's test for carbohydrates.
4. Solution of starch (1 ml) forms a deep blue colour on addition of iodine solution (1 drop). On warming the colour disappears and re-appears on cooling.

ACACIA GUM

Synonyms : Acacia, Gum Acacia, Gum Arabic, Acaciae gummi.

Biological Source : Acacia gum is the dried gummy exudate obtained from the stem and branches of *Acacia senegal* Willd. and of some related species like *Acacia arabica* Linn.

Family : Leguminosae.

Habitat : *A. senegal* is found in Sudan, Central Africa, West Africa and north-western India particularly Haryana, Gujarat and rocky hills of Rajasthan.

Collection : Acacia plant is a 6 m high thorny tree. The gum is produced by living and physiologically active cells of the phloem under certain pathological conditions by rod-shaped bacteria *(Bacterium acaciae)* found conspicuously in all the tissues. A transverse incision in the bark is made for peeling the loosened bark above and below the cuts. The cambium measuring 0.5-1.0 m in length and 5-7.5 cm in breath is exposed. Within a month new phloem cells are produced in the cambium. The tears of gum are formed on this exposed surface due to bacterial action or the action of a ferment which flow on its own and are collected in leather bags. The gum is garbled to free it from sand and vegetable debris and occasionally exposed to sunlight for 3-4 months to bleach it. During this bleaching process numerous minute cracks are formed on the outer surface of the tears due to which the surface becomes semiopaque. The tears are graded finally on the basis of external appearance, packed and exported.

Trees growing in sandy plains and semi-rocky sites give higher gum-yield than those growing in rocky areas.

Characters : Acacia gum occurs in rounded or ovoid, irregular or broken tears, 1-3 cm in diameter. Outer surface contains numerous fine cracks. Colour is white or pale yellow. The gum is very brittle and the exposed surface is transparent and glassy. It is odourless and taste is bland and mucilaginous. It is freely soluble in equal weight of water to form a viscous and acidic solution. The gum is insoluble in alcohol and other organic solvents.

Chemical Constituents : Acacia gum contains chiefly arabin which is the mixture of calcium, magnesium and potassium salts of arabic acid. On hydrolysis arabic acid yields L-rhamnopyranose, galactopyranose, L-arabofuranose and the aldobionic acid 6-β-D-glucuronosido-D-galactose. Further hydrolysis yields L-arabinose, D-galactose, D-glucuronic acid and rhamnose. The gum also possesses enzymes like oxidases, peroxidases and pectinases.

Uses : Acacia gum is demulcent, emollient, and used as emulsifying and suspending agent for the administration of

insoluble drugs. It is employed as an adhesive and binder in tablets especially in lozenges. Due to its demulcent properties it is used in various formulations for cough, diarrhoea and throat problems. Internally, Acacia gum is used in inflammation of intestinal mucosa. It is also used to cover inflamed surfaces such as burns, sore nipples, etc.

Purity Tests : 1. An aqueous solution of the Acacia gum (5 g) is prepared by dissolving in water (15 ml) to perform the following tests for identity :

1. The aqueous solution is slightly acidic and becomes more acidic on keeping.
2. On standing it does not form viscous gelly-like mass. No sediment should be deposited on standing in case of pure gums.
3. To the aqueous solution (5 ml) a few drops of dilute solution of lead acetate are added. No precipitate is formed due to absence of Tragacanth and Agar.
4. It does not form blue or brown colour with iodine solution due to absence of starch and dextrin.
5. With ferric chloride solution it does not produce any violet or green colour due to absence of tannins.
6. To the solution of gum acacia resorcinol (0.1 g) and hydrochloric acid (2 ml) are added and then heated on a water-bath. No yellow or pink colour is developed due to absence of sucrose or fructose.
7. Fine powder of the gum (5 g) is dissolved in distilled water (100 ml), dilute hydrochloric acid (10 ml) is added and the reaction mixture is boiled gently for 15 minutes. The hot solution is filtered by suction through a sintered glass crucible, washed thoroughly with hot water, dried at 105°C and weighed. The insoluble matter should not exceed 50 mg in case of pure gum.

Test for Identification

1. To the aqueous solution (5 ml) borax (0.1 g) is added. A stiff translucent mass is obtained.
2. To the dilute aqueous solution few drops of lead sub-acetate are added. A white, bulky precipitate is produced.
3. To the aqueous solution (5 ml) few drops of 1% alcoholic

solution of benzidine are added along with 10% hydrogen peroxide (0.5 ml). On shaking blue colour is produced due to enzyme oxidase.

4. Gum acacia responds positively to Fehling's solution test of reducing sugars and Molisch's test of carbohydrates.
5. To the aqueous solution (5 ml), alcohol (10 ml) is added gradually by shaking. The cloudy liquid on addition of glacial acetic acid (0.5 ml) forms a white precipitate. It is filtered and to the clear filtrate ammonium oxalate solution (50 ml) is added. The filtrate becomes cloudy again.

Allied Drugs : Gatti gum (Indian gum) is obtained from *Anogeissus latifolia* Wallich (Fam. Combretaceae). Its tears are of different colour and the outer surface is dull. Some of tears are vermiform in shape and their surface shows fewer cracks than the natural acacia. Aqueous solution of this gum has the viscosity between those of Acacia and Sterculia gums. With lead subacetate solution it forms very slight precipitates.

Starch, Tragacanth, Talka gum, Dextrin and cheaper gums from Acacia species are other adulterants of Acacia gum.

TRAGACANTH

Synonyms : Gum tragacanth, Anjira (Hindi).

Biological Source : Tragacanth is the dried gummy exudation obtained by incision from the stems of *Astragalus gummifer* Labil. (White gavan) or other Asiatic species of *Astragalus* such as *A. kurdicus, A. adscendens* and *A. strobiliferus.*

Family : Leguminosae.

Harbitat : Tragacanth plant is most widely found in Iran, also in Asia Minor, Syria, Anatolia, Iraq, Turkish, Greece and Afghanistan.

Collection : The Tragacanth plants are 1 meter high thorny branching shrubs. The gum is produced physiologically in the plant cells. When a one-or two years old plant is injured, the cell wall of the pith and then of the medullary rays are gradually converted into gum. This change is called as "gummosis". The gum absorbs water and a considerable pressure is created within the stem which forces the gum

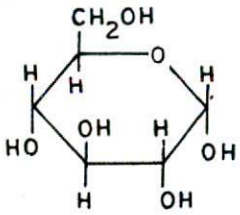
to the surface through the incision in the form of soft, solid Tragacanth. In contact of the air it is hardened due to evaporation of water. The shape of the gum depends on the shape of the incision made. The gum is collected by the natives and packed.

Characters : Tragacanth occurs as thin, flattened, curved or ribbon-like flakes, length up to 2.5 cm, breadth 1.2 cm. Colour is white or pale yellow, translucent. The surface is marked with concentric ridges which indicates the successive exudation and solidification. Longitudinal striations caused by small irregularities in the incision are present on the surface. The fracture is short and horny. It is odourless and has a little insipid, mucilaginous taste. Tragacanth is entirely insoluble in alcohol and other organic solvents.

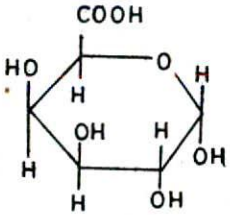
Chemical Constituents : Tragacanth consists of tragacanthin (water-soluble portion) and bassorin (water-insoluble protion). The insoluble portion swells to a gel and consists of 60-70% bassorin which is a complex of polymethoxylated acids. Tragacanthin is probably demethoxylated bassorin consisting of 30% of the gum. The gum is composed of sugar and uronic acid units. On hydrolysis of Tragacanth, galacturonic acid, D-galactopyranose, L-arabofuranose and D-xylopyranose are obtained. Starch and protein are also present in Tragacanth.

Uses : Tragacanth is used in pharmaceutical as compounding and dispensing agent, e.g. to suspend heavy insoluble powders, as an excipient for tablets and to impart consistency to touches; also in making emulsions and emulsifying agents for oils and resin; as stabilizer, thickener, and texturizer in food. As Tragacanth is resistant to acid hydrolysis, it is preferred for use in highly acidic conditions. It has demulcent and emollient properties and is used in various cosmetic formulations like hand lotions. It is also used in adhesives (mucilages, pastes); in textile sizing, textile printing and general printing inks, and in dyeing with insoluble colour lakes.

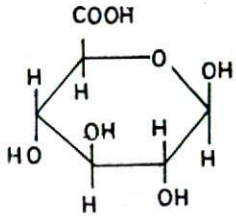
Allied Drugs : Tragacanth of lower grades, known as *hog gum* or *hog tragacanth*, is used in textile industry and pickle manufacture. The pieces are of different shape, yellow to black in colour and contaminated with earth. Their ashes give a strong reaction for iron. It is adulterated with *Chitral gum* obtained from *Astragalus strobiliferus*, Sterculia gum obtained from *Sterculia urens*, insoluble *Shiraz gum* of unknown origin imported from Iran and *Vermicelli tragacanth*



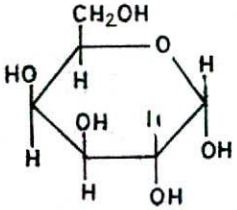
α-D-Glucose



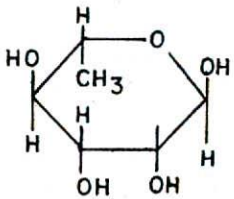
D-Galacturonic acid



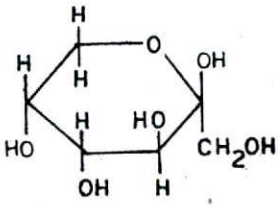
β-D-Glucuronic acid



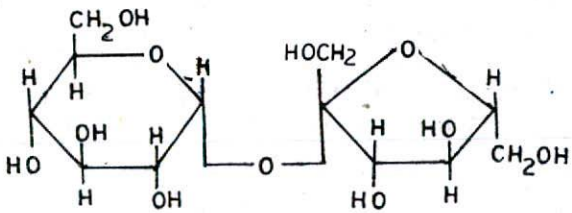
Galactose



Rhamnose



Fructose



Sucrose

obtained from *Astragalus cylleneus.*, a species found in Greece.

Tests for Identity

1. Tragacanth contains about 30% of water soluble portion.
2. On boiling with sodium hydroxide solution a brown or yellow colour is formed.
3. It responds positively with Molisch's test and Fehling's solution test.
4. It swells and forms a smooth, nearly uniform stiff, opalescent mucilage free from cellular fragments.
5. Powdered material (0.5g) is dissolved in water (1 ml) to form a homogenous mucilage. The mucilage is diluted with water (5 ml) and barium hydroxide solution added. A slightly flocculent precipitate is formed. On heating for ten minutes, it gives an intense yellow colour.

STERCULIA GUM

Synonyms : Kadaya; Mucara; Kullo; Katilo; Kuteera, Gum Karaya, Karaya gum, Indian Tragacanth, Bassora Tragacanth.

Biological Source : Sterculia is the dried gummy exudate of the tree *Sterculia urens* Roxb., *S. villosa*, *S. tragacantha* or from *Cochlospermum gossypium* Decand. (Fam. Bixaceae).

Family : Sterculiaceae.

Habitat : The tree is found mainly in India (Gujarat, Maharastra, Madras, Rajasthan, M.P. and Chota Nagpur), Pakistan and to some extent in Africa.

Collection : The gum exudes naturally or from incisions made to the heartwood and is collected twice a year, before and after the monsoon season (April-June and September). The gum of first collection has the highest viscosity. The dried irregular masses of several kilograms in weight are picked up, bark pieces are removed, packed and exported.

Characters : Sterculia gum occurs in irregular, translucent striated mass. The pure gum is colourless, medium grade is pinkish tinge and lower grades are very dark. In water it is slightly soluble but swells to many times. It has a distinct odour of acetic acid.

Chemical Constituents : Sterculia gum consists of an acetylated, branched heteropolysaccharide with a high composition of D-galacturonic acid and D-glucuronic acid moieties.

Hydrolysis of the gum affords D-galactose, L-rhamnose, D-galacturonic acid, aldobiouronic acid, acetic acid and an

acid trisaccharide. Uronic acid residues are present in 37% amount in the gum.

Uses : Sterculia gum is used as a bulk laxative, emulsifying and suspending agent and a dental adhesive. The powdered gum is used in lozenges, pastes and denture fixative powder. It is also employed in wave set solution, skin lotions, textile and printing industries and in the preparation of compositae building materials.

AGAR

Synonyms : Agar-agar, Gelose; Japan agar, Bengal isinglass; Ceylon isinglass, Chinese isinglass, Japanese isinglass; Vegetable Gelatin, Kanten.

Biological Source : Agar is the dried, hydrophilic, colloidal, polysaccharide complex extracted from the agarocytes of algae known as *Gelidium cartilagineum* (L.) Gaillon (Family Gelidiaceae), *Gracilaria confervoides* (L.) Grev. (Family Sphaerococcaceae) and some other speices of *Acanthopeltis*, *Ceramium*, and *Pterocladia*. (Family : Rhodophyceae). *Gelidium* Provides about 35% of the total agar source.

About 18 important species of marine red algae occur in Indian coasts. The seven species, viz *Gracilaria corticata*, *G. crassa*, *G. edulis*, *G. foliifora*, *G. verrucosa*, *Gelidiella acerosa* and *Pterocladia capillacea* are used to prepare Agar.

Habitat : Agar is prepared from Japan, Korea, South Africa, Mexico, Atlantic and Pacific coasts of U.S.A., Spain, and New Zea land.

Collection and Preparation : Algae are cultivated on the coast. The development of algae takes place on poles which are withdrawn from time to time to strip off the algae. The seaweed is washed for 24 hours in running water, beaten and shaken to remove sand and shells, extracted in steam heated digesters with dilute acids and then with water for 30 hours. The hot mucilaginous decoction is filtered through linen. On cooling a jelly is formed which is cut into bars. The bars are converted into strips by passing through wire netting. Water is removed by successively freezing, thawing and drying at about 35°C. The agar ice block weighing about 150 kg is crushed, melted, and filtered through a rotary vacuum pump. The moist agar flakes so obtained are dried by currents of dry air in tall cylinders.

Characters : Agar occurs in the form of a transparent or translucent, agglutinated, yellowish-white slender, lustrous, flattened strips or as fine or granulated powder. It is tough in damp, brittle in dried form, odourless or with a slight odour and taste is mucilaginous. Agar is insoluble in cold water and alcohol, slowly soluble in hot water to form a viscid solution and its 1% solution forms a stiff firm jelly on cooling.

Chemical Constituents : Agar is composed of the calcium salt of acidic polysaccharides. It can be separated into a natural gelling fraction,*agarose*, and a sulphated non-gelling fraction, *agaropectin*. The structure is believed to be a complex range of polysaccharide chains having alternating α-(1→3) and β-(1→4) linkages. On hydrolysis Agar yields galactose and sulphate ions. It is a hetrogeneous polysaccharide. Agarose, responsible for the gel strength consists of alternate residue of 3,6-anhydro-L-galactose and D-galactose. The viscosity of agar solutions is due to the presence of agaropectin which is a sulphated polysaccharide in which galactose and uronic acid moieties are partly esterified with sulphuric acid.

Uses : Agar is used to treat chronic constipation, as a laxative, suspending agent, an emulsifier, a gelating agent for suppositories, as surgical lubricants, as a tablet excipient, disintegrant, in production medicinal encapsulations and ointments; as dental impression mold base. It is extensively used as a gel in nutrient media for bacterial cultures, as a substitute for gelatin, insiglass, etc., in making emulsions including photographic, gel in cosmetics, as thickening agent in food especially confectionaries and dairy products, in meat canning; sizing for silk and paper; in dyeing and printing of fabrics and textiles; in adhesive, etc.

Chemical Tests

1. Agar responds positively to Fehling's solution test.
2. Agar gives positive test with Molisch's reagent.
3. Aqueous solution of Agar (1%) is hydrolyzed with concentrated hydrochloric acid by heating for 5-10 minutes. On addition of barium chloride solution to the reaction mixture, a white precipitate of barium sulphate is formed due to the presence of sulphate ions. This test is absent in case of Starch, Acacia gum and Tragacanth.

4. To Agar powder a solution of ruthenium red is added. Red colour is formed indicating mucilage.
5. Agar is warmed in a solution of potassium hydroxide. A canary yellow colour is formed.
6. An aqueous solution of agar (1%) is prepared in boiling water. On cooling it sets into a jelly.
7. To agar solution an N/20 solution of iodine is added. A deep crimson to brown colour is obtained (distinction from Acacia gum and Tragacanth).
8. To a 0.2% solution of Agar an aqueous solution of tannic acid is added. No precipitate is formed indicating absence of Gelatin.
9. It does not gives any precipitate with Millon's reagent due to absence of Gelatin.
10. On heating Agar with soda lime no ammonia is evolved due to absence of Gelatin.
11. To the ash of Agar dilute hydrochloric acid is added and examined under microscope. Skeletons and fragments of diatoms and sponge spicules are observed.

ISPAGHULA (Plantago)

Synonyms : Psyllium seed; Flea seed; Plantain seed; Isabgol; Ishabgul; Spogel seed.

Biological Source : Ispaghula consists of cleaned, dried, ripe seed of *Plantago psyllium* Linn, or of *Plantago indica* Linn. (*P. arenaria* Wald.), known as Spanish or French Psyllium seed, or of *Plantago ovata* Fork, known as Blonde Psyllium or Indian Plantago.

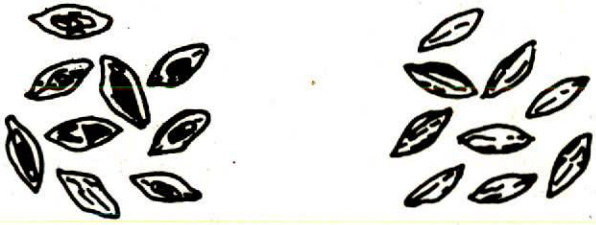
Family : Plantaginaceae.

Habitat : *P. psyllium* Linn. is indigenous to the Mediterranean region and west Asia, presently cultivated in France, Spain and Cuba. *P. ovata* is found in Punjab hills and other parts of north-west India, Sind and Baluchistan and is cultivated in Bengal, Karnataka, Gujarat and Maharashtra.

Cultivation and Collection : The plant is a stemless or subcaulescent soft, hairy annual herb. It is cultivated by spreading seeds in November in well drained loamy soil. To the fields ammonium sulphate fertilizer is added and they are irrigated at an interval of 8-10 days for about 8 times.

The crop is harvested in four months in March/April. The plants are cut just above the ground, dried and seeds are separated by thrashing.

Characters : The seeds of *P. ovata* are 2.0-3.3 mm in length, 1-16 mm in breadth; dull, pinkish grey-brown; long to elliptical in outline, boat shaped; the dorsal surface is convex with a small elliptical or elongated shining reddish brown spot while the ventral surface is concave with a deep furrow, not perfectly reaching to either end of the seeds. At the furrow a hilum is present which is covered by a thin membrane and appears as a red spot in the centre. The outer surface is smooth, hard and translucent. The seeds are odourless and taste is bland but mucilaginous.



Ventral surface Dorsal surface

Fig. 6.2. Ispaghula

Chemical Constituents : The seeds contain hydrocolloidal polysaccharide (mucilage) in the outer seed coat (20-30%), fixed oils, tannin, aucubin glycoside (iridoid), sugars, sterols and protein. The mucilage of Ispaghula is colloidal in nature and its composition varies with the conditions of preparation. It is mainly composed of xylose, arabinose and galacturonic acid; rhamnose and galactose have also been reported. Two polysaccharide fractions have been separated from the muscilage. One fraction is soluble in cold water and on hydrolysis yields xylose (46%), an aldobiouronic acid (40%), arabinose (7%) and insoluble residue. The other fraction in soluble in hot water forming a highly viscous solution which sets as a gel on cooling and yields on hydrolysis xylose (80%), arabinose (14%), aldobiouronic acid (0.3%) and trace of galactose. The fatty oil is composed of linolenic, linoleic, oleic, palmitic, stearic and lignoceric acids. *P. ovata* is a good source of linoleic acid. The amino acids reported in the seeds are valine, alanine, glycine, glutamic acid, cystine, lysine, leucine and tyrosine.

Uses : Seeds are demulcent, cooling, diuretic and used in inflammatory conditions of mucus membrane of gastrointestinal and genitourinary tracts. They are used to cure chronic dysentery, diarrhoea, duodenal ulcer, gonorrhoea, constipation and piles. Isabgol preparations are given after colostomy to assist the production of smooth solid faecal mass. The mucilage is not digested by enzymes and intestinal bacteria in the gut and comes out unchanged. Jelly-like mucilage absorbs irritating products and toxins of the gut and they are expelled from the body. The seeds are used in febrile conditons and the affections of kidneys, bladder and urethra. A decoction of seeds is prescribed in cough and cold, and the crushed seeds made into poultice are applied to rheumatic and glandular sweelings. Recently anticancer, antitoxic, antiatherosclerosis, hypocholesteremic, hypoglycemic, hypotensive, cardiac depressant, cholinergic and cervical activities have been reported.

Chemical Tests

1. Ispaghula seeds form red colour with ruthenium red solution.
2. On adding water mucilage swells forming surrounding layer outside the seed.
3. **Determination of Swelling Factor :** The drug (1 g) is placed in a 25 ml graduated cylinder. Water is added up to 20 ml mark and left for 24 hours with occasional shaking. The seeds are allowed to settle for 1-2 hours and the total volume occupied by the swollen seeds is noted. The swelling factors for the seeds are as : 14 ml for *P. psyllium;* 10 ml for *P. ovata* and 8 ml for *P. indica.*

Adulterant and Substitute : *P. lanceolata* Linn., occurring wildly in India, is adulterated in Ispaghula. Its seeds are oblong elliptical in shape with yellowish brown colour. The seeds of *P. asiatica,* (syn. *P. major* L.), found in Andhra Pradesh and Tamil Nadu, are substituted to Ispaghula. It is also adulterated with the seeds of *P. arenaria.* The seeds of *Salvia aegyptica* are frequently mixed which also yield copious mucilage. The seeds of *P. media* L. have different colour and swell very little in water.

BAEL

Synonyms : Bel, Bengal quince; Fructus belae, Bael fruit.

Biological Source : Bael consists of the entire unripe fruit or its slices of *Aegle marmelos* Corr.

Family : Rutaceae.

Habitat : Bael plant is found all over India in sub-Himalayan forests, Bengal, central and south India and also in Burma and Sri Lanka.

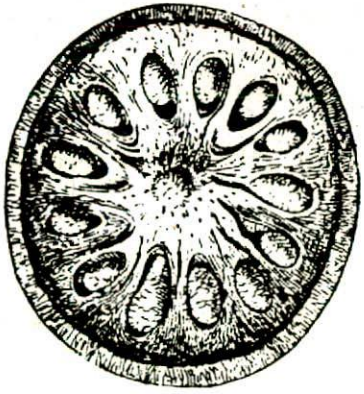
Collection : Tree is slender, deciduous, nearly 12 m in height. Generally bael is propagated by seeds which are covered with earth and watered. The tree can be propagated by root-cuttings and layers. The unripe or half-ripe fruits are collected, epicarp is removed and cut into transverse slices or irregular pieces.

Morphology : The fruit is a woody, large berry with green colour when unripe and yellowish brown on maturing, diameter 10-20 cm. The fruit is sub-spherical in shape, epicarp is hard, woody, smooth, about 2 mm thick, slightly granular. A circular scar is left by the removal of the stalk. Internally it consists of reddish-brown pulpy endocarp; mesocarp consists of 10-15 capsules, each containing several hairy, oblong, multicellular seeds surrounded by reddish mucilage. Odour is faint and aromatic and taste is mucilaginous and sweet.

The peripheral part just within the rind is fleshy and thick and has a pleasant resinous odour. The walls separating the chambers are yellow. The chambers are full of amber-or honey-coloured, viscous, very sticky or glutinous, translucent pulp.



Fruit on a branch

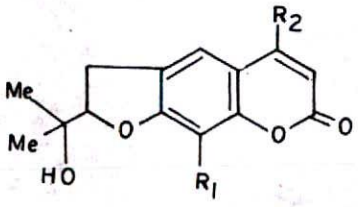


Transverse section of the fruit

Fig. 6.3. Bael fruit

Chemical Constituents : Fruit contains marmelosins (0.4%) which are the active constituents, in addition to carbohydrates (11-15%) including reducing sugars (3-4%), allo-imperatorin, β-sitosterol, tannins (20%), proteins (1%), vitamins A and C and volatile oil. Marmelosin is a furocoumarin which is identical with imperatorin. Fruits are also the source of alkaloids namely O-methylhalfordinol and isopentylhalfordinol. The furanocoumarin, alloimperatorin methyl ether, has also been isolated. It also contains marmelide (1,1-dimethyl allyl ether), psoralen, gum, etc. The fruit yields 2% water-soluble gum which on hydrolysis gives galactose, arabinose, D-galacturonic acid and rhamnose.

Uses : Unripe fruit is astringent, digestive, demulcent, stomachic, and used in diarrhoea and dysentery. Ripe fruit is sweet,aromatic, cooling, alterative and nutritive. When taken fresh, it is useful in habitual constipation, chronic dysentery and dyspepsia. Fresh juice is bitter and pungent. Root and stem barks are used as antipyretic. Aegelin, a sterol isolated from the leaves, has been tried to treat bronchial spasm. The cathartic action is caused by the swelling of the mucilaginous seed coat, therefore giving bulk and lubrication. The seeds should be taken with a considerable amount of water. In combination with powdered anhydrous dextrose, sodium bicarbonate, monobasic potassium phosphate, citric acid and others, plantago husk is used as remedy of constipation.



Marmelosin A : $R_1=R_2=H$
Marmelosin B : $R_1=H$; $R_2=Me$
Marmelosin C : $R_1=Me$; $R_2=H$

GUAR GUM

Synonyms : Guar flour; Decorpa; Jaguar; Jaguar gum; Guaran; Gum cyamopsis; Cyamopsis gum; Burtonite V-7-E.

Biological Source : Guar gum is the ground endosperms of *Cyamopsis tetragonolobus* (L.) Taub.

Family : Leguminosae.

Habitat : The plant is cultivated in dry climates in India (Maharastra, Gujarat, Karnataka and Rajasthan), Pakistan, and U.S.A. (Taxes).

It is robust erect annual, 1-3 in high plant, bearing cluster of thick and fleshy pods.

The plant is hardy and drought-resistant. It grows well on deep alluvial soils and sandy loams. It is cultivated usually as a mixed crop. The seeds are sown broadcast in northern India in May-June and harvested in September-October.

Characters : Guar gum is a pale-yellow free flowing powder; completely soluble in cold and hot water; practically insoluble in oils, greases, hydrocarbons, ketones and esters. Water solutions are tasteless, odourless, nontoxic and neutral. It is stable to heat. It has five to eight times the thickening power of starch. It forms thick colloidal solution in water and swells rapidly. The water soluble fraction (85%) is called guaran.

Chemical Constituents : Guar gum contains mainly of a high molecular weight hydrocolloidal |polysaccharide| which is a galactomannan. Guaran consists of linear chains of (1→4)-β-D-mannopyranosyl units; 1,6-linked α-D-galactopyranosyl units are attached to alternate mannose units. Ratio of D-galactose to D-mannose is 1:2. On hydrolysis Guar gum yields galactose and mannose. It also contains small amount of proteins (5-7%).

Chemical Tests

1. Powdered Guar gum on treatment with ruthenium red does not form pink colour (difference from Sterculia and Agar).
2. Aqueous solution of Guar gum is converted to a gel by small amount of borax.
3. Aqueous solution of Guar gum is precipitated with 2% solution of lead acetate.

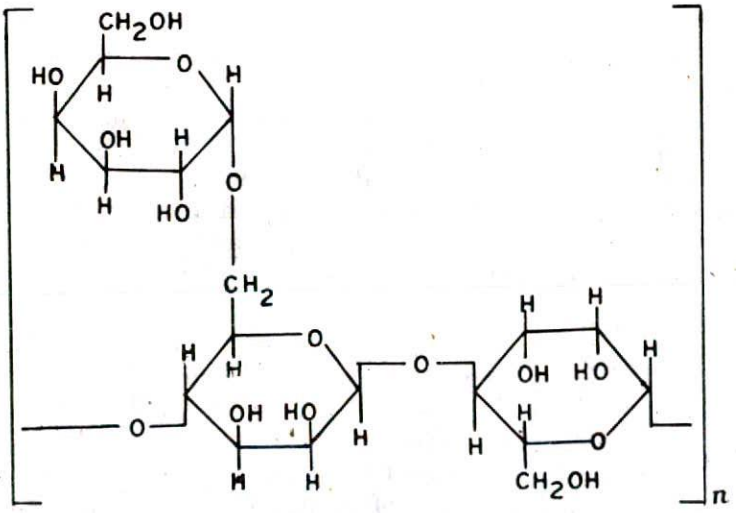
4. Aqueous solution of Guar gum does not produce any colour with iodine solution.

Uses : Guar gum is used as a thickening agent, as a tablet binder and disintegretor; as an emulsifying agent, as a protective colloid, stabilizer, thickening and film forming agent for cheese, salad dressings, ice creams, soups; in pharmaceutical jelly formulations; in suspensions, emulsions, lotions, creams, toothpastes; in the mining industry as a flocculent, as a filtering agent; and in water as a coagulant aid.

PECTIN

Biological Source : Pectin is a purified complex polysaccharide substance present in cell walls of all plant tissues which functions as an intercellular cementing material. It is a purified carbohydrate obtained from the dilute acid extract of inner portion of the peel of citrus fruits or from apple pomace. Lemon or orange rind is the richest source of pectin which contains about 30% of this polysaccharide. Other sources of pectin are papaya, guava, mangoes, and roots (beets and gentian).

Geographical Source : On commercial scale pectin is prepared in India, U.S.A., Switzerland and some other European countries.



Guaran

Preparation : Pectin occurs in the middle lamellae of cell walls, and in an insoluble form is called as protopectin. It is converted to the soluble form by treating the fruit pulp with a 20-times its weight of dilute acid at high temperature (90°C) for 30 minutes at pH 3.4-4. The aqueous solution is filtered, and alcohol is added to the filtrate to precipitate pectin. The precipitated pectin is separated and dried under reduced pressure.

Characters : Pectin occurs as a coarse or fine powder, yellowish-white in colour, practically odourless, and taste is mucilaginous. It is almost completely soluble in 20 parts of water, forming a viscous opalescent and colloidal solution containing negatively charged, very much hydrated particles. Aqueous solution is acidic to litmus. It is insoluble in alcohol and in other organic solvents. It dissolves more readily in water. It is stable under mildly acidic conditions. Depolymerization takes place in more strongly acidic or basic conditions.

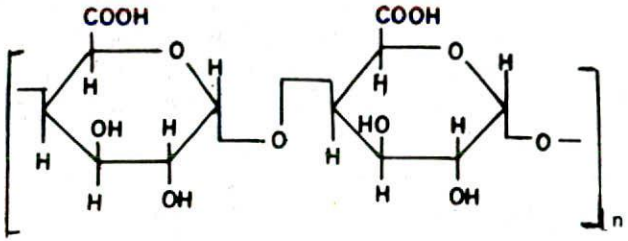
Chemical Constituents : Pectin occurs naturally as partial methyl ester of α-(1→4) linked D-polygalacturonate sequences interrupted with (1→2)-L-rhamnose residue. On hydrolysis it produces D-galactose, L-arabinose, D-xylose and L-fucose.

Chemical Tests

1. Pectin (1 g) is dissolved in water (10 ml). A stiff gel is produced.
2. To 1% aqueous solution of pectin add 2% aqueous solution of sodium hydroxide (5 ml). Within 20 minutes a transparent gel is produced. On shaking the gel with dilute hydrochloric acid gelatinous precipitates are formed which turn white on boiling.

Uses : Pectin is used in the treatment of diarrhoea due to property of colloidal absorption of toxins. It is also used as haemostatic for haemorrhage, as emulsifying agent, gelling agent, as a plasma substitute, for preparation of cosmetics, jellies and as a thickening agent in food industry for the sauces, jams and ketchup. As a colloidal solution, it has the property of conjugating toxins and enhancing the physiological action of the digestive tract through its physical and chemical properties. In the upper intestinal tract, pectin has a surface area composed of ultramicroscopical particles.

These particles, called micelles, have the property of colloidal absorption of toxins.



Pectic acid

ALGIN

Synonyms : Alginic acid sodium salt; Sodium alginate; Sodium polymannuronate; Kelgin; Minus; Protanal.

Biological Source : Algin is a gelling polysaccharide extracted with dilute alkali from giant brown seaweed, *Macrocystis pyrifera* (giant kelp), Family Lessoniaceae; or from *Laminaria digitata* (horsetail kelp), Family Laminariaceae, or from *Laminaria saccharina* (sugar kelp). Other sources are the species *Ascophyllum, Ecklonia* and *Nereocystis.*

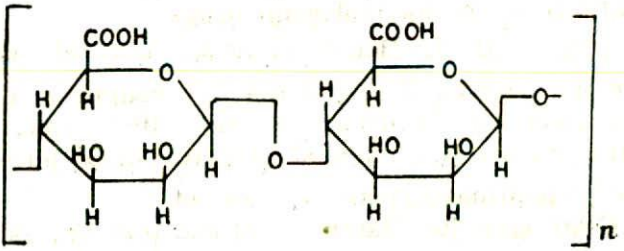
Geographical Source : USA (California), Norway, Chile, China, Canada, Iris Republic, Australia, Iceland, UK (Scotland), and South Africa.

Preparation : The dried milled seaweed is macerated with dilute sodium carbonate solution. The resulting paste-like mass is diluted with soft water to separate the insoluble matter by modern super-decanters or continuous-setting devices. The resulting clear liquor contains most of the alginate orginally present in the algae. It is poured into dilute sulphuric acid or dilute calcium chloride solution, when the insoluble alginic acid or its salt, calcium alginate, is precipitated as a bulky, heavily hydrated gel from which liquor is separated by roller or expeller presses. Wood pulp-like product is obtained which is agitated aganist a stream of hydrochloric acid. Then calcium is removed and the highly swollen pulp of alginic acid is roller-pressed and then neutralized with sodium carbonate to give sodium alginate. In an another procedure the sodium alginate may be

precipitated from the clear liquor by addition of ethyl alcohol directly or after partial evaporation.

Characters : Algin is a cream-coloured powder, soluble in water, forming a viscous and colloidal solution, insoluble in alcohol and in hydro-alcoholic solution in which the alcohol content is >30% v/v. It is insoluble in chloroform, ether and in aqueous acid solutions when the pH is below 3. It liberates carbon dioxide from carbonates. With compounds containing ions of alkali, metals, or ammomium or magnesium, it reacts to give salts (alginates) which are water soluble. The salts of most other metals are water-insoluble.

Chemical Constituents : Alginic acid is composed of residues of D-mannuronic and L-glucuronic acids; the chain length is long and varies with the method of isolation and the source of algae. The sugar units are joined by β-1, 4-glycosidic linkages. Its molecular weight varies from 220 to 860 units.



Algin

Uses : Alginates are used as stabilizing, thickening,emulsifying, deflocculating, gelling and film-and filament-forming agents in the rubber, paint, textile, food (including as stabilizing colloid), cosmetics and pharmaceutical industries. It is also used in drilling muds; in coatings, in the flocculation of solids in water treatment; as sizing agent, thickener, emulsion stabilizer, suspending agent in soft drinks and in dental impression preparations. Alginate fibres are used as absorable haemostatic dressings.

Algin is metabolized in the body. It has a caloric value of about 1.4 calories per gram. Alginic acid is relatively less soluble in water. It is used as a tablet binder and thickening agent. Gel-forming properties are associated with salts of different polyvalent cations and alginic acid. The propylene

glycol ester of Algin has been prepared. It is useful in formulations that require greater acid stability than that of the parent hydrocolloid.

QUESTIONS

1. What are carbohydrates ? How are polysaccharides formed in the plants ? Enumerate the polysaccharides containing uronic acid or other units. Give some useful tests for sugars and other carbohydrates (Delhi University, 1988).
2. How will you differentiate the following pair of drugs: (a) Maize starch and Potato starch (b) Acacia and Gelatin (c) Agar and Starch (d) Sterculia gum and Acacia gum.
3. What are gums and mucilage ? Give official source, chemical constituents and uses of Ispaghula, Agar, Bael and Guar gum.
4. Give chemical constituents and chemical tests for the identification of the following drugs :
   (a) Tragacanth (b) Honey (c) Acacia gum (d) Algin.
5. Give the sources of starch that are commonly used in pharmaceutical practice. Discuss their microscopic characteristics and method of determining purity.
6. Give a pharmacognostic account of :
   (a) Guar gum (b) Starch (c) Acacia gum (d) Bael.
7. What are gums ? How are they formed in plants ? What is their usual composition ? Give a complete pharmacognostic account of one gum studied by you.
8. What is Agar ? How is it obtained ? Give important chemical test for identification of Agar.
9. Describe purity tests and uses of Honey, Acacia gum and Agar.
10. Discuss the biological sources, chemical constituents and uses of the carbohydrate drugs belonging to the following families : (a) Apidae (b) Sterculiaceae (c) Plantaginaceae (d) Rutaceae.
11. Give the source, methods of preparation, chemical constituents and uses of the following : (a) Sodium alginate (b) Pectin (c) Plantago.

7

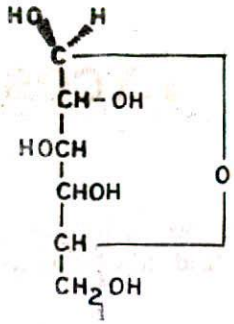
GLYCOSIDES

Glycosides are compounds which upon hydrolysis give rise to one or more sugars (glycones) and a compound which is not a sugar (aglycone or genin).

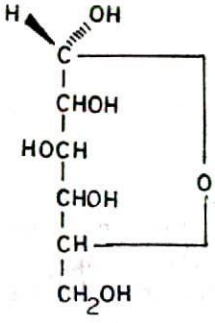
In a glycosidic compound a sugar residue is linked to C-1 through oxygen (O-glucoside), nitrogen (N-glucoside) or sulphur (S-glucoside) moiety. β-D-Glucose is the most common sugar found in glycosides. The other sugars detected are rhamnose, digitoxose, and cymarose (deoxysugar). The glycosides from individual sugars are called glucoside, rhamnoside, galactoside, fructoside, etc.

In glycosides the hydroxyl of a sugar is condensed with the hydroxyl of the non-sugar component. The secondary hydroxyl within the sugar molecule is condensed to form an oxide ring. Thus, they may be considered as acetals or sugar ethers. By acid or base catalyzed or enzymic hydrolysis glycosides yield the parent sugar together with the non-sugar compound. The sugar component is known as the *glycone*; while the nonsugar residue is called as *aglycone*. The aglycone may be an alcohol, phenol, cyanohydrin or complex fused ring or heterocyclic hydroxy compounds. More than one molecule of sugars may be present in glycosides which are formed by either separate linkages or stepwise substituion of the sugars to the aglycone. In plants only β-forms of glycosides are formed, although the α-linkage is detected in nature in some carbohydrates such as sucrose, glycogen and starch. In α-strophanthoside, the outer glucose molecule occurs in α-linkages and the inner glucose possesses β-linkage.

Most of the glycosides are colourless, crystalline compounds. Anthracene glycosides are red or orange coloured compounds and flavone glycosides are yellowish in colour. They are soluble in water and alcohol, but insoluble in other organic solvents like petroleum ether, solvent ether, chloroform, carbon tetrachloride, etc. Glycosides are optically laevorotatory.



β-Form



α-Form

Classification

Various types of classifications of glycosides have been mentioned. On the basis of linkage of sugar molecule to aglycone, they are divided as follows :

1. **O-glycosides** : In these glycosides the sugar is combined with alcoholic or phenolic hydroxyl function of aglycone: e.g. digitoxin.
2. **N-glycosides** : In these glycosides nitrogen of amino group (—NH_2/—NH—) is condensed with a sugar, e.g., nucleoside.
3. **S-glycoside** : These glycosides contain a sugar moiety attached to a sulphur of the aglycone, e.g., isothiocyanate glycosides.
4. **C-glycosides** : Condensation of a sugar directly to a carbon atom gives rise to C-glycosides, e.g., aloin, and cascaroside. These glycosides are not hydrolyzed with acids, alkalies or enzymes.

On the basis of the chemical nature of aglycone the glycosides are classified as follows :

1. **Steroidal Glycosides** : These glycosides contain a sterol as an aglycone, e.g. diosgenin.

2. **Flavonoid Glycosides** : A flavonoid aglycone is present in these glycosides, e.g. rutin.
3. **Anthracene Glycosides** : In these glycosides, sugar moiety is attached to an anthracene aglycone, e.g. frangulin, barbaloin.
4. **Cyanophoric Glycosides** : Cyanogen is the aglycone part. They yield hydrocyanic acid on hydrolysis, e.g. amygdalin, prunasin.
5. **Triterpenic Glycosides** : A triterpene molecule is condensed with a sugar component, e.g., glycyrrhizin.
6. **Alcohol Glycosides** : e.g. Salicin.
7. **Lactone Glycosides** : e.g. Hydroxycoumarin glycosides.
8. **Isothiocyanate Glucosides** : e.g. Sinigrin, sinalbin.
9. **Saponin Glycosides** : e.g. Dioscin.

On the basis of nature of sugars the glycosides are called as glucosides, fructosides, rhamnosides, ribosides, etc.

Pharmacological classification of glycosides is depended on their activities. For example, cardiac glycosides exhibit their action on heart. Glycosides possessing bitter taste are called bitter glycosides, e.g. glycosides of Gentianceae.

Glycosides are used for the treatment of various illness. Digitalis and Strophanthus contain cardiac glycosides and are used as cardiac stimulant drugs. Anthraquinone glycosides, present in Senna, Cascara, Rhubarb and Aloe, are used as laxative. Picrorhiza roots and rhizomes possess picroside glycosides and are utilized as bitter tonic and to protect damaged liver. Wild Cherry bark and Scilla glycosides have expectorant properties. Dioscin is a saponin glycoside found in the tubers of *Dioscorea* species and its hydrolysis furnishes diosgenin aglycone. Various steroidal drugs have been synthesized from diosgenin. Some glycosides are less effective in original form, but produce active compounds on hydrolysis. For example, sinigrin, a glycoside of black mustard, is non-irritating in its natural form, but on hydrolysis a powerful irritating substance, allylisothiocyanate, is formed.

SAPONIN GLYCOSIDES

Saponins are highly complex glycosides which are widely distributed in the higher plants. The drugs like Quillaia,

Sarsaparilla and Senega have their medicinal properties due to the saponins they contain. Saponins form colloidal solution in water which give a soap-like froth on shaking. They have the property of causing haemolysis of red blood corpuscles, even at great dilution. Most of the saponins are highly toxic when injected into the body, much less so when taken orally. They are very toxic to fish. On hydrolysis they yield an aglycone known as 'sapogenin' which may be a steroid or a triterpene and the sugar moiety may be glucose, galactose, a pentose or a methylpentose. Saponins have a high molecular weight and they are purified with difficulty.

Steroidal saponins are less common than the pentacyclic triterpenoid type in plants. They are related with compounds such as sex hormones, cortisone, diuretic steroids, vitamin D, withanolides and cardiac glycosides. Natural sapogenins differ only in their configuration at carbon atoms 3, 5 and 25.

Cardiac Glycosides : These are steroidal glycosides and show highly specific and powerful action upon the cardiac muscles. The sugar part is attached at C-3 position of the steroidal nucleus. The steroid aglycone or genins are of two types :

(i) Cardenolides which are C_{23} steroids having an α, β-unsaturated five - membered lactone ring attached at 17β position. These compounds are present in Digitalis, Strophanthus, Oleander, Calotropis and Convallaria.

(ii) Bufadienolides which are C_{24} steroids having double unsaturated six-membered lactone ring at the 17α position. The name bufadienolides has been derived from the generic name for the toad, *Bufo*, since the compound bufalin was isolated from the skin of toads.

Cardenolides are distributed in excess amount in nature. For maximum cardiac activity the aglycone should possess an α, β-unsaturated lactone ring attached β-position at 17-carbon of the steroid nucleus and the A/B and C/D ring junctions should have the cis-configuration. The sugar portion of the glycoside helps in its absorption and distribution in the body. Oxygen substitution on the steroid nucleus also affects the distribution and metabolism of the glycosides. When number of hydroxyl groups is increased on the molecule, the more rapid is the action in the body.

Cardiac glycosides increase the force of systolic contraction and decrease the heart rate.

The sugar units, attached at C-3 of the steroid, are composed of up to three sugar molecules. Glucose, rhamnose, digitoxose and cymarose are the sugars usually attached to the aglycone. Cardiac glycosides containing cyclic sugars have been isolated from *Calotropis* species.

DIGITALIS

Synonyms : Foxglove; Purple foxglove; Fairy gloves; Digifortis; Digitora; Neodigitalis; Pil-digis, Folia digitalis; Digitalis folium.

Biological Source : Digitalis consists of dried leaves of *Digitalis purpurea* Linn. possessing not less than 0.3 per cent of total cardenolides calculated as digitoxin. The collected leaves are immediately dried at a temperature below 60° and stored in a water proof container. The moisture should not be less than 5 per cent. (Family : Scrophulariaceae).

Habitat : Southern and Central European countries, England, Germany, Holland, France, Northern U.S.A. and in Kashmir. In India it is cultivated in Kashmir at Tangmarg and Kishtwar at 2000-2300 m; Darjeeling district and the Nilgiris.

Cultivation and Collection : Digitalis is a biennial herb occurring wildly. For its cultivation especially stained seeds are sown in a soil consisting of equal parts of clean sand, garden soil, manure and leaf mould in March. After about two months the seedlings are transferred in fields. The leaves are collected in the early afternoon from September to November by hand. Leaves of the first year crop contain maximum amount of active constituents. The leaves are dried immediately after collection below 60°C. If drying is rapidly, then characteristic green colour remains as such. Dried leaves are packed in air-tight containers. Usually a desiccating substance like silica gel or calcium oxide is placed in the container to absorb moisture. Some plants are allowed to grow for the next year during flowering and seeds are developed which are used for cultivation of the next crop.

Characters : The leaves are linear or oblong-lanceolate, with obtuse or rounded apex, size 10-10 cm long and 4-8 cm wide. The margin is crenate to dentate with water pores on

many teeth. Lamina is decussate at the tapering base. Upper surface is pubescent, dark green and little wrinkled and veins are depressed. The lower surface is greyish-green and veins are more prominent. Both the surfaces are hairy, but the lower surface is more hairy in comparison to upper one. Venation is pinnate, all types of veins are less prominent on the upper surface; lateral veins leave the mid-rub at an acute angle and anastomose on the margin. Petiole is winged, 2.5-10 cm in length. Odour is distinct and taste is bitter.

Chemical Constituents : Digitalis contains about 35 glycosides and some of these glycosides are summarized in Table 1. The most important compounds of medicinal importance are digitoxin, gitoxin, and gitaloxin which are secondary glycosides. These glycosides possess a linear chain of three deoxy sugars at C-3 of the aglycone and not the terminal glucose as in purpurea glycosides A and B. These two glycosides are the prominent active components of the fresh leaves. When the drug is dried, enzymatic degradation takes place resulting the removal of terminal glucose to give digitoxin, gitoxin and gitaloxin.

Purpurea glycosides A and B and glucogitaloxin are the primary glycosides which contain a linear chain of three digitoxose sugar moieties terminated by the fourth sugar glucose at C-3 of the aglycone residue.

In addition to cardiac glycosides the presence of tannins, inositol, luteolin, acids, fatty matters, antirhinic acid, digitalosmin, digitoflavone and pectin have been reported in the drug. It also contains anthraquinone derivatives such as 1-methoxy-2-methylanthraquinone, 3-methoxy-2-methyl-anthraquinone, digitolutein (3-methylalizarin-1-methyl ether), 3-methylalizarin and 1,4,8-trihydroxy-2-methylanthraquinone.

Uses : Digitalis is used as a cardiac stimulant and tonic. The drug stimulates cardiac muscles, increases the systole of heart ventricle and normalizes the heart frequency. In this way the drug is useful in congestive heart failure, atrial flutter and atrial fibrillation.

Chemical Tests

Digitalis glycosides respond to the following tests due to five-membered lactone ring present at C-17.

1. **Keller-Kiliani Test** : To an extract of the drug in

glacial acetic acid few drops of ferric chloride and concentrated H_2SO_4 are added. A reddish-brown colour is formed at the junction of two layers and the upper layer turns bluish green. This test indicates the presence of digitoxose.

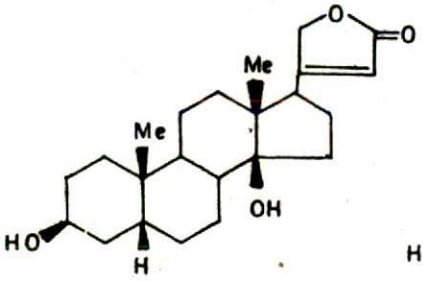
2. **Legal Test** : To a solution of glycoside in pyridine sodium nitroprusside solution and sodium hydroxide solution are added. A pink to red colour is formed.
3. **Baljet Test** : To a leaf lamina sodium picrate reagent is added. A yellow or orange colour is formed in the presence of glycosides.

Table 1. Some Cardioactive Glycosides of *Digitalis purpurea*.

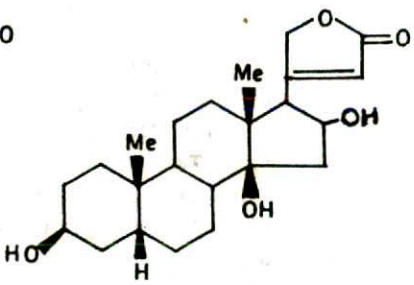
	Glycoside	Aglycone	Sugar moieties
1.	Purpurea glycoside A	Digitoxigenin	$(Digitoxose)_3$-glucose-
2.	Digitoxin.	Digitoxigenin	$(Digitoxose)_3$-
3.	Glucodigitoxigenin-digitoxoside	Digitoxigenin	$(Digitoxose)_2$-glucose-
4.	Gluco-evatromonoside	Digitoxigenin	Digitoxose-glucose-
5.	Purpurea glycoside B	Gitoxigenin	$(Digitoxose)_3$-glucose-
6.	Gitoxin	Gitoxigenin	$(Digitoxose)_3$-
7.	Glucogitoroside	Gitoxigenin	Digitoxose-glucose-
8.	Digitalinum verum	Gitoxigenin	Digitalose-glucose-
9.	Stropeside	Gitoxigenin	Digitalose-
10.	Glucogitaloxin	Gitaloxigenin	$(Digitoxose)_3$-glucose
11.	Gitaloxin	Gitaloxigenin	$(Digitoxose)_3$-
12.	Glucogitaloxigenin-bis-digitoxoside	Gitaloxigenin	$(Digitoxose)_2$-glucose-
13.	Gluco-lanadoxin	Gitaloxigenin	Digitoxose-glucose
14.	Gluco-verodoxin	Gitaloxigenin	Digitalose-glucose
15.	Verodoxin	Gitaloxigenin	Digitalose-

ALLIED DRUGS

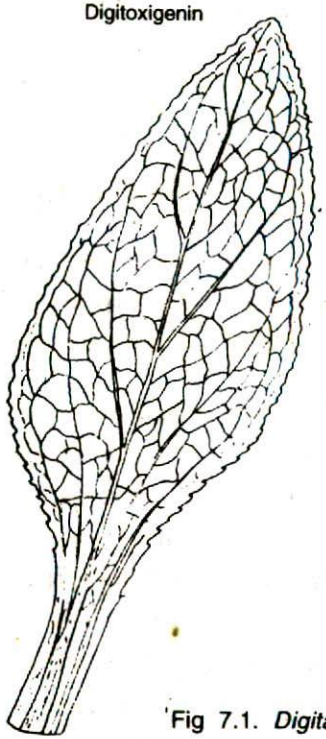
Digitalis lanata : (Grecian Foxglove, Wooly foxglove). The leaves of *Digitalis lanata* Ehrh. (Fam. Scrophulariaceae)

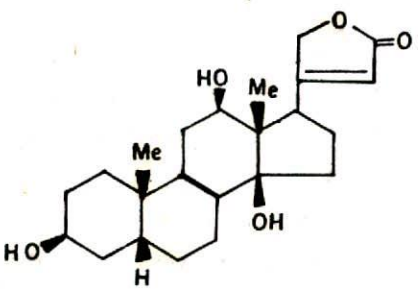


Digitoxigenin



Gitoxigenin





Digoxigenin

Fig 7.1. *Digitalis purpurea* leaf

contain the glycosides digoxin and lanatoside C. It is a perennial or biennial herb, nearly 1m in height, found in Europe, Holland, Ecuador and in Kashmir at Tangmarg and Baramulla. The leaves are sessile, oblong, up to 30 cm in length and 4 cm broad. The margin is entire and acuminate apex. The veins are joined to the midrib at a very acute angle.

D. lanata contains lanatosides A, B, C, D and E, acetyldigitoxin, digitoxin, glucogitoroside, digitalinum verum, deacetyl-lanatoside C, digoxin, glucolanadoxin, and glucovero-

doxin. The aglycone parts of lanatosides A-E are given in Table-2. Some flavone derivatives, e.g., scutellarein, luteolin and dinatin have also been reported from *D. lanata*.

D. lanata leaves are used for the preparation of lanatosides and digoxin.

In addition to *D. lanata* the leaves of *D. thapsi*, found in Spain and Italy, *D. lutea*, and *D. ferruginia* are used as allied drugs.

Tabel 2 : Some Cardioactive Glycosides of *D. lanata* Leaves

Glycoside	Aglycone	Sugar Moieties
Lanatoside A	Digitoxigenin	Glycose-acetyldigitoxose-$(digitoxose)_2$-
Lanatoside B	Gitoxigenin	Glucose-acetyldigitoxose-$(digitoxose)_2$-
Lanatoside C	Digoxigenin	Glucose-acetyldigitoxose-$(digitoxose)_2$-
Lanatoside D	Diginatigenin	Glucose-acetyldigitoxose-$(digitoxose)_2$-
Lanatoside E	Gitaloxigenin	Glucose-acetyldigitoxose-$(digitoxose)_2$-
Digitoxin	Digitoxigenin	$(Digitoxose)_3$-
Glucoevatromonoside	Digitoxigenin	Glucose-digitoxose-
Digitalinum verum	Gitoxigenin	Glucose-digitalose-
Glucolanadoxin	Gitaloxigenin	Glucose-digitoxose-
Glucoverodoxin	Gitaloxigenin	glucose-digitalose-
Acetyldigitoxin	Digitoxigenin	Acetyldigitoxose-$(digitoxose)_2$-
Acetyldigoxin	Digoxigenin	Acetyldigitoxose-$(digitoxose)_2$-
Deacetyl-lanatoside C	Digoxigenin	Glucose-$(digitoxose)_2$-

Adulterants : Digitalis is adulterated with the leaves of mullein (*Verbascum thapsus* Linn.), comfrey (*Symphytum officinale* Linn.), primrose (*Primula vulgaris* Huds.), elecampane (*Inula helenium* Linn.), ploughman's spikenard (*Inula conyza DC*) and nettle (*Urtica dioica*).

STROPHANTHUS

Synonyms : Strophanthus seeds; Semina strophanthi.

Biological Source : Strophanthus is the ripe seeds of *Strophanthus kombe* Olive, or *S. hispidus* DC.

Family : Apocynaceae.

Habitat : East and central Africa.

Collection : Seeds are collected usually from wild plants. The plants are large climbers. Fruits are many-seeded, dehiscent and consist of two divergent follicles. Mature fruits are collected in June-July, epicarp and mesocarp are separated and seeds are removed. The seeds are washed and dried.

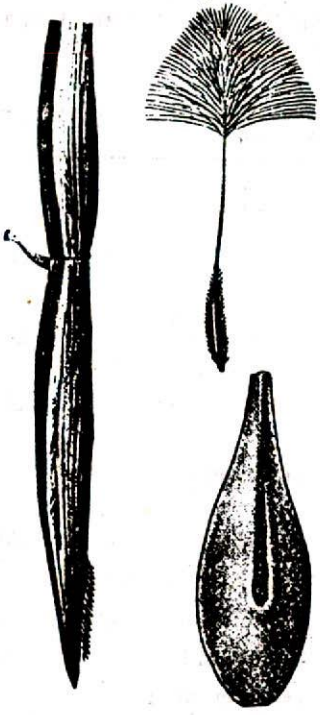


Fig. 7.2. Seed of Strophanthus

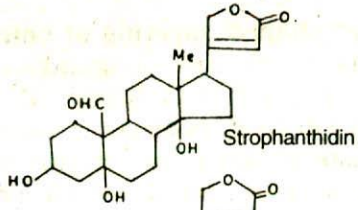
Chemical Constituents : Strophanthus contains a cardiac glycoside strophanthin-K (2-5%), kombic acid, choline, trigonelline, fixed oil (30%), resin and mucilage. Strophanthin-K, is a mixture of K-strophanthoside, K-strophanthin-β and cymarin and the genin part of all these glycosides is strophanthidin. The genin strophanthidin is coupled to a trisaccharide consisting of cymarose, β-glucose and α-glucose.

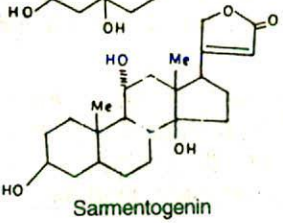
The enzyme α-glucosidase removes the terminal α-glucose to yield K-strophanthin-β and the enzyme, strophenthobiase, present in seeds, converts this to cymarin and glucose.

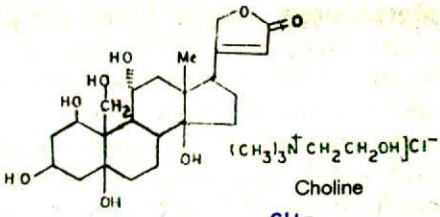
Uses : Strophanthus is used as cardiac tonic, diuretic and arrow poison.

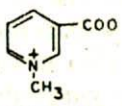
Allied Drugs : *Strophanthus gratus* contain 4-8% of ouabain (G-strophanthin). Ouabain has also been reported in the wood of African *Acokanthera ouabaio*.

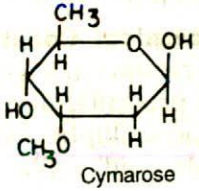
Seeds of *S. sarmentosus* contain a number of glycosides with sarmentogenin as the aglycone.











SQUILL

Synonyms : Sea onion; Bulbus Scillae; Meerzwiebel, Scilla bulb; White Squill; European Scilla; Radix scillae.

Biological Source : Squill consists of the dried sliced scales of the fleshy inner bulb of the white variety of *Urginea maritima* (L.) Baker *(Scilla maritima* L.). The central part of the bulb is removed during its preparation.

Family : Liliaceae.

Habitat : Mediterranean seacoasts of Spain, France, Italy, Greece, Algeria, Morocco; Algiers and Cyprus.

Collection : The bulbs grow half immersed in the sandy soil. It is collected in August during flowering stage. Outer membraneous scales, fibrous roots and central portion are removed. Then the bulbs are cut transversely into thin slices, dried in the sun or stove heated and packed in bags or in barrels. On drying about 80% weight is lost.

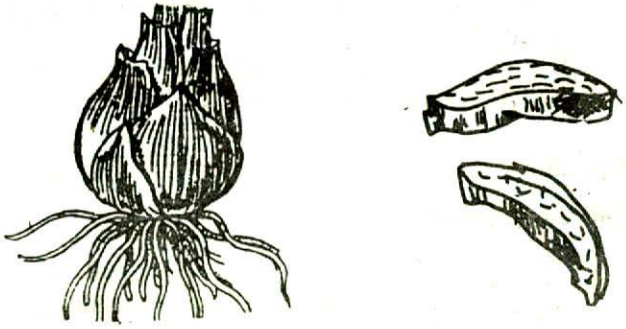
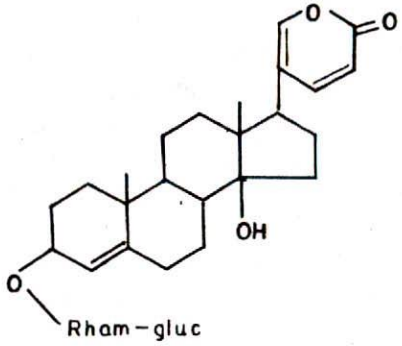


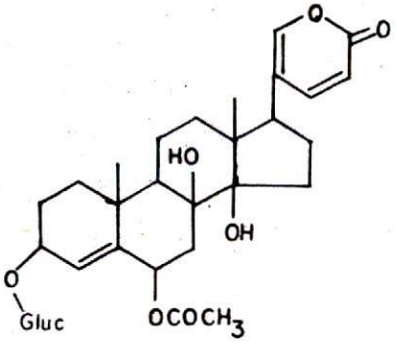
Fig. 7.3. Squill

Morphology : Squill bulbs are pear-shaped, tapering at both ends, diameter 15-30 cm. Surface contains longitudinal furrow. Colour is yellow, fracture is short and brittle. The slices of the drug are nearly 0.5-5 cm long, tapering at both ends. The odour is slight and taste is bitter, mucilaginous and acrid. The drug is hygroscopic and should be stored carefully in air-tight containers.

Chemical Constituents : The drug contains about a dozen of cardioactive glycosides scillaren A, scillaren B, glucoscillaren A, proscillaridin A, scillaridin A, scilliglaucoside, scillipheoside, glucoscillipheoside, scillicyanoside, scillicoeloside, scilliazuroside and scillicryptoside.



Scillaren A.



Scilliroside

Two-third amount of the total glycosides is of scillaren A. On hydrolysis it forms the aglycone scillarenin (bufadienolide), rhamnose and glucose. In addition to glycosides the drug also contains various flavonoids, like quercetin derivatives and kaempferol polyglycosides; sinistrin, mucilage and calcium oxalate.

Uses : Squill is used as expectorant, diuretic, and cardiotonic, but it shows emetic action.

ALLIED DRUGS

Indian Squill or Urginea

It consists of dried longitudinal slices of the bulb of *Drimia indica* (syn. *Urginea indica* Kunth) (Family Liliaceae). The drug is found in western Himalaya, Bihar, Chota Nagpur, Konkan and Coromandel Coast. It is a small glabrous herb, bulb diameter is about 1.5 cm or more, flowers appearing before the leaves drooping or spreading. Surface of the bulb

is fleshy and longitudinally ribbed, fracture is brittle, yellowish colour, odour is slight and taste is bitter and acrid.

It is also cultivated is sandy soils near the sea-shore in south India. The bulb prefers a sandy soil and average temperature of 15°C. The plants are grown from seeds and in 5-6 years the bulbs develop. Bulbs are also raised from the bulblets. Planting is generally done in rows. The bulbs are collected in the early autumn when the leaves wither after flowering. The bulbs are cleaned of the soil, the dry outer scales separated and cut into four parts. The core is cut out and the quarters are finally sliced. The slices are dried in the sun, or on slow fire to lose 80% of their weight and packed in bags or barrels.

Indian Squill occurs in the form of curved or irregularly shaped strips, 3-6 cm long, 3-8 mm broad and 1-3 mm thick. They are thickened in the middle, but tapering towards the ends, translucent or yellowish white, and slightly darker in colour than the European Squill. They are brittle when dried, but become tough when moistened; fracture is brittle. It is odourless and has a slight bitter, mucilaginous and acrid taste.

In large doses it is emetic and cathartic and may cause cardiac depression. It is used to treat cough, dropsy, rheumatism, skin troubles; to remove warts and corns; as cardiac tonic, expectorant and diuretic.

Indian Squill contains scillarens A and B and mucilage is consisted of mannose, glucose and xylose. Scillaren A yields on hydrolysis proscillaredin A and than scillaredin A. With iodine water a reddish purple colour is formed and this test is negative with European Squill.

Red Squill : Red Squill is a variety of *Urginea maritima* (Fam. Liliaceae). It contains cardiac glycosides and glycosides scilliroside and scillirubroside. Red Squill is used as a rodenticide to kill rodents. When taken by rodents, convulsions, respiratory failure and death occur. It contains cardic glycoside scillaren A and enzyme scillarenase composed of proscillaridin and glucose.

ANTHRAQUINONE GLYCOSIDES

Anthraquinone glycosides possess anthracene or their derivatives as aglycone. Hydrolysis of these glycosides yields aglycones which are di-, tri- or tetrahydroxyanthraquinones.

The glycosides are found in the drugs like Senna, Aloe, Rhubarb, Cascara, Cochineal, etc. In addition of hydroxy groups, some other groups have been detected, for example, methyl in chrysophanol, hydroxymethyl in aloe-emodin and carboxyl in rhein.

Anthraquinone derivatives are usually orange-red compounds, soluble in water or dilute alcohol. When the alcoholic or ethereal extract of powdered drug is treated with ammonia or caustic soda solution, a pink, red or violet colour is formed.

Anthranols and anthrones are the reduced anthraquinone derivatives found in free or combined state as glycosides. They are converted to other compounds in solution. They are pale yellow, non-fluorescent substances, and insoluble in alkali. They contain significant therapeutic action of the crude drugs.

Oxanthrones are intermediate products between anthraquinones and anthranols. They are present in Cascara bark and produce anthraquinone on oxidation.

In dianthrones two anthrone molecules are combined at C-10 which may be identical or different. These compounds are found in species of *Cassia*, *Rheum* and *Rhamnus*. Sennosides are the glycosides belonging to dianthrone group.

Aloin-type or C-glycosides are obtained from *Aloe* species. They are resistant to normal acid hydrolysis.

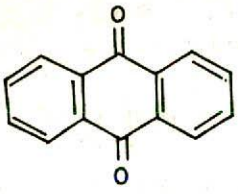
The anthraquinone aglycones in free state exhibit little therapeutic activity. The anthraquinone and related glycosides act as stimulant cathartics and increase the tone of the smooth muscle in the wall of large intestine. Glycosides of anthranols and anthrones exhibit more drastic action than the related anthraquinone glycosides.

SENNA

Synonyms : Alexandrian Senna (Egyptian Senna); Tinnevelly Senna (Indian Senna); Senna Leaves; Folia sennal.

Biological Source : Senna consists of dried leaflets of *Cassia acutifolia* Delile *(C. senna* L.) known as Alexandrian Senna, and of *C. angustifolia* vahl, known as Tinnevelly Senna. It contains about 2.5% of hydroxyanthracene glycosides, calculated as sennoside B.

Family : Leguminosae.



Anthraquinone



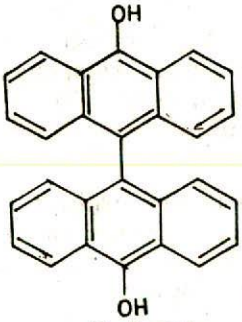
Anthrone



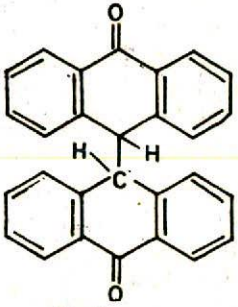
Oxanthrone



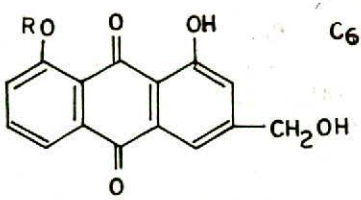
Anthranol



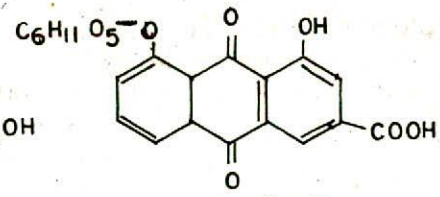
Dianthranol



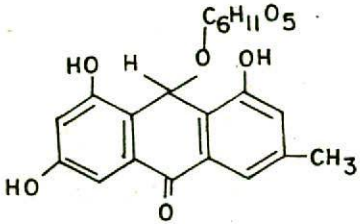
Dianthrone



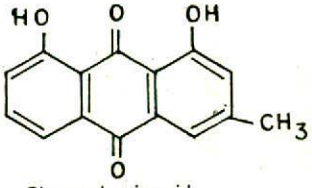
Aloe-emodin-8-glucoside (R=Glucose)
Aloe-emodin (R=H)



Rhein-8-glucoside



Emodin-oxanthrone glucoside



Chrysophanic acid

Habitat : Egypt and neighbouring region for Alexandrian Senna; Tinnevelly Senna is cultivated in South India in Tinnevelly, Madurai, Trichinopoly, Mysore; in N.W. Pakistan and Jammu.

Cultivation and Collection : The plant is a small shrub bearing paripinnate compound leaves.

C. angustifolia is cultivated usually on dry land in south India. It is grown on rice land immediately after the rice crop is harvested. It may be given a light irrigation and grown as a semi-irrigated crop. The plant grows well above 10°C. Seeds are sown either by broadcasting or by dribbing. Abrading of the tough seed coats is done by pounding the seeds lightly with coarse sand in a mortar to induce quick germination. The plants require bright sunshine and occasional drizziling. Continuous rains during growth spoils the quality of the leaves. When the leaves are fully grown and are thick and bluish in colour, they are stripped off by hand before flowering. The leaves are spread out on a hard floor to dry in shade. The pods and large stalks are separated by means of sieves. The colour changes to yellow. They are graded and packed under hydraulic compression into balls and sent to the market.

Tinnevelly Senna plants are more luxuriant than Alexandrian senna. It is grown on dry or wet conditions as a successor to rice. The leaves are gathered by hand and dried in the sun. Leaves are graded according to their size and colour of the leaflets, compressed into bales and exported.

Morphology : Senna occurs in leaflets. The leaflets of Alexandrian Senna are less entire and more broken, 2-4 cm long, about 1 cm wide; margin is entire, curled, apex is acute with sharp spine at apex, base is asymmetrical, surface is pubescent, venation is pinnate, veins are anastomosing towards margin, texture is thin, brittle; colour is greyish green, odour is faint, taste is mucilaginous and slightly bitter.



Fig. 7.4. Senna leaves

Tinnevelley Senna **differs** slightly from the Egyptian Senna. Its leaflets are **2.4-6 cm** long, shape is lanceolate and colour is yellowish green.

Epidermal trichomes are present on the leaflets which are unicellular, conical, thick-walled and with a warty cuticle. Lamina is isobilateral.

Chemical Constituents : Senna contains dianthrone glycosides, the sennosides A, B, C and D, aloe-emodin-dianthrone-diglycoside, rhein-anthrone-8-glycoside, rhein-8-diglycoside; aloe-emodin-8-glucoside and aloe-emodin-anthrone diglucoside. In addition to these two naphthalene glycosides, viz. 6-hydroxymusizin glycoside and tinnevellin glycoside have been isolated. Senna also contains flavonoids like kaempferol, its glucosides (kaempferin), isorhamnetin; a sterol and its glucoside, mucilage, calcium oxalate, resin and free anthraquinones.

Chemical Test

1. **Bornträger Test for Anthraquinones** : Senna leaves are boiled with dilute H_2SO_4, filtered, the filtrate is extracted with chloroform or ether. On addition of ammonia to the extract in organic phase pink to red colour is formed due to the presence of anthraquinone compounds.
2. A little drug extract is treated with 5 N sodium hydroxide and sodium hyposulphite. On heating red colour appears.

Uses : Senna is used as purgative and cathartic. It is stimulant laxative. The drug is used in acute constipation and in all cases in which defaecation with a soft stool is required; e.g. with haemorrhoids, after anal-rectal operations, before and after abdominal operations, with anal fissures, for the evacuation of X-ray contrast media from intestines, etc. The sennosides are first hydrolyzed by the intestinal bacteria and then reduced to anthrone stage, the actual active form.

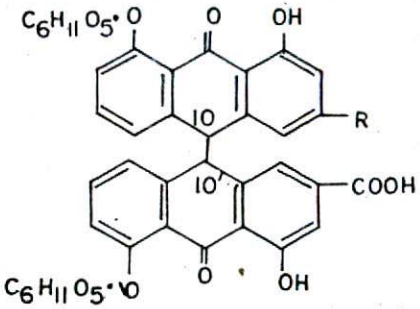
There may be reddening of urine (harmless) and passage of some of the anthracene derivatives into mother's milk which may cause diarrhoea in infants. Overdose may lead to colicky abdominal pains and the formation of thin, water stools.

Allied Drugs : *Bombay, Mecca* and *Arabian Sennas* are the

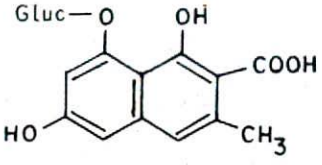
leaves of *Cassia angustifolia* found in Arabia and used as a substituent.

Dog Senna is obtained from the leaves of *Cassia obovata*. The leaves are ovate and it contains about 1% anthraquinone derivative.

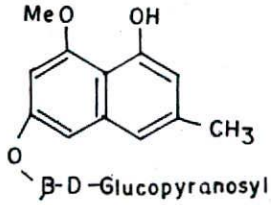
Palthe senna is obtained from *Cassia auriculata*. This adulterant does not contain any sennosides. It can be examined by with a hand lens by the dense pubescence on the lower surface of the leaf, and by the trichomes, which are very long, slightly wirty, and more sharply covered towards the tips. With 80% sulphuric acid, palthe senna gives a carmine-red colour due to conversion of leuco-anthocycinidin to the oxonium salt. In addition to these, leaves of other senna are substituted.



	R	10-10'
Sennoside A	COOH	trans
Sennoside B	COOH	meso
Sennoside C	CH_2OH	trans
Sennoside D	CH_2OH	meso



6-Hydroxymusizin glycoside



Tinnevellin glycosede

RHUBARB

Synonyms : Rheum, Rhizome Rhei, Rhei Radix, Revandchini (Hindi); Rhubarb rhizome; Turkey Rhubarb, Radix rhei.

Biological Source : Rhubarb is the dried rhizome and roots of *Rheum officinale* Baill, *R. palmatum* L. or other species of *Rheum* (excepting *R. rhaponticum* L.), deprived of most of its bark. It contains about 2.5% of hydroxyanthracene derivatives, calculated as rhein.

Family : Polygonaceae.

Habitat : China, Tibet, Nepal, Central Asia; cultivated in Europe, southern Siberia, and North America.

Collection : Rhubarb grows at a high altitude of 3000 m. The plant is perennial bearing large and vertical rhizome and thick-branched roots.

The drug is collected in autumn or spring from 6-10 years old plants by digging out. Roots are cut and outer bark is separated by peeling. The big rhizomes are cut longitudinally into small pieces, dried and exported.



A. Rhizome with small roots B. Rhizome piece

Fig. 7.5. Rhubarb

Morphology : The drug occurs as round or flat pieces, 5-15 cm long, diameter is 3-8 cm; shape is cylindrical ; surface is smooth, firm, non-shrunken and bright yellow showing white reticulations due to fusiform or lozenge-shaped cut ends. Fracture is irregular and granular. Odour is characteristic and aromatic; taste is bitter and astringent. Holes in pieces of the drug may be caused by insect attack or made for hanging the drug up to dry.

Chemical Constituents : Rhubarb contains free anthraquinones and their glycosides (3-12%) such as chrysophanol, aloe-emodin, emodin, physcion and rhein. Anthrones or dianthrones of chrysophanol, emodin, aloe-emodin, or physion are reported. The dianthrone glucosides of rhein (sennosides A and B) and the oxalates of these

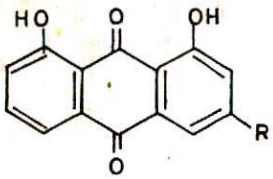
(sennosides E and F) are isolated. Heterodianthrones are derived from two different anthrone molecules; for example, palmidin A (aloe-emodin anthrone and emodin anthrone); palmidin B (aloe-emodin anthrone and chrysophanol anthrone), palmidin C (emodin anthrone and chrysophanol anthrone), sennidin C, rheidin B and rheidin C.

Besides these, Rhubarb contains glucogallin, free gallic acid, (-)-epicatechin gallate, catechin, rheotannic acid, erythroretin, methylchrysophanic acid, rhubarberon, cinnamic acid and calcium oxalate.

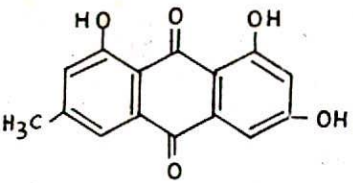
Chemical Tests

1. Bornträger's test described under Senna is positive due to anthraquinone derivatives.
2. It gives pink colour with ammonia.
3. A blood red colour is formed on treating Rhubarb powder with 5% KOH solution.

Uses : Rhubarb is used as a laxative; in larger doses as a purgative.



Rhein (R=COOH)
Chrysophanol ($R=CH_3$)



Emodin

OTHER RHUBARBS

Indian Rhubarb : It consists of the dried rhizomes and roots of *R. emodi* and *R. webbianum*. *R. emodi* is a stout herb, 1.5-3.0 m in height, distributed in the Himalayas from Kashmir to Sikkim at altitudes of 3,300-5,200 m. It is also cultivated in Assam for its leaves consumed as vegetable. Roots are very stout.

The drug is collected from the wild plant, found in the hills of Kangra, Kulu, Kumaun, Nepal and Sikkim. The herb is drought resistant, and can be propagated either through rhizome-cuttings or seeds. The plant requires deep, rich soil, mixed with well-rotten manure. The cuttings are planted in

early spring at a spacing of 1.2 - 1.5 m beneath the surface. Aerial portions wither away during winter and die, but the rhizomes regenerate during the ensuring spring. Rhizomes and roots are dug up in September from 3 to 10 years old plants. They are washed and cut into pieces of proper size, kiln- or sun-dried, and stored in air-tight containers and protected from sunlight.

Indian rhubarb contains a number of anthraquinone derivatives based on emodin, emodin-3-monomethyl ether (physcion), chrysophanol, aloe-emodin and rhein. These occur free and as quinone, anthrone or dianthrone glycoside. The astringent principle consists of gallic acid, present as glucogallin, along with tannin and catechin. The drug also contains cinnamic and rheinolic acids, volatile oil, starch and calcium oxalate. Free chrysophanic acid, sennoside A and sennoside B are also present. The characteristic odour of the essential oil is due to presence of eugenol.

Indian rhubarb is used as a purgative and astringent tonic, in atonic dyspepsia, and for cleaning teeth. Powdered roots are sprinkled over ulcers for quick healing.

Chinese Rhapontic (Rhapontic rhubarb) : It is obtained from *Rheum rhaponticum*. Its odour is sweet. It contains anthracene derivatives and a stilbene derivative, rhaponticin. Its alcoholic extract on filter paper shows a distinct blue fluorescence in U.V. light due to rhaponticin.

Japanese Rhubarb : It is a hybrid of *R. coreanum* and *R. palmatum* and contains anthraquinone derivatives, naphthalene glycosides, stilbene glycosides and *d*- catechin.

ALOE

Synonyms : Aloes; Ghrit kumari (Sansk)

Biological Source : Aloe is dried juice of the leaves of *Aloe barbadensis* Mill. (*A. vera* L.), *A. ferox* Mill and *A. africana* Mill. or their hybrids. It contains about 28% of hydroxyanthracene derivatives, calculated as anhydrous barbaloin.

The liquid is obtained from the transversely cut leaves which is concentrated by boiling and solidifies on cooling.

Family : Liliaceae.

Habitat : There are about 180 species of Aloe and most of them are found in South Africa and West Indies. *A.*

barbadensis is a native of Northern Africa but it is planted in Indian gardens and many other tropical countries. Aloe plant is a typical xerophyte with thick, fleshy, strongly cuticularized spiny margined leaves arranged in rosette formation. Erect unbranched flower rises after rainy season in winter. It fluorishes on poorest soil and can be propagated easily by means of a sucker.

Commercial Varieties of Aloe

1. *Aloe barbadensis* (Syn. *A. vulgaris, A. officianalis)* : This is known as Curacao Aloe or Barbados Aloe. It is native of northern Africa. At present it is cultivated in Aruba, Bonaire and Curacao islands near West Indies. It is coarse - looking perennial plant with a short stem found in semi-wild parts; leaves 30-60 cm, erect, crowded in basal rosette, full of juice, glaucous - green, narrow-lanceolate, long-acuminate, smooth; flowers yellow, in dense racemes terminating the scapes. The juice of the Aloe is collected in a tin vessel. It is packed in gourds. The Aloe is also known as Hepatic Aloe or Liver Aloe. The plant of *A. barbadensis* is of herbaceous type.
2. *Aloe ferox* and its hybrids : This drug is called as Cape Aloe and occurs wildly on the Islands of Socotra, South Africa, Kenya and neighbouring mainland of East Africa. The juice of the plant is collected in canvas or goat skin. Cape Aloe is exported from the Republic of South Africa and largely used in veterinary practice. The plant of *A. ferox* is of the arborescent type.
3. *Aloe perryi* : This Aloe is known as Socotrine and Zangibar Aloes. This is cultivated in Socotra and Zangibar Islands. It has simple stem, 2.5 cm in diameter, scarcely rising above the ground, and crowded leaves much shorter than those of *A. succotrina.* The plant is suitable to grow in the limestone-tract and can be cultivated in the driest situation and poorest soil. Zangibar Aloe is packed in skins of carnivorous animals. This Aloe is also called as Monkey skin Aloe. The juice of Socotrine Aloe is collected in goat or sheep skin.

Collection : The Aloe leaves contain spines at the margins. For collection of juice of *A. barbadensis,* (Curacao Aloe) the leaves are cut in March-April in V-shaped and a vessel is kept under the incision. The juice is evaporated in copper

vessel on open fire, poured into cans or tins, allowed to solidify and exported. The methods of preparation of aloes from different varieties are varied slightly. The juice of *Aloe perryi* (Scotorine Aloe) is collected in goat's or sheep's skin container which is evaporated itself without applying heat. The latex of leaves of *Aloe ferox* (Cape Aloe) is boiled in a drum for about 4-5 hours on an open fire. It is then cooled quickly for getting vitreous or shiny aloe.



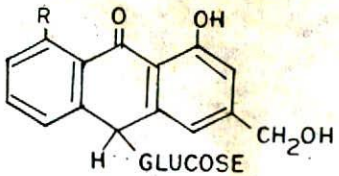
Fig. 7.6. Aloe vera

Characters : Aloe is available as opaque masses, colour ranges from reddish black to brownish black, fracture is waxy. Cape Aloe is glassy mass having characteristic, sour odour, taste is nauseous and bitter. Curacao Aloe is yellowish brown to chocolate brown in colour, opaque, breaks with a waxy fracture, nauseous and bitter taste and iodoform-like odour.

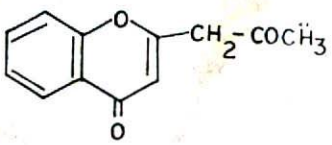
Chemical Constituents : Aloe contains a mixture of crystalline glycosides known as 'aloin' (4-5% in Cape Aloe; 18-25% in Curacao Aloe), resin (16-63%), emodin and volatile oil. It also possesses the anthraquinone glycosides like barbaloin (aloe-emodin anthrone C-10 glucoside); chrysophanic acid, β-barbaloin, and iso-barbaloin. Barbaloin is a C-glycoside and it can not be hydrolyzed easily. The

O-glycosides present in the Aloe are aloe-emodin-8-glucoside and emodin oxanthrone glucoside. Aloe resin is the ester of p-coumaric acid or p-hydroxycinnamic acid with aloe resinotannol.

The principal constituents of aloin are barbaloin, isobarbaloin, β-barbaloin, aloe-emodin and resins. Phenolic glucosides identified are isoeleutheraol, β-D-glucopyranoside, aloesaponol III-8-0-β-D-glucopyranoside, aloesaponol II-6-0-d-glucopyranoside, aloenin and aloesin. During storage of aloin the content of aloe-emodin increases. In addition to these, flavonoids, oxanthraquinones, coumarins, amino acids, monosaccharides, polysaccharides, oils, sterols, triterpenes, vitamin C and group B vitamins, citric, L-malic and formic acids are present in all aloes. Cholesterol, compesterol, β-sitosterol and lupeol are found in lipid fraction. Presence of minerals B, P, Al, Mg, Cu, Ni, Ca, K, Si, Fe, Pb, Cr, Ba, Ag, Zn and Sr have been confirmed. A new bitter C-glucoside, aloe resin D, has also been isolated from Kenya aloe. Some aloes also contain polysaccharides "aloeferon" and "aloeulcin".



Aloin (R = H)
Barbaloin (R = OH)



Aloesin

Chemical Tests : Aqueous solution of Aloe is used to perform the following tests :

1. **Schonteten's Test :** To a solution (5 ml) borax (0.2g) is added and it is heated to dissolve completely. Few drops of the liquid are poured in a test-tube filled with water. A green fluorescence is produced.
2. **Bromine Test :** A pale yellow precipitate of tetrabromaloin is formed on addition of bromine.
3. **Nitric Acid Test :** On addition of nitric acid (2 ml) to a solution of Aloe (5ml), Cape aloe forms a brown colour which changed rapidly to green; Curacao gives a deep brownish-red; Socotrine a pale brownish-yellow; Zanzibar a yellow-brown colour.
4. **Nitrous Acid Test :** To an aqueous solution of Aloe a small amount of sodium nitrite and few ml of acetic acid

are added. Pink colour is developed.

5. **Klunge's Isobarbaloin Test :** To an aqueous solution (20 ml) copper sulphate solution (1drop) is added followed by sodium chloride (1 g) and 90% alcohol (10 ml). A purple colour is formed due to the presence of isobarbaloin. This test is sensitive in case of Curacao Aloe.
6. **Modified Bornträger's Test :** Aloe (0.1 g) is boiled with dil. HCl (5 ml) and 5% solution of $FeCl_3$ (5 ml) for 5 minutes. The solution is cooled, filtered and the filtrate is shaken with benzene. The benzene layer is separated, ammonia solution is added to this when a pink colour is formed.

Uses : Aloe is used as purgative and given in constipation. It is one of the ingredient of Compound Benzoin Tincture, Ointment of aloe-gel is used to cure burns caused by heat, sun or radiation and skin irritations. The plant is valued to cure many skin diseases, ulcerative skin conditions, wounds, burns, snake bite, as hair tonic, to treat enlarged spleen; tonic for stomach and brain, as a febrifuge and emmenagogue to relieve buring sensation.

Allied Drug

Indian Aloe : It is obtained from *Aloe vera* Var. *Officinalis.* It is found on the coasts of Bombay, Gujarat and Madras.The colour of the aloe is dark. It contains aloin but *iso*-barbaloin is almost absent. It is widely used in cosmetic products.

Aloe is substituted by Socotrine and Zangibar varieties from *Aloe perryi* and Natal Aloe *(A. candelabrum).* Socotrine Aloe occurs as yellowish-brown to blackish brown, opaque masses and breaks with a porous fracture. Zanzibar in identical but has a waxy fracture. Natal Aloe grows near Pietermaritzburg. It contains nataloin, homonataloin, and a resin consisting of nataloresinotannol and paracoumaric acid. Mocha Aloe is imported from Bombay. It is black, brittle, glassy aloe with strong odour and is of inferior quality. Jafferabad Aloe in nearly black.

CASCARA BARK

Synonyms : Sacred bark; Chittem bark; Chittim bark; Purshiana bark; Persian bark; Bearberry bark; Bearwood; Cascara sagrada; Rhamnus purshiana; Cortex rhamni.

Biological Source : Cascara is the dried bark of *Rhamnus purshiana* DC usually collected one year before its use.

Family : Rhamnaceae.

Habitat : Cascara is grown on the Pacific coast of North America, British Columbia, Oregon, Washington, California and Kenya.

Collection : The bark is collected during April-August from 6-12 meters high tree.The bark is removed from the tree by making longitudinal incisions. The trees are often felled and the bark is separated from larger branches. It is dried in the shade or in sun by keeping cork upper side. The bark is stored by protecting from rain and damp. The dried bark is cut into small pieces.

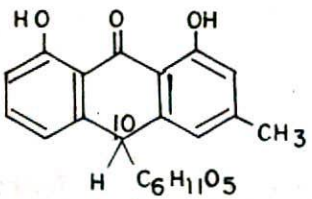
The bark occurs in quills, channelled or flat pieces, length up to 20 cm, thickness1-4 mm with short fracture. Odour is slight and distinct; taste is bitter.

Chemical Constituents : Cascara contains anthracene derivatives which are normal O-glucosides (10-20%) and C-glucosides (80-90%) and free anthraquinones. Cascarosides A, B, C and D contain both O- and C- glucosidic linkages.

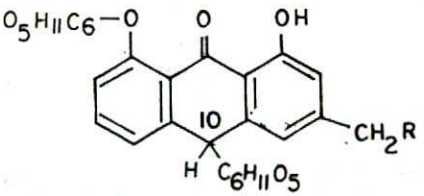
Two aloins, namely barbaloin derived from the aloe-emodin anthrone and chrysaloin derived from chrysophanol anthrone, are the C-glycosides. Cascara possesses O-glycosides derived from emodin, emodin oxanthrone, aloe-emodin and chrysophanol. Various dianthrones such as those of emodin, aloe-emodin and chrysophanol and the heterodianthrones palmidins A, B and C have been reported in Cascara bark. It also contains aloe-emodin, chrysophanol and emodin in the free state.



Fig. 7.7. Bark of Cascara sagrada



Chrysaloin



Cascaroside A = 10β, R=OH
Cascaroside C = 10β, R=H;

Cascaroside B = 10α, R=OH
Cascaroside D = 10α, R=H

Uses : Cascara is purgative and generally used in the form of liquid extract, elixir or tablets prepared from a dry extract.

DIOSCOREA

Synonyms : Wild yam; Colic root; Rhematism root.

Biological Source : Dioscorea is the dried rhizome of several species of *Dioscorea* like *D. villosa, D. prazeri* Prain & Burk; *D. composita* and *D. spiculiflora; D. deltoidea* and *D. floribunda.*

Family : Dioscoreaceae.

Habitat : North America and Mexico. In India the plants grow wildly in Western Himalayas up to an altitude of 3000 m.

Dioscorea plants are climbing; roots tuberous; tubers large; stem leafy.

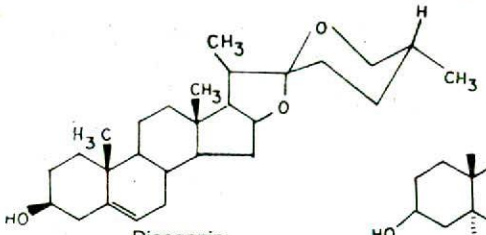
Dioscorea species are distributed throughout India except in the dry north-western region. These plants are cultivated mostly as garden crops or subordinate crops with ginger, turmeric, brinjal, sweet potato or maize. They thrive best in deep sandy loams with adequate moisture and good drainage. The field should be well prepared by digging to considerable depth and manuring liberally. Farmyard manure is usually applied. Both tuber tops and aerial tubers borne on the stems are used for propagation. The planting period is generally April-June after the onset of the monsoon, but it may vary according to local condition and the species. Vines are allowed to trail on ground or are trailed over stakes or trees near by. The crop is ready after 5-8 months of planting. During this period, the field is hoed and weeded and earthed up round the stems.

Tubers are variable in shape and size. Some species produce large cylindrical tubers penetrating deep into the ground while others produce globose tubers, close to the soil surface. Tubers are either solitary-one from each plant - or several of them are clustered together at the base of the plant. The yield ranges from 2 to 14 tons per acre dipending upon the variety cultivated, the soil and the cultural treatment. Discoreas are stored in cool sheds under dry earth or sand for about 6 months.

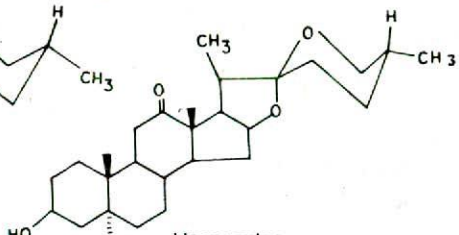
The yams of several species are soft, fleshy and edible.

Chemical Constituents : Dioscorea is a source of saponin glycoside diosgenin. Botagenin and diosgenin are obtained

from the root of *Dioscorea spiculiflora*. Diosgenin is obtained by hydrolysis of dioscin. Dioscorea also contains small quantities of hecogenin having keto group at 12 position of diosgenin; and an acrid resin. Dioscin on acidic hydrolysis yields diosgenin, rhamnose and glucose.



Diosgenin



Hecogenin.

The alkaloid, dioscorine, and the saponin, dioscin, occur in varying quantities in different species. American species contain the steroidal sapogenins, diosgenin, yamogenin, kryptogenin, etc. Botogenin, obtained from *D. mexicana*, is a starting material for the synthesis of cortisone, used in the treatment of rheumatoid arthritis and rheumatic fever.

Uses : Diosgenin is used for the production of various steroidal drugs like progesterone, and as a cheap source of carbohydrate food. Some species, e.g. *D. alata*, are used for the extraction of starch. Some of them are rich in vitamins B_1, B_2 and B_6.

Allied Species : *D. alata*, a native of south east Asia, is the most important cultivated species throughout the tropics. They are starchy and used as vegetable, anthelmintic, in leprosy, piles and gonorrhoea.

D. bulbifera is a large unarmed climber with stems twining to the left. The tubers are used mostly as famine food, to prepare starch, for washing wool and as fish bait in Kashmir, applied for ulcers, in piles, dysentery and syphilis.

D. deltoidea is an extensive climber with unarmed stem twining to the left. The tubers are rich in saponin and are used for washing silk, wood and hair, and in dyeing. They kill lice.

D. esculenta is a prickly climber; tubers 4 to many stalked, produced in branches close to the surface of the ground. The tubers are starchy and free from dioscorine. They have a sweetish taste; in flavour and mealiness, closely resemble potatoes. The Tubers are applied for swelling.

D. glabra is a climber with stems twining to the right. This species occurs in Assam, Bengal, Bihar, Orissa, Andaman and Nicobar Islands. The tubers are used as food edible.

D. hamiltonii is a climber with angled glabrous stem twining to the right. *D. hispida* is a climber with prickly stem twining to the left. The tubers are large, contain high amount of starch and used as famine food. The toxic principle is dioscorine which is distributed throughout the plant. The milky juice of tubers with the juice of *Antiaris toxicaria* is used as arrow poison.

D. oppositifolia is a climber with glabrous or finely pubescent stem. The tuber is usually single with few rootlets; skin reddish; flesh white, soft and edible. The tubers are used externally to reduce swellings.

D. pentaphylla is a tall, slender, prickly climber. Tubers are almost invariably single; texture and shape variable, skin brown, yellow or purplish. They are used to disperse swellings and as tonic.

D. prazeri is a climber with smooth or slightly ridged, unarmed stem. The tubers contain saponin and used for hair wash for killing lice and as fish poison.

D. puber is a large unarmed climber. The tubers are edible.

GLYCYRRHIZA

Synonyms : Liquorice; Licorice; Liquorice root; Mulethi (Hindi), Sweetwood; Radix glycyrrhizae.

Biological Source : Glycyrrhiza consists of the dried unpeeled roots and rhizome of *Glycyrrhiza glabra* L. var. *typica* or of *G. glabra* var. *glandulifera* or of other varieties of *G. glabra* yielding a yellow and sweet wood. It contains not less than 4% of glycyrrhizinic acid.

Family : Leguminosae.

Habitat : The drug is found from southern Europe to central Asia in Iran, Iraq, Russia, Arabia, Afghanistan, Turkestan, Asia Miror, Greece and Siberia. The plant is cultivated in Punjab, sub-Himalayan tracts from Chenab eastwards, Sind, Peshawar valley, to Burma and in Andaman Islands.

Cultivation and Collection : The plant is a 1 m high perennial herb. It is cultivated by planting rhizome or stolon

cuttings in well moist sandy soil in March. It grows better near the banks of river in sunny climate. Manure is added for favourable growth. Drug is collected from 3-4 years old plants during autumn. Roots and rhizomes are dug out, rootlets and buds are removed, washed in water and cut into small pieces.

Morphology : The drug occurs in peeled or unpeeled stolons and roots, length 5-30 cm, diameter 1-2 cm, cylindrical, branched or unbranched. Unpeeled drug is longitudinally wrinkled; contains dark, reddish-brown bark. The peeled drug has yellow colour. Fracture is fibrous; odour faint and typical; taste, sweet.



Fig. 7.8. Glycyrrhiza

Chemical Constituents : Glycyrrhiza contains 6-14% of glycyrrhizin (the glucoside of glycyrrhetic acid), sugars and resin. The saponin like glycoside, glycyrrhizin, is 150 times as sweet as sugar. On hydrolysis the glycoside is converted into the aglycone glycyrrhetic acid and two moles of glucuronic acid. Glycyrrhetic acid is a pentacyclic triterpene of β-amyrin series. Other hydroxy-and deoxytriterpenoid acids related to glycyrrhetic acid and 20-epimer of glycyrrhetic acid (liquiritic acid) have been reported in the drug. The yellow colour of Glycyrrhiza is due to the presence of more than 30 flavonoids like isoliquiritin (a chalcone), liquiritin, liquiritigenin, isoliquiritigenin, rhamnoliquiritin and various 2-methylisoflavones. The other constituents are a coumarin named as liqcoumarin (6-acetyl-5-hydroxy-4-methylcoumarin), 5-15 per cent of sugars (glucose, mannitol, sucrose), asparagine (1-2%), β-sitosterol, starch (20%), protein, bitter principles (glycyramarin), umbelliferone (coumarin), 22, 23-dihydrostigmasterol, malic acid and resin. Liquiritin on hydrolysis affords liquiritigenin and glucose.

Uses : Glycyrrhiza possesses tonic, laxative, demulcent, diuretic, emmenagogue and emollient properties and used in genito-urinary diseases, coughs, sore throat, in scorpion-biting, as demulcent, in inflammatory affections or irritable

conditions of the bronchial tubes, bowels and catarrh; and to relieve peptic ulcer pain. Glycyrrhiza is added to chewing gums, chocolate candy, cigarettes, smoking mixtures, snuff and chewing tobacco. Glycyrrhetinic acid is used to cure rheumatoid arthritis, Addison's disease and various inflammatory conditons.

Substituents and Adulterants : *Glycyrrhiza uralensis* is a source of Manchurian Liquorice. It resembles Russian Liquorice in appearance. The bark is pale chocolate-brown in colour and exfoliates readily. It contains only a small percentage of sugar and gives a pungent extract. *G. glabra* var. *typica* is the source of Spanish Liquorice collected chiefly in Sicily and Spain. The drug consists of pieces of underground roots. Unpeeled pieces are dark reddish or purplish brown in colour and longitudinally wrinkled. The fracture is fibrous in the bark and splintery in the wood. Peeled pieces are smooth and yellow. The drug has a faint characteristic odour and a sweet taste free from bitterness.

Russian Liquorice is derived from *G. glabra* var. *glandulifera*. It is collected in southern Russia chiefly from wild plants. It consists mainly of roots and some pieces of rootstock. Bigger pieces are longitudinally split. Unpeeled pieces are purplish; taste is sweet accompanied by a perceptible, bitterness and acridity. It is usually exported in peeled form.

Persian Liquorice is derived from *G. glabra var. violacea* and is collected chiefly from the Tagris and Euphrates valley in Iraq. It is usually thicker than other varieties and is marketed in an unpeeled state.

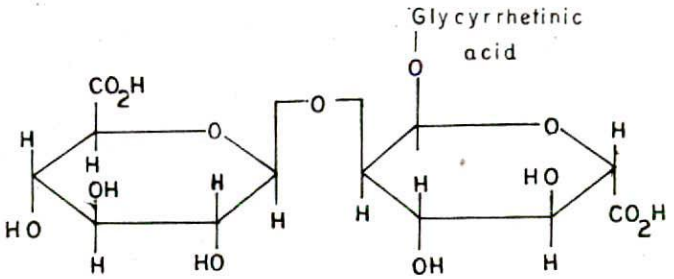
Roots and rhizomes of some related plant genera are also used as substituents and adulterants of Liquorice. The roots of *Abrus precatorius* are used as adulterant in the trade as Indian Liquorice.

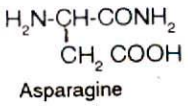
QUILLAIA BARK

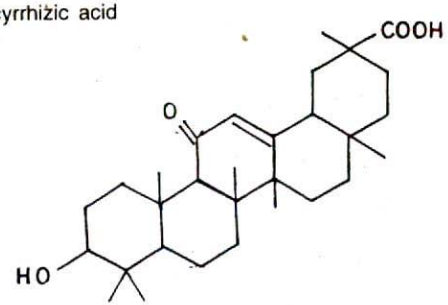
Synonums : Quillaja; Soap bark, Quillary bark, Panama bark; China bark, Murillo bark, Panama wood; Cortex quillaiae.

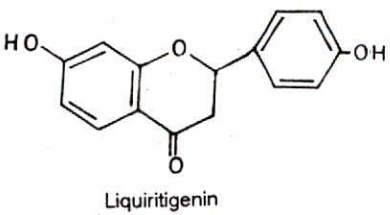
Biological Source : Quillaia bark is the inner dried bark of *Quillaia saponaria* Molina and other species of *Quillaia.*

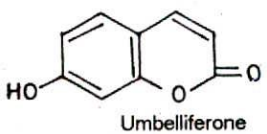
Family : Rosaceae.

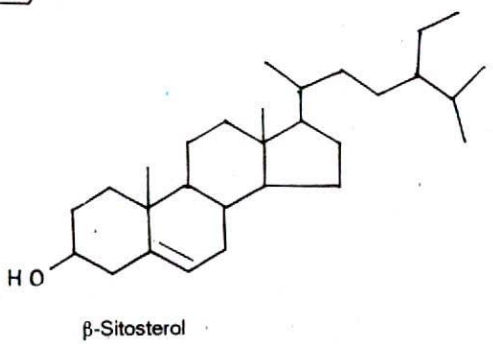












Habitat : *Q. saponaria* is about 18 m high evergreen, graceful tree found in Peru, Chile, Bolivia, South America, California and India.

The bark is collected from the stem; outer, dark-coloured rhytidome is removed, dried and graded. It consists mainly of saponaceous inner bark (phloem).

Morphology : Quillaia bark occurs in flat pieces, about 1

m long, 20 cm wide, and 3-10 cm thick. Outer surface is brownish-white, smooth and contains reddish- or blackish-brown patches of rhytidome adhere to the outer surface. The rhytidome is made of dead secondary phloem. The inner surface is yellowish-white and smooth. Fracture is splintery. Large crystals of calcium oxalate are present. Odour is sternutatory and taste is acidic and astringent.

Chemical Constituents : Quillaia bark contains saponins (10%), quillaic acid, calcium oxalate, starch, sucrose and tannin. Quillaia saponin on hydrolysis forms pentacyclic triterpenoid, quillaic acid (Quillaja sapogenin), and a sugar glucuronic acid.

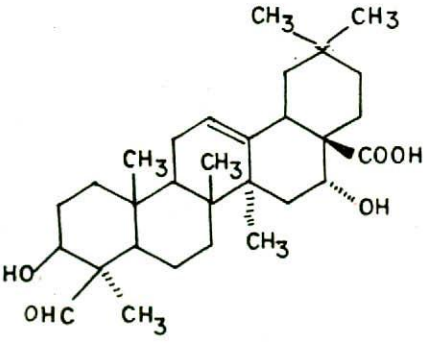


Outer surface Inner surface

Fig. 7.9. Quillaia bark

Chemical Tests

1. Powdered drug on shaking with water produces soap like froth which persists for some time.
2. On addition of a small portion of drug or its alcoholic extract in a drop of blood on a microscopic slide, a haemolytic zone surrounding the drug is formed.



Quillaic acid

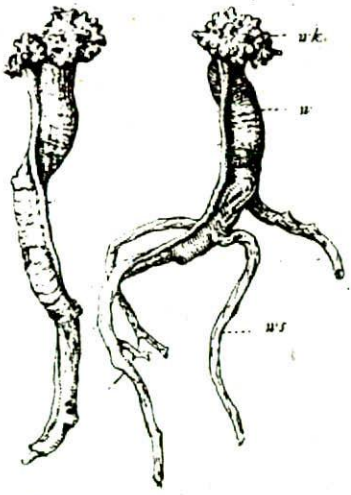


Fig. 7.10. Roots of *Polygala senega* (Senega root)

Uses : Quillaia bark is used as an emulsifying agent, for coal tar emulsion, cleaning industrial equipments, washing delicate fabrics, to prepare tooth powders, tooth pastes, hair shampoos, hair tonics, tar solutions and metal polishes. The drug is highly irritating and causes nausea and is expectorant on internal consumption. It is diuretic and a cutaneous stimulant.

SENEGA

Synonyms : Senega snakeroot; Seneca snakeroot; Rattle snake root; Radix senegae.

Biological Source : Senega consists of the dried roots and rootstocks of *Polygala senega* Linn. or *P. senega* var. *latifolia.*

Family : Polygalaceae.

Habitat : North America, Canada, Japan.

Collection : The plant is a pluricaulous perennial herb, 20—30 cm in height consisting of yellow twisted, branched roots with crown. Roots are dug out, aerial parts are removed, washed and dried.

The roots are twisted, curved, tapering, longitudinally striated, colour-brown, odour is methyl salicylate-like, taste is first sweet and then acrid.

Senega thrives in the open and also in partial shade. It grows in any type of soil, containing a fair amount of leaf-mould. It can be propagated either by seed or rootstocks. The seedlings cannot withstand frost in the first year and need protection. The plants grow slowly and nearly 4-year old plants yield roots of the required size. They are cleaned and dried.

The rootstocks are yellowish orange to brownish conical pieces, 5-20 cm long and 2-12 mm in diameter. They are sweetish, and acrid in taste. The odour is characteristic, resembling that of methyl salicylate. Powered Senega causes sneezing.

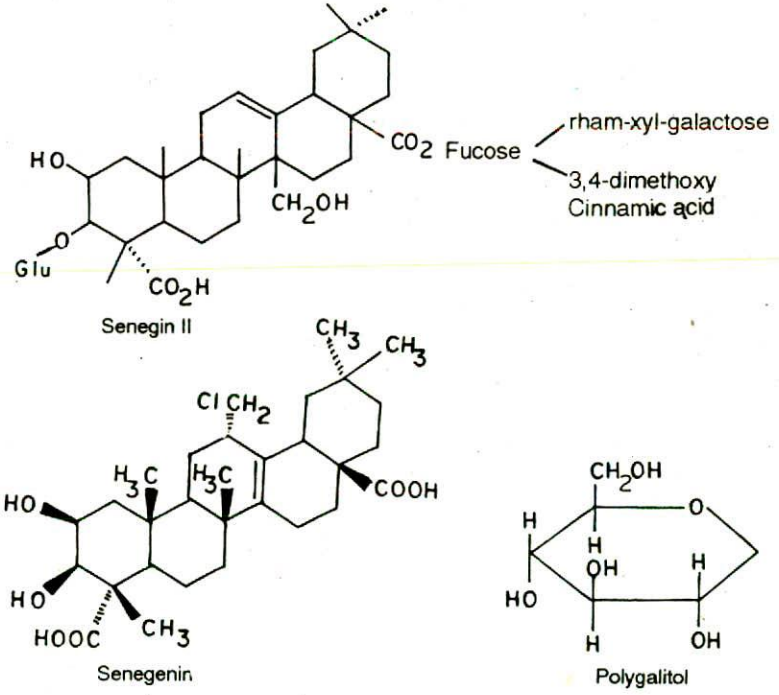
In market foreign Senega *(P. senega)*, Indian Senega *(P. chinensis)*, Nowshera or Pakistan Senega (roots of *Andrachne aspera*), Delhi Senega, Kulu Senega, Tuticorin yellow *(Glinus oppositifolius)* and Tuticorin Brownish green are available.

Chemical Constituents : Senega contains a mixture of saponins A, B, C and D (8-10%), polygallic acid (senegenic

acid), polygalitol (1, 5-anhydro-sorbitol), anhydride of the hexahydric sugar alcohol sorbitol, sucrose, fat, sterols, methyl salicylate, volatile oil and fixed oil. Hydrolysis of the crude saponin (senegin) yields glucose, presenegenin, senegenin, senegenic acid, polygallic acid and hydroxysenegin. Senegenin is a chlorinated triterpenoid. The roots also contain 2, 3, 27-trihydroxy-12-oleanene-23, 28-dioic acid, α-spinasterol and free fatty acids.

Uses : Senega is used as a stimulant, expectorant in chronic bronchitis, and as emetic.

Side effects include nausea, diarrhoea, stomach upsets and dizziness.



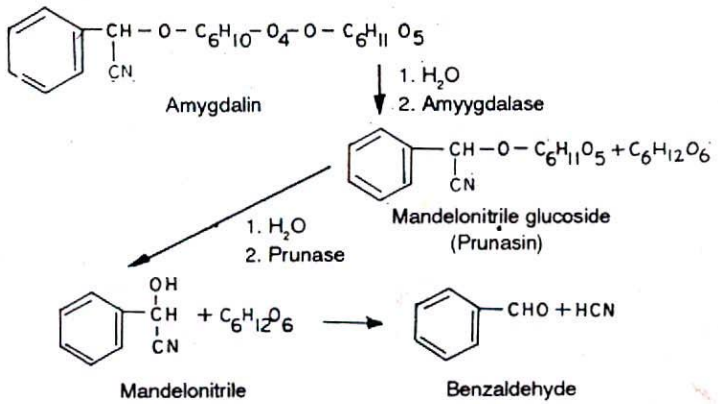
CYANOGENETIC OR CYANOPHORE GLYCOSIDES

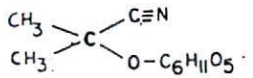
Cyanogenetic glycosides on hydrolysis yield hydrocyanic acid as one of the products. The glycoside amygdalin is most widely distributed in nature. Usually these glycosides are derived from the nitrile of mandelic acid. This group is represented by amygdalin which is the major component of bitter almonds and in kernels of apricots, cherries, peaches,

plums and many other seeds of the Rosaceae. Prunasin is found in *Prunus padus* and yields d-mandelonitrile on hydrolysis as the aglycone. Other cyanogenetic aglycosides are prulaurasin from cherry laurel leaves and sambunigrin from *Sambucus nigra.*

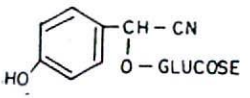
Cyanogenetic glycosides contain nitrogen, but the sugar moiety is attached to oxygen and not to nitrogen. The sugar residue of the molecule may be a monosaccharide or a disaccharide as gentiobiose or vicianose. Amygdalin on hydrolysis yields two molecules of glucose. The enzyme emulsin, found in almond kernels, consists of two enzymes, amygdalase and prunase. The first enzyme breaks the molecule to liberate one of mandelonitrile glucoside. The latter enzyme liberates the remaining glucose forming benzaldehyde-cyanohydrin known as mandelonitrile.

Drugs containing cyanogenetic glycosides are widely used as flavouring agents and as anticancer agents.





Linamarin (*Linsum Usittissimum*)



Dhurrin (*Sorghum vulgare*)

Chemical Tests

Sodium Picrate Test : A strip of filter paper is dipped in 10% aqueous solution of picric acid. It is drained and re-dipped in 10% sodium carbonate solution and drained again. To powdered drug in a flask, water is added to moisten it.Sodium picrate paper is kept on the mouth of flask with

cork. Hydrocyanic acid vapours turn the paper brick red or maroon-coloured.

BITTER ALMOND

Synonyms : Badam (Hindi); Amygdala amara.

Biological Source : Bitter almond is the dried ripe seeds of *Prunus amygdalus* Batsch var. *amara.* or *P. amygdalus* var. *dulcis.*

Family : Rosaceae.

Habitat : Italy, Spain, southern France, North America, and in Kashmir.

Cultivation : The almond requires a cold and dry climate, but a fairly warm weather during its ripening period. The trees are raised from seeds which are sown in nurseries and seedlings transplanted after one year. The trees are planted 6-8 m apart in circular pits. The trees tend to grow large with long branches. The fruit is borne largely on short-spurs. The almond crop comes to harvest from July to September. Almonds are graded into several classes to meet the demand for specific purposes. Unshelled almonds are stored in a cool, dry and well-ventilated place.

Characters : Almond tree is about 5 m in height. The bitter almond is 1.5-2 cm long, rounded at one end and pointed at the other. Cinnamon-brown coloured testa is present which is removed by soaking in hot water. The oil kernel consists of two large, oily planoconvex cotyledons. A small plumule and radicle are present. Some almonds possess cotyledons of unequal sizes. The presence of bitter almonds in sweet almonds can be detected by the sodium picrate test for cyanogenetic glycosides.

Chemical Constituents : Bitter and sweet almonds contain fixed oil (40-55%), proteins (20%), mucilage and emulsin. The bitter almonds contain a colourless, crystalline, cyanogenetic glycoside amygdalin (about 3%). In the presence of water the enzyme emulsin acts upon amygdalin and decomposes it into



Fig. 7.11. Bitter Almond Fruits.

a volatile oil which is a mixture of benzaldehyde and hydrocyanic acid. A casein like protein, amandin, is also present in bitter almond.

Uses : Bitter Almond seeds have demulcent, mild laxative, stimulant and nervine tonic properties. Almond oil is used as a flavouring agent in the preparation of toilet articles, as a vehicle for oily injections and in manufacturing of liquors. Due to the presence of hydrocyanic acid in the volatile oil, it gives relief in bronchitis and cough.

WILD CHERRY BARK

Synonyms : Wild black cherry, Cherry bark; Virginian Prune Bark; Prune bark, Cortex Pruni Virginianae; Prunus Virginiana; Prunus serotina.

Biological Source : Wild Cherry bark is the dried stem bark of *Prunus serotina* Ehrh.

Family : Rosaceae.

Habitat : United States and Canada.

Collection : Wild Cherry plant is a tree, 30 m high or more. The bark is collected in autumn from young branches and stem, cork and cortex are removed by peeling to get 'rossed bark', dried and preserved in containers.

Morphology : The drug occurs in curved or channelled pieces, length up to 10 cm, width 5 cm, thckness 0.3-1.4 mm. Outer surface of unpeeled bark (unrossed bark) is reddish-brown, covered with thin papery, glossy, exfoliating cork cells and bears very conspicuous whitish lenticles. The outer surface of the bark is rough with pale buff-coloured lenticels. Inner surface is reddish-brown with striated and reticulately furrowed appearance. Patches of wood adhering to the inner surface are sometimes present. The fracture is granular and short. Slightly moist drug contains benzadehydic odour. Taste is bitter and astringent.

Chemical Constituents : Wild Cherry bark contains a cyanogenic glycoside, prunasin (d-mandelonitrile glucoside), the enzyme prunase, benzoic acid, trimethylgallic acid, p-coumaric acid, starch, tannin and volatile oil.

The enzyme emulsin hydrolyzes prunasin to benzaldehyde, glucose and hydrocyanic acid. The bark

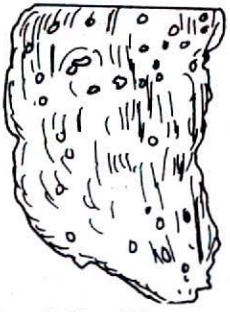
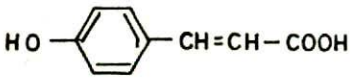


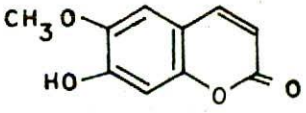
Fig. 7.12. Wild Cherry bark

possesses resin which yields the fluorescent compounds, e.g. scopoletin, on hydrolysis.

Uses : Wild Cherry is used in cough preparations as sedative expectorant and as flavouring agent.



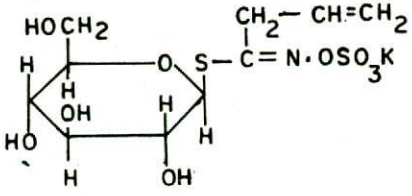
p-Coumaric acid



Scopoletin

ISOTHIOCYANATE GLYCOSIDES

Isothiocyanate glycosides contain sulphur and present in many Cruciferous plants. On hydrolysis they produce isothiocyanate aglycones which may be aliphatic or aromatic. Sinigrin from Black Mustard, sinalbin from White Mustard and gluconapin from Rapeseed are isothiocyanate glycosides. Sinigrin on hydrolysis in the presence of the enzyme, myrosin, yields allyl isothiocyanate, glucose and potassium acid sulphate. The activity of the fixed oil content of these seeds is due to allyl isothiocyanate. These glycosides are irritant and employed as counter-irritant externally in neuralgia and rheumatism.



Sinigrin

$$+ \; H_2O \xrightarrow{\text{Myrosin}}$$

$CH_2 = CH\text{-}CH_2\text{-}N = C = S$ Allyl isothiocyanate (Mustard oil) $+ KHSO_4 +$ $C_6H_{12}O_6$

Pot. acid sulphate — Glucose

MUSTARD

Synonyms : Black Mustard, Brown Mustard, Red Mustard, Sinapis Nigra; Semina Sinapsis Nigrae.

Biological Source : Mustard is the dried ripe seed of *Brassica*

nigra (L.) Koch. or of *B. juncea* (L.) Czern. & Coss. or of these varieties.

Family : Cruciferae.

Habitat : Europe, U.S.A., southwestern Asia, India. *B. juncea* is abundantly cultivated in upper Indian region.

Collection : The plant is an annual herb with erect slender stems, yellow flowers. Leaves large, pinnatifid, without basal lobes, terminal lobe much larger. The aerial parts of the plant are cut after maturation. Seeds are removed by thrashing or beating of the dried parts and then sieving.

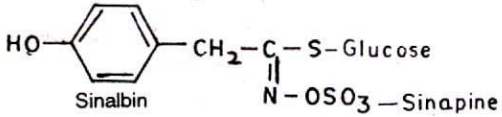


Fig. 7.13. Brassica nigra

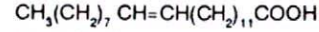
Characters : Seeds are small, brown to red colour, globular in shape, testa is minutely pitted, embryo is oily, yellow in colour, consisting of two cotyledons.

Chemical Constituents : Mustard contains fixed oil (30-35%), proteins (20%), sinigrin (potassium myronate), myrosin, sinapine sulphocyanate, erucic acid, behenic acid and sinapolic acid. Sinigrin is the active constituent of the drug and its amount varies from 0.7 to 1.3%. In the adjacent cell of sinigrin an enzyme, myrosin, is present. In the presence of water myrosin activates the hydrolysis of sinigrin and yields allyl isothiocyanate, potassium hydrogen sulphate and glucose.

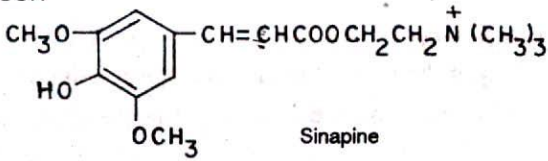
Uses : Mustard is used in the form of plasters, as rubefacient, vesicant, counter-irritant and as condiments. It acts as emetic in large doses.



Sinalbin



Erucic acid



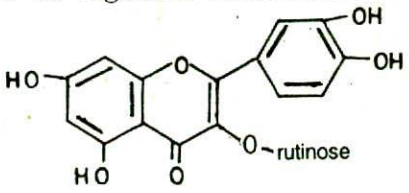
Sinapine

Allied Drugs : White Mustard or Sinapsis alba Bois. is the dried ripe seed of *Brassica alba* Bois. (Fam. Cruciferae). The seeds are globular in shape, 1.5-2.5 mm in diameter. It contains the glucoside sinalbin and myrosin. In the presence of moisture, sinalbin is hydrolyzed into sinapin hydrogen sulphate, acrinylisothiocyanate and glucose. The isothiocynate is an oily liquid with pungent taste. Sinapine hydrogen sulphate is the salt of an unstable alkaloid. The seeds also contain fixed oil (30%), protein (20-25%) and mucilage.

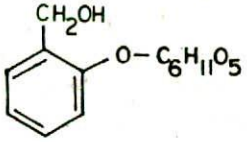
White Mustard is used as counter-irritant, emetic and carminative.

OTHER GLYCOSIDES

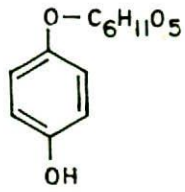
Flavonol glycosides or flavonoids are widely distributed in nature. Rutin, quercitrin, and Citrus biflavonoids are the examples of flavonoid constituents. The phenolic glycoside salicin is found in several species of *Salix* and *Populus*. Salinigrin, isolated from *Salix discolour*, is formed by combination of glucose with m-hydroxybenzaldehyde. Several glycosides of hydroxylated coumarin derivatives are found in plant kingdom. Bitter glycosides are found in Gentianaceae species which are used as stomachic, febrifuge, bitter tonic and in digestive disturbances.



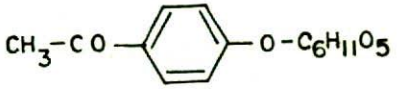
Rutin



Salicin



Arbutin



Picroside (Salinigrin)

GENTIAN

Synonyms : Yellow Gentian, Pale Gentian, Gentian root, Bitter root; Radix Gentianae.

Biological Source : Gentian is the dried rhizome and roots

of *Gentiana lutea* Linn. It contains about 33% of water-soluble extractives.

Family : Gentianaceae.

Habitat : Central and southern Europe, Asia Minor, Pyrenees.

G. lutea requires a moist situation, good drainage and a suitable soil consisting of loam, peat and grit. Seeds are slow to germination, seedlings frequently taking several years to appear. The roots and rhizomes are collected from the 2-5 years old plants during May-October and allowed to ferment in heaps. They are then washed, dried in the open and cut into variable length.

Collection : The plant is a large perennial herb. The drug is collected from a 2-5 years old plant in the autumn. Turf is stripped and the rhizomes are dug up. It is cut into pieces of different length and dried quickly first in air and then in sheds.

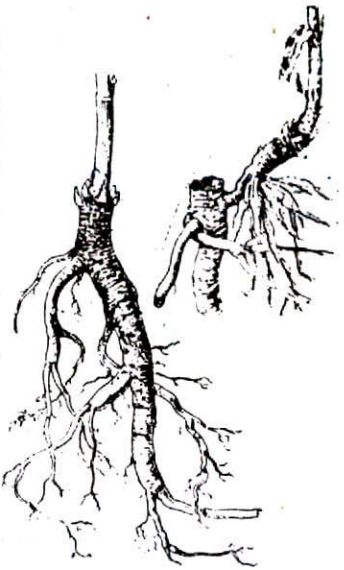


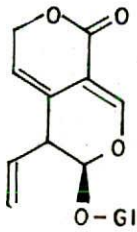
Fig. 7.14. Gentian rootstock and roots

Morphology : Gentian consists of brownish, subcylindrical, entire or longitudinally split pieces of rhizomes and roots, 15-20 cm or more in length and 2.5 to 8 cm in thickness at the crown. The root is longitudinally wrinkled and the rhizome, which is sometimes branched, frequently terminates in one or more buds and bears numerous encircling leafscars, which appear as transverse annulations. The drug in brittle and breaks with a short fracture. It has a characteristic odour and the taste is sweet at first and intensely bitter afterwards.

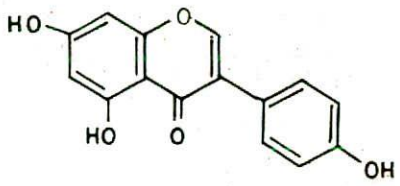
Chemical Constituents : Gentian contains the bitter glycoside gentiopicrin (~2%) as a principal active constituent. On hydrolysis it yields the aglycone mesogentiogenin and glucose. Gentiopicrin is a secoiridoid, gentiopicroside, and it is decomposed on fermentation and drying of the drug. Other bitter compounds are gentisin, gentiopicroside, amaropanin, amarogentin and amaroswerin. Gentian also centains abundant of starch, trisaccharide gentianose,

disaccharide gentiobiose, sucrose, alkaloid gentianine, yellow xanthone pigments gentisin (or gentianin), isogentisin, and its glycoside gentioside, gentiin, gentiamarin, gentisic acid, tannins, pectin and calcium oxalate.

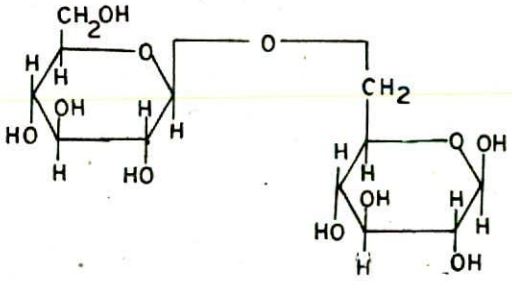
Uses : Gentian is used as a bitter tonic and stomachic for increasing appetite and to cure debility.



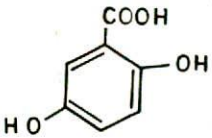
Gentiopicroside (Seco-iridoid)



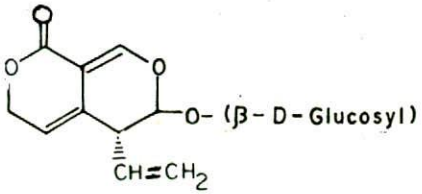
Genistein



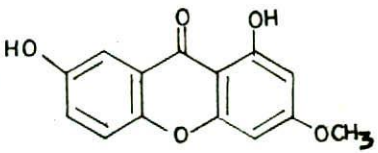
Gentiobiose



Gentisic acid



Gentiopicrin



Gentisin

QUASSIA

Synonyms : Bitter wood, Bitter ash; Quassia wood; Lignum quassiae.

Biological Source : Quassia is the dried stem wood of *Picrasma excelsa* (Swartz) Planchon (syn. *Picroena excelsa* or *Aeschrion excelsa)* which is known in commerce as Jamica

Quassia, or of *Quassia amara* Linn. which is known in commerce as Surinam Quassia.

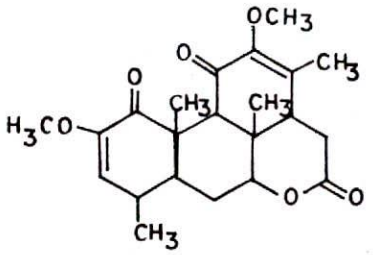
The plant is propagated by seeds, cuttings or layers.

Family : Simarubaceae.

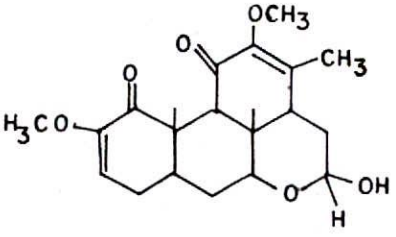
Habitat : *P. excelsa* inhabits in West Indies, Jamaica and the Caribbean Islands. *Quassia amara* Linn. is a native of Brazil and Guiana and is cultivated in Colombia, Panama and the West Indies.

Collection : *P. excelsa* is a 25 m high tree; *Q. amara* is a branching, 2-3 m high shrub or small tree. The stem is cut and small branches are separated. Bark is removed from the stem and big branches are cut into logs of up to 30 cm length or chips and dried to check mould's growth.

Morphology : Quassia is found in logs, chips or rasping. The logs are up to 30 cm in length, covered with a dark grey cork. The colour of wood is white in beginning and becomes yellow on exposure. The drug is odourless but the taste is intensely bitter.



Quassin



Neoquassin

Chemical Constituents : Quassin and neoquassin are the bitter terpenoid principles of Surinam Quassia while picrasmin (isoquassin) is the active constituent of Jamaica Quassia. These bitter principles are obtained in 0.1-0.2% yields and appear commercially under the name of quassin. Other compounds reported from Quassia are 18-hydroxyquassin, scopoletin (coumarin) and cathine-6-one (alkaloid).

Uses : Quassia is used as a bitter tonic, as an insecticide in the form of fly poison on fly-paper, and as an enema for the expulsion of thread worms.

FLAVONOL GLYCOSIDES

The flavonol glycosides and their aglycons are called flavonoids. A large number of different flavonoids are found in nature. These are yellow pigments of higher plants. The important flavonoids are rutin, quercitrin, hesperidine, hesperetin, diosmin and naringen. Rutin and hesperidine are known as vitamin P or permeability factors. They are used in the treatment of different disorders such as capillary bleeding and increased capillary fragility. Bioflavonoids are reported to treat symptoms of the common cold.

ALCOHOL GLYCOSIDES

Salicin is an alcoholic glycoside obtained from several species of *Salix* and *Populus*. The important sources are *Salix purpurea* and *S. fragilis*. Salicin is hydrolyzed into D-glucose and saligenin by emulsin. Salicin has antirheumatic properties. Its actions are similar to that of salicylic acid.

ALDEHYDE GLYCOSIDES

Vanilla contains an aldehydic aglycone, vanillin. Vanilla is the cure, full grown unripe fruit of *Vanilla planifolia* or of *V. tahitensis* (Family Orchidaceae). The plants are perennial, climbing, dioecious epiphytes attached to the trunks of trees and found in eastern Maxico. The plant is propagated from cuttings. The fruits are collected, cured by dipping in worm water and repeated sweating between woolen blankets in the sun for two months. Green Vanilla contains two glycosides, glucovanillin and glucovanillic alcohol. Vanilla is used as flavouring agent and as a pharmaceutical aid. It is a source of vanillin.

QUESTIONS

1. What are bitters, saponins, thiocyanate glycosides and cardiac glycosides ? Give official source and uses of Senna, Aloe, Rhubarb and Strophanthus.
2. (a)What are cardiac glycosides ? Write official source and chemical constituents of Digitalis.

(b) What are bitter glycosides ? Give official source and chemical constituents of Black Mustard.

(c) What are saponin glycosides ? Write a short note on Dioscorea.

3. (a)Name two different cyanogenetic types of principles present in drugs. Mention the drugs in which they are present.

(b) Differentiate between hydragogus and irritant purgatives.

(c) Explain the Keller-Kiliani test.

(d) Why chrysarobin is not used internally as purgative. What is its actual use ?

4. Draw the labelled diagrams of the following drugs and mention their uses :

(a) Digitalis (b) Strophanthus (c) Wild Cherry bark (d) Rhubarb (e) Aloe.

5. Give the important diagnostic features of

(a) Dioscorea (b) Digitalis (c) Rhubarb

(d) Quillaia bark. What are their uses ?

6. What are glycosides ? Classify drugs containing glycosides. Give important substitutes and adulterants of Digitalis.

7. Describe 'Indian Senna' under a suitable pharmacognostic scheme.

8. What are saponin glycosides ? Discuss their occurrence, properties and pharmaceutical significance. Write a note on diosgenin.

9. Give distinguishing features of the following :

(a) *Urgenia scilla* and *Urginia indica;*

(b) *Rheum palmatum* and *Rheum emodi.*

(c) Glycyrrhizine and Glycyrrhetinic acid.

10. Enumerate method of extraction, separation and isolation of diosgenin from Dioscorea tubers.

11. Discuss the biosynthesis of cardiac glycosides and their distribution is nature. Give a comparative account of glycosides of Digitalis, Strophanthus and Scilla.

12. What are glycosides ? How are they classified ? Describe different steps involved in the biosynthesis of digitoxin.

8

TANNINS

Tannins are complex organic, non-nitrogenous derivatives of polyhydroxy benzoic acids which are widely distributed in the vegetable kingdom. They are the active constituents of materials like oak bark, which are used in the tanning of skins. They are present in aerial parts, e.g. leaves, fruits, barks or stem; generally occur in immature fruits, but disappears during ripening process. New leaves of deciduous plants contain high concentration of tannins. Tannins occur in many crude drugs. They probably serve as a protective to the plant during growth and are destroyed or deposited as end products of metabolism in some dead tissues of the mature plant, i.e., outer cork, heartwood, galls, etc. Some phenolic substances, such as gallic acid, catechins and chlorogenic acid often occur with tannins and are called as 'pseudotannins'. Most of the true tannins have the molecular weight in between 1000 to 5000.

Most tannins are very complex substances which can only be isolated in the pure state with the greatest difficulty. Many of them are glycosidal in nature (e.g. glucogallin). The gallotannins on hydrolysis yield a sugar and gallic acid. Tannins are non-crystalline substances, occur as mixtures of polyphenols and form colloidal solutions with water. Their aqueous solutions are acidic in nature and possess sharp 'puckering' taste. They are precipitated with solutions of gelatin and alkaloids. They produce greenish black or blue colour with ferric chloride and deep red colour with potassium ferricyanide and ammonia. They form precipitate

with salts of copper, lead, and tin and by strong aqueous potassium dichromate or 1% chromic acid.

Tannins precepitate and combine with proteins. The protein tannin complex is resistant to proteolytic enzymes. This property is known as astringent action and many tannin- containing drugs are used in medicine as astringent. During healing process of burns, the proteins of the exposed tissues are precipitated producing a mildly antiseptic, protective layer under which the new tissues are regenerated. Tannins are used in the tanning process of animal hides to convert them into leather. Aqueous solutions of tannins are used to precipitate gelatin, proteins and alkaloids in the laboratory. They are used as healing agents in inflammation, leucorrhoea, gonorrhoea, burns, piles, diarrhoea and as antidote in the treatment of alkaloidal poisoning. Their deep red coloured complexes with iron salts are used to manufacture inks.

Tannins are classified as :

1. Hydrolysable tannins
2. Condensed tannins and
3. Pseudotannins.

1. **Hydrolysable Tannins :** These tannins are esters of a sugar, usually glucose with one or more trihydroxybenzene carboxylic acids. They are hydrolyzed by acids or enzymes to yield several molecules of phenolic acids such as gallic and ellagic acids. The phenolic acids are combined to a central glucose residue by ester linkages. The tannins derived from gallic acid are known as gallitannins and from that of ellagic acid as ellagitannins. Gallitannins occur in Rhubarb, Cloves, Chestnut, Rose petals, Bearbery leaves, Chinese leaves, Turkish galls, Maple and Chestnut. The sources of ellagitannins are Myrobalans, Pomegranate bark and rind, Eucalyptus leaves, Chestnut, Oak bark, etc. These tannins form blue or black colour with ferric chloride, and pyrogallol on heating. They do not give blue colour with bromine solutions.
2. **Condensed Tannins (Proanthocyanidins) :** Condensed tannins are resistant to hydrolysis and they are derived from the flavanols, catechins and flavan-3, 4-diols. On treatment with acids or enzymes they are decomposed into phlobaphenes. On dry distillation condensed tannins produce catechol. Therefore, these tannins are

called as catechol tannins. Condensed tannins are found in bark (Cinnamon, Cinchona, Wild Cherry, Willow, Acacia, Oak and Hamamelis), roots and rhizomes (Krameria and Male fern), seeds (Cacoa, Kola, Areca and Guarana), leaves (Hamamelis and Tea) and extracts (Catechu, Acacia, Butea gum, etc.). These tannins give green colour with ferric chloride solution, produce catechol on heating, yield phloroglucinol with conc. HCl or vanillin-HCl and phlobaphene on oxidation.

3. **Pseudotannins :** Pseudotannins are phenolic compounds of lower molecular weight and they do not show the goldbeater's skin test. They occur as gallic acid (in Rhubarb), catechins (in Catechu, Acacia, Cutch, Kinos, Cacoa, Guarana), chlorogenic acid (in Mate, Coffee and Nux vomica) and ipecacuanhic acid in Ipecacuanha.

Solubility : Tannins are freely soluble in water, alcohol, glycerol, acetone and dilute alkalies. They are sparingly soluble in chloroform, ethyl acetate and some other organic solvents.

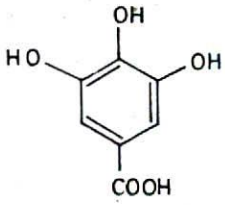
Phlobaphenes are soluble in alcohol but practically insoluble in water. Phlobaphenes result from phlobatannins in many ways. They are slowly deposited from a cold aqueous solution of a phlobatannin, and rapidly if the solution is subjected to prolonged boiling, or if boiled with sulphuric acid. Glycerine appears to minimize conversion of phlobatannins to phlobaphenes.

Chemical Tests

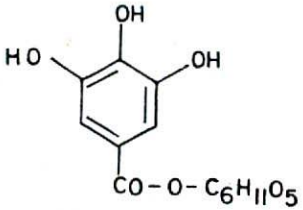
1. **Goldbeaters Skin Test :** A small piece of goldbeater's skin (a membrane prepared from the intestine of an ox) is soaked in 2% hydrochloric acid, rinsed with distilled water and placed in a solution of tannin for 5 minutes. The skin piece is washed with distilled water and kept in a solution of ferrous sulphate. A brown or black colour is produced on the skin due to the presence of tannins.
2. **Gelatin Test :** To a solution of tannin (0.5-1%) aqueous solutions of gelatin (1%) and sodium chloride (10%) are added. A white buff-coloured precipitate is formed.
3. **Phenazone Test :** A mixture of aqueous extract (5 ml) of a drug and sodium acid phosphate (0.5g) is heated,

cooled and filtered. A solution of phenazone (2%) is added to the filtrate. A bulky coloured precipitate is formed.

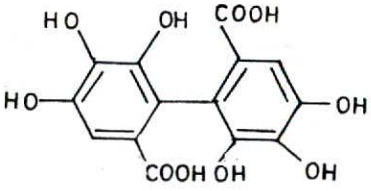
4. **Catechin Test (Matchstick Test) :** A matchstick is dipped in aqueous plant extract, dried near burner and moistened with concentrated hydrochloric acid. On warming near a flame the matchstick wood turns pink or red due to formation of phloroglucinol.
5. **Chlorogenic Acid Test :** An extract of chlorogenic acid containing drug is treated with aqueous ammonia. A green colour is formed on exposure to air.
6. **Vanillin-Hydrochloric Acid Test :** (Vanillin 1 g, alcohol 10 ml, concentrated hydrochloric acid 10 ml). When a drug is treated with vanillin-hydrochloric acid reagent, pink or red colour is formed due to formation of phloroglucinol.



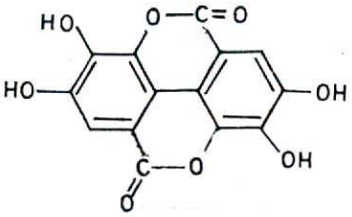
Gallic acid



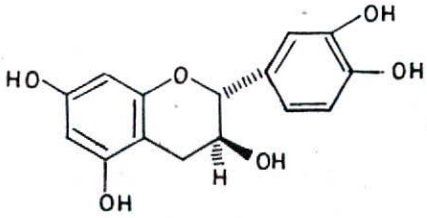
Glucogallin



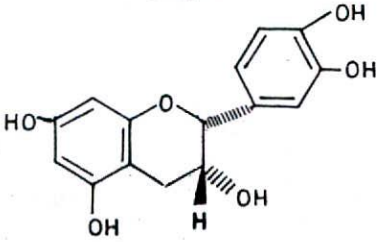
Hexahydroxydiphenic acid



Ellagic acid



(+)-Catechin



(+)-Epicatechin

PALE CATECHU

Synonyms : Gambier; Catechu; Gambier Catechu; Terra japonica.

Biological Source : Pale Catechu is the dried aqueous extract of leaves and twigs of *Uncaria gambier* (Hunter) Roxb. (syn. *Ourouparia gambier).*

Family : Rubiaceae.

Habitat : The plant is indigenous to Malaya and cultivated in Indonesia, Malaya and Borneo.

Preparation : Plant is a climbing shrub and grown from seeds. The leafy twigs up to 50 cm in length are cut at an interval of 4-6 months from 2 to 10 years old plant. The leaves and twigs are boiled with water for 3 hours in a large pan. The leaves and twigs are removed and the extract is concentrated to form a yellowish green pasty mass. It is cooled in shallow wood tube, put into trays or tin containers and cut into cubes of uniform size. The cubes are dried in sun, packed and exported. Sometimes semisolid mass is packed into bales. It contains more water, less tannins and is of inferior quality.

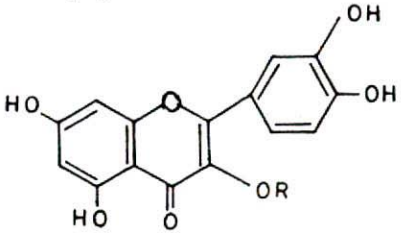
Characters : Pale catechu occurs as cubes of 2.5 cm length and breadth. Sometimes cubes are broken and adhere to each other. Colour is dark reddish-brown, internal surface is pale brown and dull. Cubes break easily and are friable. The fractured surface appears porous internally. The drug is odourless and taste is astringent followed by bitterness in the beginning and sweetish afterwards.

Chemical Tests

1. **Gambir-Fluorescin Test** : A mixture of alcoholic extract of Pale Catechu (1 g), sodium hydroxide solution (5 ml), and petroleum ether (5 ml) is shaken and kept for sometimes. The petroleum ether layer shows green fluorescence.
2. Catechin or matchstick test is positive in Pale Catechu.
3. Vanillin-hydrochloric acid test is positive in Pale Catechu.
4. **Chlorophyll Test** : powdered drug (0.5 g) is heated with chloroform (5 ml) on a water bath for 1-2 minutes. The organic layer is filtered in a white China dish and

evaporated on the water. A greenish residue is remained due to the presence of chlorophyll.

Chemical Constituents : Pale Catechu contains catechins (7-33%), catechutannic acid (22-50%), catechu red, quercetin, pyrogallol, Gambir fluorescein, fixed oil and wax. It contains not less than 70% water-soluble substance and not less than 60% alcoholic soluble portion.



Quercetin (R = H)
Quercitrin (R = Rhamnose)

Catechin is crystallized into white, accicular crystals which are water soluble. Removal of one mole of water from catechin gives catechutannic acid which is an amorphous phlobatannin.

Uses : Pale Catechu has astringent action and is used in diarrhoea, in lozenges, for tanning and dyeing fabrics brown or black.

BLACK CATECHU

Synonyms : Cutch, Catechu; Cachou: Peru Catechu; Cashoo; Catechu nigrum; Kattha (Hindi).

Biological Source : Black Catechu is a dried aqueous extract prepared from the heartwood of *Acacia catechu* Willd.

Family : Leguminosae.

Habitat : The tree is a native of India and found in Burma.

Preparation : The tree is felled and bark as well as sapwood are removed, cut into small pieces and boiled with water in earthenware or stainless steel vessels. The decoction is filtered and concentrated to get a viscous mass. The thick syrup is poured into wooden frames on papers, cooled and the solidified product is cut into small pieces.

Characters : Black Catechu occurs in black, irregular mass. Outer surface is rough and dull and rarely glossy. Fracture is hard and brittle and the broken surface is dark brown with a dull gloss and porous. It is partially soluble in cold water and alcohol and completely soluble in hot water. The drug is odourless and taste in bitter in the beginning and astringent afterwards.

Chemical Constituents : Black Catechu contains a mixture of catechin isomers, acacatechin (2-12%), catechutannic acid or phlobatannin (25-35%), gum (20-30%), quercitrin, quercetin, catechu red and water. Acacatechin contains (-)-epicatechin which is the *trans-* form of acacatechin. During the extraction of heartwood chips with boiling water epicatechin undergoes epimerization and recemization to dl-acacatechin. Isomers of acacatechin present in Black Catechu are l-acacatechin (m.p. 230°) and d-iso-acacatechin (m.p. 226-228°).

Acacatechin is insoluble in cold water but soluble in hot water. It undergoes oxidation to catechutannic acid in the presence of water.

Uses : Black Catechu possesses cooling and digestive properties. It is used in relaxed condition of throat, mouth and gums and in cough and diarrhoea. Externally as an astringent medicament it is applied to ulcers, boils, and skin eruptions and in a number of medicinal preparations.

Black Catechu is mainly used as an ingredient of betal leaf (Paan) and *Paan masala.*

Chemical Tests

1. Catechin (match-stick) test is positive.
2. Vanillin-hydrochloric acid test is positive.
3. Gambir-fluorescin test is negative distinguishing it from Pale Catechu.
4. Chlorophyll test is also negative distinguishing Black Catechu from Pale Catechu.
5. Add a few drops of a fresh aqueous extract to lime water (10 ml); a brown colour is produced and on standing for three minutes a red precipitate is formed.
6. To an aqueous solution (2%), add solution of ferric ammonium sulphate; a dark green colour is formed. Add sodium hydroxide solution, the colour changes to purple.

GALLS

Synonyms : Turkey galls, Galla, Nutgall, Aleppo galls, Blue galls, Gallae ceruleae.

Biological Source : Galls are vegetable outgrowths formed

on the twigs of dyer's oak. *Quercus infectoria* (Fam. Fagaceae) due to deposition of eggs of the gall-wasp *Adleria gallaetinctoriae* Olivier (Fam. (Cynipidae).

Habitat : The plant is found in Turkey, Syria, Persia, Cyprus and Greece.

Preparation : The plant is a 2 m high small tree or shrub. The gall-wesp lays eggs on the twigs in early summer. Larvae come out from the eggs and enter into the soft epidermis near the growing point of the twigs. The larvae secrete an enzyme from its mandible which stimulates abnormal development of vegetable tissues around the larvae. During this process their is rapid conversion of starch in the surrounding tissues into sugars which stimulates cell division. Shrinkage of tissue takes place due to disappearing of starch and a central cavity is formed in which development of larvae and pupae takes place. The larva remains in the galls for 5 to 6 months. The mature insect bores the covering of the galls and escapes. The colour of galls changes from bluish-grey to white during this process. The galls are collected before escaping the insect.

Characters : Galls are globular or subspherical in shape, 1-2.5 cm in diameter with short basal stalk. Numerous rounded projections are present on the outer surface. 'White galls', from which the insects have emerged, contain circular holes, 2-3 mm in diameter, on the lower part on one side. Colour is grey or white and the projections are dark brown in colour. White galls are brownish or yellowish-brown. Gall are hard and heavy and shrink in water. Taste is very astringent.

Chemical Constituents : Galls contain tannin known as gallotannic acid (50-70%), gallic acid (2-4%), ellagic acid, β-sitosterol, methyl betulate, methyl oleanolate, starch, calcium oxalate, nyctanthic acid, roburic acid and syringic acid.

Uses : Galls are used as astringent, for tanning and dyeing, and in the manufacture of inks and tannic acid.

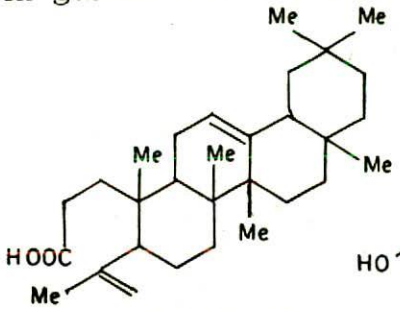
Allied Drugs

Chinese and Japanese Galls : They are produced on the petioles of the leaves of *Rhus chinensis* (Anacardiaceae) by an aphis, *Schlechtendalia chinensis*. The galls on breaking show a large, irregular cavity and contain tannin (57-77%). They are used as astringent and to treat haemorrhoids.

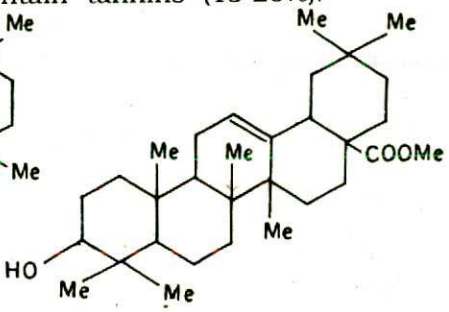
Crowned Aleppo Galls : They are about globular, 0.5 cm in diameter, stalked and contained a crown of projections near the apex. They are produced by an insect, *Cynips polycera.*

Hungarian Galls : They are formed on a tree, *Quercus robur,* growing in Yungoslavia, by an insect *Cynip lignicola.* They are used in tanning.

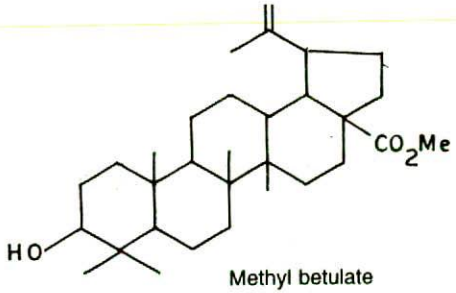
English Oak Galls : They are produced by *Adleria kollari* on *Quercus robur* and contain tannins (15-20%).



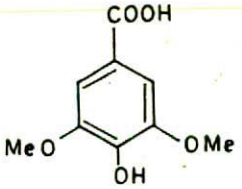
Nyctanthic acid



Methyl oleanolate



Methyl betulate



Syringic acid

TANNIC ACID

Synonyms : Tannin, Gallotannin, Gallotannic acid.

Biological Source : Tannic acid occurs in nutgalls of *Quercus infectoria* Oliv, bark of the oak species, in Sumac and Myrobalan. It is produced from Turkish or Chinese nutgalls, the former containing, 50-60%, the latter about 70%. Galls are produced by an aphis, *Schlerchtendalia chinensis,* on the petioles of the leaves of *Rhus chinensis* (Fam. Anacardiaceae).

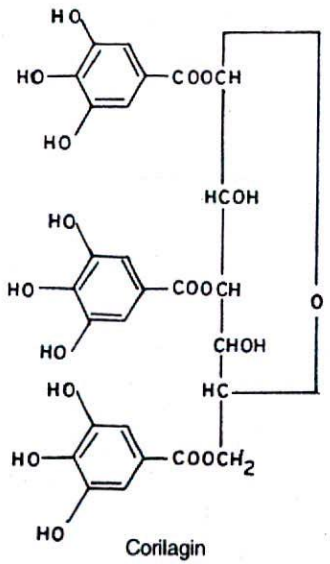
Preparation : Tannic acid is obtained by extracting powdered galls with a mixture of ether, alcohol and water. Two layers are formed; the aqueous layer contain gallotannin and the free gallic acid is present in the ethereal layer which is

evaporated to get the gallic acid. Tannic acid is purified by various procedures.

Previous to extraction the galls are exposed to a moist atmosphere for some time, during which fermentative changes occur and the yield is increased.

Chemical Composition : The chemistry of the tannic acid is most complex and non-uniform. Tannic acid is not a single homogenous compound but a mixture of esters of gallic acid with glucose. Chinese Galls on hydrolysis yield methyl gallate and 1, 2, 3, 4, 6-pentagalloyl glucose. The structure of tannic acid named corilagin is given hereunder.

Tannic acid is yellowish white to light brown, amorphous, bulky powder or flakes, or spongy masses; faint characteristic odour, astringent taste, gradually darkens on exposure to air and light, mp 210-215°, decomposes mostly into pyrogallol and CO_2. It gives insoluble precipitates with albumin, starch, gelatin, most alkaloidal and metallic salts and produces a bluish-black colour or precipitate with ferric salts. One gram of tannic acid is dissolved in 0.35 ml water, 1 ml warm glycerol; very soluble in alcohol and acetone, practically insoluble in benzene, chloroform, ether, petroleum ether, carbon disulphide and carbon tetrachloride.



Corilagin

Uses : Tannic acid is astringent and is used as hemostatic, in solution for burns and as a heavy metal antidote and in

case of alkaloidal poisoning. It is also used as mordant in dyeing, manufacturing ink; sizing paper and silk; printing fabrics, with gelatin and albumin for manufacturing of imitation horn and tortoise shell, tanning, clarifying beer or wine, in photography, as coagulant in rubber manufacturing, for commericial preparation of gallic acid and pyrogallol and as a reagent in analytical chemistry.

Utilization of certain tannin-rich plant materials for long time may be harmful due to their carcinogenic activity. The habitual chewing of betal nut *(Areca catechu)* produces oral and esophageal cancer. The drug contains piperidine-type alkaloids like arecoline, arecaidine, guvacine and guvacoline and is also rich in condensed tannins. Utilization of ordinary tea (leaves of *Camellia sinensis)* without milk causes esophageal obstruction. Milk binds tannins of the tea and it becomes less harmful.

The property of precipitation of proteins by tannins is also utilized in the process of vegetable tanning. It converts animal hides to leather. The tannin affects the pliancy and toughness of the leather and acts as a preservative due to its antiseptic action. Different types of tannins produce a variety of leather. Certain hydrolyzable tannins form a *bloom leather* whereas the nonhydrolyzable tannins give the *tanner's red leather.* Solutions of tannins are used in the laboratory as reagents for the detection of gelatin, proteins and alkaloids due to their precipitating properties.

QUESTIONS

1. Enlist four plant drugs containing tannins and give their exact botanical source, chemical constituents and therapeutic uses
2. What are tannins? Name the drugs which contain tannins and give their official source, chemical constituents and uses
3. Describe tannins. Discuss official sources, chemical constituents and uses of tannin containing drugs.
4. How is Black Catechu differentiated from Pale Catechu? Describe biological source, chemical constituents, preparation and uses of Black and Pale catechues.

9

FATS, OILS AND WAXES

Fixed oils and fats are esters of glycerol with higher long-chain fatty acids such as palmitic, stearic, oleic, and linoleic acids. Fats are solid or semi-solid at 15.5-16.5°C while oils occur as liquid at this temperature. These compounds are obtained from plants (Arachis oil, Castor oil) or animals (Lard, Cod liver oil). There is no chemical difference in fats and oils. The fatty acids may be saturated (e.g., palmitic acid, stearic acid) or unsaturated (e.g. oleic acid), but usually they contain unbranched carbon chains and have an even number of carbon atoms.

Most of the saturated glycerides are solid at ordinary temperature, but most unsaturated glycerides are oily liquids. Therefore, vegetable oils contain larger proportions of unsaturated glycerides than the solid animal fats. The identity, quality and purity of fatty substances are determined by finding out their acid value, saponification value, Reichert-Meissl number, iodine number, melting point, specific gravity and refractive index.

If the fatty acid present in a glyceryl ester is the same, then it is known as 'simple' glyceride. For example, tripalmitin, tristearin, and triolein are simple glycerides. If different fatty acids are present in a glyceride, then it is called as mixed glyceride, e.g., 2-oleodipalmitin and 1-oleo-2-palmitostearin. In mixed glycerides two or sometimes three different acid groupings are present. Animal fats, such as Lard and Suet, and 'fixed' or fatty vegetable oils, such as Olive oil, Almond oil, and Theobroma oil, are mixtures of glycerides. On hydrolysis they yield both saturated and

unsaturated acids. In addition to glycerides, the oils and fats contain other substances like phosphatides, phytosterols, stigmasterol, hydrocarbons, fat-soluble vitamins A, D and E and some volatile substances.

Seeds are the principal source of fats and oils. The oil containing seeds are Sesame seed, Coconut, Arachis, Castor, etc. The compounds are also present in Olive fruits, Cod liver, Shark, etc. The fats and oils are important products used as pharmaceutically, industrially and as articles of food.

Fixed oils and fats are separated from plant parts by hot or cold expression in hydraulic press or by extraction with an organic solvent. Animal fats are isolated by heating the animal tissues with steam. The fat melts which floats on the top and is separated by decantation.

Fats and oils have certain common characteristics. They are greasy subtances and are lighter than water. They are insoluble in water, sparingly soluble in alcohol, and freely soluble in solvent like petroleum ether, chloroform and benzene. Their specific gravity is always less than water and, therefore, they float on the aqueous surface. When a drop of fats or oils is placed on a paper, they form a permanent translucent stain on it. Due to this property they are called as fixed oils. They cannot be distilled and on heating they are decomposed producing an odour of scorched fat due to formation of acraldehyde (CH_2=CH-CHO). Many fats and oils become rancid on long exposure to air, give acidic reactions and develop very disagreeable odour. In moist conditions the hydrolysis of fats is affected with lipase enzyme and free fatty acids are formed. In the presence of light and micor-organisms keto-, keto acid-, oxide- and peroxide-derivatives of fatty acids are produced and all these substances are responsible for rancidity of fats.

The oil obtained by expression contains water, mucilaginous matter, and ground seed tissues in suspension. It may also have a strong odour and a dark colour. The presence of a very small proportion of fatty acid affects the taste and flavour of oils. The oils is purified and refined by removing free fatty acids, decolourization, deodourization and demargination. Free fatty acids are removed by adding sodium hydroxide solution and the resulting sodium salts are separated by suitable means. For decolourizing, the oil is heated to about 200°C for about 30 minutes with 2-4% fuller's earth and 0.2-1.0% of animal charcoal, followed by

filtration. For deodourization, the oil is placed in an autoclave, vacuum is created in the apparatus and then superheated for a very short time. In demargination process, the solid glycerides are removed at room temperature. Cod-liver oil is to be demarginated and this is accomplished by cooling it to about 0°C; at which tempearture a portion solidifies and is separated by filtration, the filtrate constituting non-freezing Cod Liver oil.

Catalytic reduction of unsaturated fatty acids in the presence of hydrogen and a catalyst (e.g., Raney Nickel or Pd-C) yields saturated compounds which are solid at normal temperature. Vegetable ghee is prepared by hydrogenation of oils.

A thin layer of Linseed oil is dried and forms a hard transparent film. This oil is, therefore, called as drying oil and used in paints and varnishes. Cottonseed oil resinifies and dries without forming a thin film. Such oils are called semi-drying oils. Some Oils, like Olive oil, neither dry nor form a thin layer. Such oils are called as non-drying oils.

Fatty acids are used to treat skin lesions (linolenic and linoleic acids), wounds, burns, sunburns, eczema and dandruff; as emollient, laxative (Castor oil), in the preparation of ointments, liniments and suppositories, as a source of vitamins A, D and E; as cholesterol suppressant, antifungal agent, and in the manufacture of soaps, glycerine, paints, varnishes and lubricants.. Chaulmoogra oil is utilized to cure leprosy.

Saturated Fatty Acids Detected in Oils and Fats

Butyric	$CH_3\ (CH_2)_2\ COOH$
Isovaleric	$(CH_3)_2\ CHCH_2\ COOH$
Caproic	$CH_3\ (CH_2)_4\ COOH$
Caprylic	$CH_3\ (CH_2)_6\ COOH$
Capric	$CH_3\ (CH_2)_8\ COOH$
Lauric	$CH_3\ (CH_2)_{10}\ COOH$
Myristic	$CH_3\ (CH_2)_{12}\ COOH$
Palmitic	$CH_3\ (CH_2)_{14}\ COOH$
Stearic	$CH_3\ (CH_2)_{16}\ COOH$
Arachidic	$CH_3\ (CH_2)_{18}\ COOH$
Behenic	$CH_3\ (CH_2)_{20}\ COOH$
Lignoceric	$CH_3\ (CH_2)_{22}\ COOH$
Cerotic	$CH_3\ (CH_2)_{24}\ COOH$

Unsaturated Fatty Acids Detected in Oils and Fats

Palmitoleic	$CH_3\ (CH_3)_5\ CH{=}CH\ (CH_2)_7\ COOH$
Oleic	$CH_3\ (CH_2)_7\ CH{=}CH\ (CH_2)_7\ COOH$
Ricinoleic	$CH_3\ (CH_2)_5\ CHOH{-}CH_2\ CH{=}CH\ (CH_2)_7\ COOH$
Linoleic	$CH_3\ (CH_2)_4\ CH{=}CHCH_2\ CH{=}CH\ (CH_2)_7\ COOH$
Linolenic	$CH_3\ CH_2\ CH{=}CHCH_2\ CH{=}CHCH_2\ CH{=}CH{-}(CH_2)_7\ COOH$
Eleostearic	$CH_3\ (CH_2)_3\ (CH{=}CH)_3\ (CH_2)_7\ COOH$
Licanic	$CH_3\ (CH_2)_3\ (CH{=}CH)_3\ (CH_2)_4\ CO(CH_2)_2\ COOH$
Parinaric	$CH_3\ CH_2\ (CH{=}CH)_4\ (CH_2)_7\ COOH$
Tariric	$CH_3\ (CH_2)_7C{\equiv}C\ (CH_2)_7\ COOH$
Gadoleic	$CH_3\ (CH_2)_9\ CH{=}CH\ (CH_2)_7\ COOH$
Arachidonic	$CH_3\ (CH_2)_4\ (CH{=}CHCH_2)_4\ (CH_2)_2\ COOH$
Cetoleic	$CH_3\ (CH_2)_9\ CH{=}CH\ (CH_2)_9\ COOH$
Erucic	$CH_3\ (CH_2)_7\ CH{=}CH\ (CH_2)_{11}\ COOH$
Selacholeic or nervonic	$CH_3\ (CH_2)_7\ CH{=}CH\ (CH_2)_{13}\ COOH$

CASTOR OIL

Synonyms : Castor bean oil; Castor oil seed; Ricinus oil; Oil of Palma Christi; Tangantangan oil; Neoloid; *Oleum Ricini*, Cold-drawn Castor oil.

Biological Source : Castor oil is a fixed oil obtained by cold-expression from the seeds of *Ricinus communis* Linn.

Family : Euphorbiaceae.

Habitat : The plant is extensively cultivated in temperate climate such as India, South America, African countries, Brazil, China, East and West Indies and Thailand. The plant is an annual soft-wooden 15 meters high tree.The fruit is a three-celled spiny capsule, each cell has an ovoid albuminous seed.

Cultivation : Castor is an essential crop of the tropics and to some extent of sub-tropics. It is grown on sandy or clayey deep red loams and on good light alluvial loams. Generally seeds are sown in September-October. Affication of organic manures such as farmyard manure, groundnut or castor cake, and inorganic fertilizers is beneficial. The harvesting period varies between 4 and 9 months. The harvested spikes

are stacked in heaps till the capsules blacken. They are dried in the sunlight. The seeds are beaten out of the capsules by sticks, or thrushed under the feet of bullocks.

Characters of Seeds : The seeds are oval, anatropous, compressed, 0.8-1.8 cm long, 0.4-1.2 cm broad with variable size and colour. The testa is smooth, thin and brittle. The colour is grey, brown or black with brown or black mottled. At one end there is a small yellowish caruncle from which the raphe extends on the flat or ventral side, to the chalazal at the opposite end. The testa is easily removable exposing the large white and oily endosperm bearing thin, flat foliaceous cotyledons, one on either side of a central, lenticular cavity, and connected with the short caulicle and radicle.

Castor oil Preparation : The seed coat is removed by passing the seeds through a decorticator. The rollers with sharp cutting edges break testa but do not injure the kernel. The tasta are removed by sieves and compressed air. The kernels are cold expressed with 1-2 pressure per sq. inch to get about 30% oil. The oil is filtered and steam is passed through the oil to destroy toxic proteins albumins (ricin). The oil is bleached and sold.

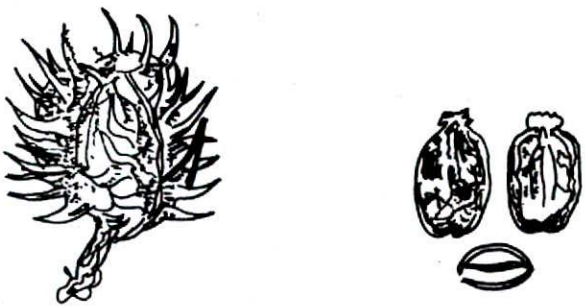


Fig. 9.1. Castor *(Ricinus communis)*

Characters : Castor oil is a colourless or pale yellow viscous liquid. It has slight somewhat characteristic (nauseating) odour. The crude oil tastes slightly acrid with a decidedly nauseating after-taste. It has excellent keeping qualities, and does not turn rancid unless subjected to excessive heat. When exposed to the air, it gradually thickens, darkens in colour and develops more intense odour and taste. It is

dextrorotatory, $(\alpha)_D$ 0.96, viscosity 6-8 poises, acid value <4, saponification number 176-187, iodine number 81-91, acetyl value 144-150, hydroxyl value 161-169. It is miscible with alcohol, ether, chloroform and glacial acetic acid. It dissolves in its own volume of petroleum ether and in 95% alcohol due to the presence of hydroxyl group in ricinoleic acid. When heated to 300° for several hours it polymerizes and becomes miscible with mineral oil.

Chemical Constituents : Castor seeds contain fixed oil (45-55%), proteins (20%) consisting of globulin, albumin, nucleoalbumin, glycoprotein and ricin (a toxalbumin), ricinine alkaloid and some enzymes. The fixed oil consists of the glycerides of ricinoleic (87%), isoricinoleic, stearic (1%), dihydroxystearic (traces), linoleic (3%), oleic (7%), and palmitic (2%) acids. The purgative nature of the oil is due to free ricinoleic acid and its stereoisomers which are produced by hydrolysis of triricinolein by lipases in the duodenum.

Uses : Castor oil is purgative and emollient. It is used as ointment base, for the preparation of flexible collodion, to prepare undecylenic acid which is a fungistatic preparation, to manufacture lipsticks, perfumed hair oil and hair fixers. As an industrial raw material it is used for the preparation of chemical derivatives used in coating, urethane derivatives, surfactants and dispersants, cosmetics, lubricants, paints, varnishes, grease, polishes, etc. It is the chief raw material for the production of sebacic acid.

SHARK LIVER OIL

Synonym : Oleum selachoide.

Biological Source : Shark liver oil is the fixed oil obtained from the fresh and healthy livers of shark fish, *Hypoprion brevirostris*.

Order : Selachii.

Habitat : Shark is found on seacoasts of many European countries and in India in Tamil Nadu, Maharastra and Kerala.

Preparation : Livers are removed from the fishes, cleaned thoroughly, freed from fatty substances and attached tissues like gall-bladders. Then the livers are heated in water at about 80°C. The oil exudes, floats on the top, and is separated, washed and water is removed. The dehydrated oil is cooled to separate stearin. The suspended materials are

removed by centrifugation. The oil is supplemented with vitamins A and D in desired amount.

Characters : Shark liver oil is pale yellow to brownish yellow viscous liquid with fishy odour and bland taste. It is insoluble in water, sparingly soluble in alcohol and freely miscible in non-polar solvents such as petroleum ether, chloroform and benzene. Its acid value is about 2, saponification value 150-200 and iodine value 160-350.

Chemical Constituents : The active principle of Shark liver oil is vitamin A which varies from 15,000-30,000 I.U. per g of the oil. It contains glycerides of saturated and unsaturated fatty acids.

Chemical Tests

1. A solution of Shark liver oil (1 drop) in chloroform (1 ml) is treated with sulphuric acid (1 drop). A violet colour changing to purple or brown is formed due to the presence of vitamin A.
2. Shark liver oil (1 ml) is dissolved in chloroform (10 ml). Few drops of saturated solution of antimony trichloride in chloroform are added to the solution. A blue colour is formed due to the presence of vitamin A.

Uses : Shark liver oil is used to treat xerophthalmia (abnormal dryness of the surface of conjunctiva) occurring due to deficiency of vitamin A. The oil is nutritive and used as tonic.

Storage : The oil is sensitive to light and air. It should be stored in air tight, completely filled, coloured containers.

ARACHIS OIL

Synonyms : Groundnut oil; Monkeynut oil; Peanut oil; Katchung oil; Earth-nut oil.

Biological Source : Arachis oil is obtained by expression of shelled and skinned seeds of *Arachis hypogaea* Linn.

Family : Leguminosae.

Habitat : South America (Brazil) is the original home of ground nut and now found in South and Central America, Peru, Argentina, Nigeria, Australia, Gambia, and other reasonably warm regions of all countries.

Groundnut plant is a small, prostrate, diffuse, erect, branched, annual herb, 30-60 cm in height, leaves alternate

with adnate stipules and yellow papilionaceous flowers. After fertilization, the pedicel elongates rapidly and enters the ground, where the ovary begins to develop into a pod maturing in about two months. Pods or nuts are cylindrical, hard, reticulated, indehiscent and inflated, 2.5-5.0 cm long, 1-3 seeded, with pericarp constricted between the seeds. The seeds are covered by a light or deep reddish brown seeds coat, and consisting of two white fleshy cotyledons rich in oil and proteins.

Fruits are dug out by raking the plants from the soil, seeds are separated by machine and expressed in a hydraulic press at ordinary temperature. The remaining oil of cakes is removed by solvent extraction. The two oil fractions are combined and purified.

Cultivation : Groundnut is predominantly a crop of the tropical and subtropical countries, up to an elevation of 1,160 m. It requires plenty of sunlight, timely and evently distributed rainfall (50-125 cm) during its growth and a long season for its maturation and harvesting. It also requires a high temperature (21-26°) particularly during the nights to induce early flowering. The plant does not stand frost, long and severe drought and water stagnation. Groundnut seeds are sown from April-May to June-July. It requires light, well-drained, loose, friable soil. No regular manuring is done by the growers and the plant is benefitted from green manuring.

Groundnut is susceptible to infection by several fungi, bacteria and viruses. Some important diseases in India are tikka leaf spot, collar rot, dry root rot, stem rot, rust, bud necrosis and yellow mould.

Groundnut Oil : It is a non-drying oil belonging to the oleo-linoleic acid group of oils. It is pale-yellow in colour or almost colourless liquid with a nutty odour and bland taste. Clouds are formed in the oil at low room temperature. It has acid value 0.08-6, saponification value 188-195, iodine value 84-102; thiocyanogen value 67-73 and hydroxyl value 2.5-9.5. It very slowly thickens and becomes rancid on prolonged exposure to air. It is miscible with solvent ether, petroleum ether, chloroform, carbon disulphide, benzene; very slightly soluble in alcohol.

Chemical Constituents : The important constituents of the glycerides of groundnut oil are the fatty acids palmitic (8.3%), stearic (3.1%) oleic (56%), linoleic (26%), arachidic (24%),

eicosenoic, behenic (3.1%) and lignoceric (1.1) acids. Myristic, hexacosanoic, erucic, caprylic, lauric and trace amounts of odd carbon fatty acids are also present.

The principal glycerides of the oil are triolein (11%), dioleolinolein (21%), saturated oleolinoleins (22%), dilinoleo-olein (12%), saturated diolein (15%) and saturated dilinoleo-olein (6%).

The yellow colour of the oil is due to the presence of carotenoid pigments, chiefly β-carotene and lutein. The unsaponifiable matter consists of sterols, (campesterol, stigmasterol, β-sitosterol and cholesterol), sterol glycosides (β-sitosterol-D-glycoside and others), and triterpenoid alcohols (β-amyrin, cycloartenol and 24-methylene cycloartenol). Tocopherols occur free in groundnut oil. Squalene, an unsaturated hydrocarbon, occurs in extremely small amounts in the unsaponifiable fraction. Two other unsaturated hydrocarbons, hypogene and arachidene, have also been reported.

The kernels contain fixed oil (40-50%), proteins (26.2%), water (1.8%), carbohyorates (20.6%), ash and high concentration of thiamine. The chief proteins are arachin and conarchin, both are globulins of different solubility. The vitamin content of groundnut is moderate, the largest being in the episperm.

Uses : Groundnut oil is used as an edible oil, in control of pasture bloat, as a substitute for Olive oil, as a solvent in pharmaceutical aid, in hydrogenated state as shortening, in mayonnaise, in confections; for the manufacture of margarine, soap, paints, liniments, plasters and ointments, as vehicle for intramuscular medication and in the laboratory as heat transfer medium in melting point apparatus.

SESAME OIL

Synonyms : Benne oil; Teel oil; Gingelli oil, Sesamum Seed oil.

Biological Source : Sesame oil is obtained by refining the expressed or extracted oil from the seeds of cultivated varieties of *Sesamum indicum* Linn.

Family : Pedaliaceae.

Habitat : The plant is widely cultivated in India, China, Japan, East Indies, West Indies and in the southern United States.

Cultivation : The plant is an annual herb, 1 m in height. Sesamum is cultivated in the plains and on elevations up to 1,200 m at temperature of 21° and above. It requires a warm climate and cannot withstand frost, continued heavy rain or prolonged drought. It grows on a light well-drained soil which is capable of retaining adequate moisture. It thrives best on typical sandy loams.

The seeds are sown broadcast. In nothern India the crop is sown in June-July and harvested in October-November. The crop is not generally manured.

The seeds are small, flat, oval, smooth and shiny, whitish, yellow or reddish brown; sweet and oily taste; odour is slight. They are pointed at one end where hilum is located, raphe runs as a line from hilum, along the centre of one flat face to the broader end. The endosperm is present as a thin layer around the embryo. The seeds contain fixed oil (45-55%), proteins (aleurone, 22%) and mucilage (4%).

Preparation : The oil is expressed by hydraulic or low and medium-powered screw presses. A good yield of the oil is obtained by three successive expression. Prior to processing in the screw press, the seed is subjected to a cooking process. If live steam is used for cooking, the cuticles separate partly from the kernels and the mixture of kernels, cuticles and seed slips in the cage and lumpy material is obtained instead of a firm cake. If the seed is heated in cooker without the addition of steam or water, and water is added at the point of entry of dried seed into the screw press cage, the efficiency of oil extraction is greatly enhanced. Alkali refining, bleaching, hydrogenation and decolourization of Sesame oil can be effected with very little loss.

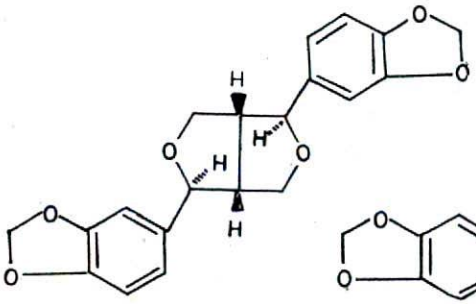
The sesame oil is pale yellow liquid, almost odourless, bland taste, saponification no. 188-193, iodine no. 103-122, soluble in chloroform, solvent and petroleum ether, carbon disulphide; slightly soluble in alcohol and insoluble in water.

Chemical Constituents : Sesame oil consists of a mixture of glycerides of oleic (43%), linoleic (43%), palmitic (9%), stearic (4%), arachidic, hexadecenoic, lignoceric and myristic acids. It also contains the lignan sesamin (1%) and the related sesamolin, and vitamins A and E.

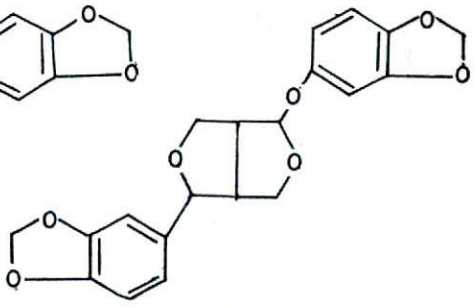
Sesamol forms pink colour when the oil (2 ml) is shaken with concentrated hydrochloric acid (1 ml) containing 1% sucrose (Bandouin's test). Furfural may be used in place of

sucrose and this modified test (Villavecchia test) is widely used to detect Sesame oil in other oils and fats. The presence of sesamolin or free sesamol is responsible for this colour which are not found in other vegetable oil.

Uses: Sesame oil is used as demulcent, in dysentery and urinary complaints, as a solvent for injection of steroids, antibiotics, and hormones, as mild laxative, nutritive, emollient, pediculicide, in manufacture of oleomargarine, cosmetics, iodized oil, anti acids, ointment, etc. It is injectable as a vehicle for fat soluble substances. The oil is also used an insecticidal sprays.



Sesamin



Sesamolin

LINSEED AND LINSEED OIL

Synonyms : Flax seed, Alsi (Hindi), Linum; Semina Lini.

Biological Source : Linseed is the dried, ripe seed of *Linum usitatissimum* Linn. Linseed oil is obtained by expression of linseeds.

Family : Linaceae.

Habitat: Linseed is cultivated in many sub-tropical countries such as South America, India, USA, Canada, England, Russia, Greece, Italy, Spain and Algeria.

Collection : Linseed in an erect annual herb, 60-120 cm high with sky-blue flowers and a globular capsule. The plant is cultivated for its seeds and fibre (flax). A moderate rainfall is best suited for its growth. It grows in almost all types of soils where sufficient moisture is available, but thrives best in heavy soils with high moisture retaining capacity. As a mixed crop it is sown either on the margins of fields or in rows alternating with the other crop. Nitrogenous fertilizers yield better crop. The crop is harvested in February and March before the capsules are dried. Plants are cut close

to the ground, dried in the field and threshed to separate seeds.

Morphology of Seeds : The seeds are oval, flattened, 4-6 mm long, and 2-3 mm wide. Testa is glossy, smooth, reddish-brown with minutely pitted surface. Seeds are rounded at one end. The other end is obliquely pointed where the hilum and micropyle are present in a slight depression. Raphe is present along one edge. Endosperm is narrow and encircles the embryo. It consists of two thick flattened, planoconvex cotyledons and a radicle. The seeds are odourless but possess an oily and mucilaginous taste.

Chemical Constituents : Linseed contains fixed oil (30-40%), mucilage (6%), protein (25%) (linin and colinin), small amount of enzyme lipase and linamarin which is a cyanogenetic glycoside. The carbohydrates present are sucrore, raffinose, cellulose and mucilage. Linamarin is a glucose ether of acetone cyanohydrin and is identical to phaseolunatin. Unripe seeds contain starch which is converted to mucilage on ripening the seeds. Mucilage consists of calcium salts of linseed acids which on hydrolysis produces arabinose, rhamnose, galactose, galacturonic acid and xylose. Mucilage swells with water and forms red colour with ruthenium red. Linamarin on hydrolysis yields acetone, hydrocyanic acid and glucose. The other constituents are phytin, lecithin, wax, resin, pigments, and malic acid.

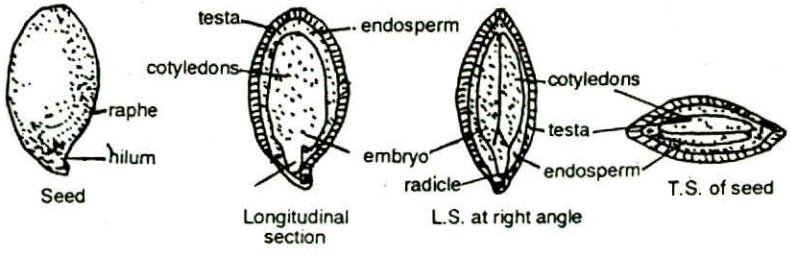


Fig. 9.2. Linseed

LINSEED OIL

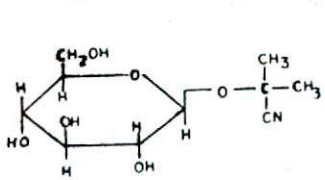
Preparation : The dried seeds are crushed in rollers, moistened and heated to 80-90° C in steam to soften the seed tissues. They are then pressed through hot hydraulic press at a high pressure. The oil so obtained is treated with alkali to separate free fatty acids and bleached with fuller's

earth or charcoal. On cooling the oil waxy substances are removed.

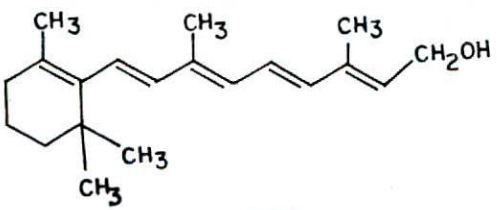
Linseed oil is a yellowish liquid, with a peculiar odour and bland taste. On exposure to air it gradually thickens, becomes darker and acquires a more pronounced odour and taste. On drying it forms a hard varnish. It has a high iodine value (~170) which indicates the presence of excess amount of glycerides of unsaturated fatty acids. The oil is slightly soluble in alcohol, miscible with chloroform, ether, petroleum ether, carbon disulphide and terpentine oil. It has density 0.925-0.935, viscocity 1.47, congealing point -20°C, saponification number 187-195, refractive index 1.47-1.48, and unsaponifiable matters not over 1.5%. A water-soluble resinous matter with antioxidant properties has been isolated from the oil.

On hydrolysis Linseed oil produces unsaturated acids like linolenic acid (30-50%), linoleic acid (23-24%), oleic acid (10-18%) together with saturated acids-myristic, stearic and palmitic (5-11%).

Uses : Linseed is used as demulcent and in form of poultices for gouty and rheumatic swellings. Internally it is used for gonorrhoea and irritation of the genito-urinary system. Linseed oil has emollient, expectorant, diuretic, demulcent and laxative properties and is utilized externally in lotions and liniments. Non-staining iodine ointment, soap, linoleum, greases, polishes, polymers, varnishes, paints, putty, oil cloths, printing inks, artificial rubber, tracing cloth, tanning and enamelling leather, etc. are prepared from Linseed oil. It is applied to paper and fabrics to render them waterproof and tough. The mucilaginous infusion is used internally as a demulcent in colds, coughs and bronchial affections, inflammation of the urinary tract, gonorrhoea and diarrhoea.



Linamarin



Vitamin A

Adulterants : When **market price is** high, Linseed oil is adulterated with vegetable **oils**, **such** as rape, cottonseed,

soyabean, sunflower, safflower and candlenut, as well as with rosin and mineral and fish oils. Boiled linseed oil is more frequently adulterated than raw oil. Adulteration is rather difficult.

Admixture of rape and mustard oil may be detected by the presence of erucic acid; the adulterants lower the saponification value. Fish oil may be detected by the odour produced on heating and by melting points of ether - insoluble bromides. Rosin and mineral oils increase the proportion of unsaponifiable matter.

OLIVE OIL

Synonyms : Salad oil; Sweet oil, Oleum olival.

Biological Source : Olive oil is a fixed oil obtained by expression of the ripe fruits of *Olea europoea* Linn. (Fam. Oleaceae).

Geographical Source : Olive is a native of Palestine and produced extensively in the countries adjoining the Mediterranean sea, Spain being the largest producer. It is also grown in the south western United States and many other subtropical localities.

The tree is propagated by cuttings; grafting and budding of *O. europoea* or Indian olive *(O. ferruginea).*

For proper growth the plant needs deep fertile soil and a temperature average to 13° not dropping to below -10°.

Collection and Preparation : The olive is an evergreen tree, up to 12 m in height which produces drupaceous fruits about 2-3 cm in length, purplish in colour when ripe. The fruits are collected from November to April. After grinding, the pulp is introduced into coarse, grass baskets and placed in a screw press. The oil coming out is collected into tubes containing water and the upper layer is skimmed off. The product is called as *Virgin oil* obtained by gently pressing the peeled pulp freed from the endocarp. The marc is then treated with water and again expressed to yield second grade of edible oil. Finally, the pulp is mixed with hot water and pressed again for technical oil. The pulp may be extracted with carbon disulphide to obtain "sulphur" olive oil of inferior quality. The yield is from 15 to 40 per cent. If the fruit is not fully mature, the yield of the oil is poor and its taste is bitter.

Characters : Olive oil is a pale yellow or light greenish-yellow due to presence of chlorophyll or carotenes, non-drying oily liquid with a pleasanting delicate flavour. Taste is bland becoming faintly acrid. It is miscible with ether, chloroform and carbon disulphide and is slightly soluble in alcohol. Upon cooling at +5 to 10° it becomes cloudy and at 0°C it usually forms a whitish granular mass. It becomes rancid on exposure to air. It has specific gravity of 0.914-0.919, acid value 0.2-2.8, saponification value 187-196 and iodine value 79-90.

Chemical Constituents : Olive oil contains mixed glycerides of oleic acid (83.5%), palmitic acid (9.4%), linoleic acid (7%), stearic acid (2.0%), and arachidic acid (0.9%). The minor constituents are squalene up to 0.7%, phytosterol and tocopherols about 0.2%.

Uses : Olive oil is used in the manufacture of pharmaceutical preparations, soaps, textile lubricants, sulphonated oils, liniments, cosmetics, plasters; as food in salads, with sardines for cooking and baking. It has demulcent, emollient and laxative properties.

CHAULMOOGRA OIL

Synonyms : Hydnocarpus oil; Gynocardia oil.

Biological Source : Chaulmoogra oil is the fixed oil obtained by cold expression from ripe seeds of *Taraktogenos kurzii* King, (syn. *Hydnocarpus kurzii* (king) Warb.), *Hydnocarpus wightiana* Blume, *H. anthelmintica* Pierre, *H. heterophylla* and other speices of *Hydnocarpus*.

Family : Flacourtiaceae.

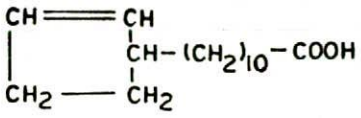
Habitat : The plants are tall trees, up to 17 m high, with narrow crown of hanging branches; native to Burma, Thailand, eastern India and Indochina.

The tree bears irregular fruits which are collected once in 2-3 years when a full crop is expected. The seeds resemble brown pebbles in appearance and are of varying size and shape. Commercial oil obtained by the expression of kernels. They contains large amounts of free fatty acids which are of poor quality.

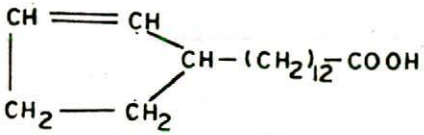
Characters : The oil is yellow or brownish yellow. Below 25°C it is a soft solid. It has peculiar odour and sharp taste. It is soluble in benzene, chloroform, ether, petrol; slightly

soluble in cold alcohol; almost entirely soluble in hot alcohol and carbon disulphide.

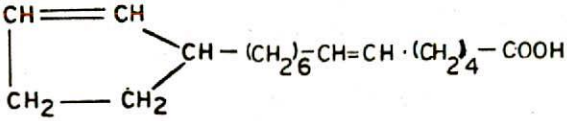
Chemical Constituents : Chaulmoogra oil contains glycerides of cyclopentenyl fatty acids like hydrocarpic\ acid (48%), chaulmoogric acid (27%), gorlic acid with small amounts of glycerides of hydrocarpic acid, palmitic acid (6%) and oleic acid (12%). The cyclic acids are formed during last 3-4 months of maturation of the fruit and are strongly bactericidal towards the Micrococcus of leprosy.



Hydnocarpic acid



Chaulmoogric acid



Gorlic acid

Uses : The oil is useful in leprosy and many skin diseases. The cyclopentenyl fatty acids of the oil exhibit specific toxicity for *Mycobacterium leprae* and *M. tuberculosis*. The oil has now been replaced by the ethyl esters and salts of hydnocarpic and chaulmoogric acids. At present organic sulphones have replaced Chaulmoogra oil in therapeutic use.

KOKUM

Synonyms : Kokum butter; Kokum oil.

Biological Source : Kokum is the fat obtained by expression of the ripe seeds of *Garcinia purpurea Roxb.* (syn. *G. indica* Chois.).

Family : Guttiferae.

Habitat : The trees are slender evergreen with drooping branches found in tropical rain forests of Konkan, western ghats of Bombay, Malabar and Canara.

Seeds are separated from the ripe fruits. The dried pericarp is composed of fat which is known as Kokum. Its taste is sweet-sour. Seeds are expressed to get solid wax-like fat 'Kokum butter' (30%). Kokum bitter is also obtained

by extracting the seeds with boiling water and skimming off the fat from the top or by churning the crushed pulp with water. It is greyish-white fat having slight odour or taste, mp. 39-42°C.

Kokum butter consists of egg-shaped lumps or cakes of light grey or yellowish colour with a greasy feel and a bland oily taste.

It contains a mixture of stearic and oleic acids; the other acids isolated are palmitic, arachidic and linoleic acids. It contains about 75% of mono-oleodisaturated glycerides. The glyceride components are as : tristearin (1.5%), oleodistearin (68%), oleopalmitostearin (8%), stearodiolein (20%), palmitodiolein and triolein. The Kokum bitter has mp. 39-42°, saponification value 299.5 and iodine value 37.4.

Uses : Kokum has emollient, nutritive, demulcent and astringent action and is used in skin diseases, dysentery, mucous diarrhoea, and phthisis pneumonia. Externally, it is employed to cure ulcers, fissures of lips and hands,chapped skin, wounds and sores. It is used as a base in ointments suppository, for the preparation of pomades, as garnish to give an acid flavour to curries and for preparing cooling syrups during hot months.

THEOBROMA

Synonyms : Cacao butter; Cocoa butter; Cacao seeds; Cacao beans; Semina Theobromatis; Cocao seeds.

Biological Source : Theobroma oil is obtained by expression of the ground kernels of *Theobroma cacao* Linn. (family Sterculiaceae).

Geographical Distribution : The Cocoa tree (Chocolate tree) is a native of tropical America (Mexico), and cultivated in Ecuador, Curacao, Mexico, Trinidad, Central America, Brazil, West Africa (Nigeria and Ghana), Sri Lanka, the Philippine Islands, South India and Orissa.

Good growing conditions for Cacao require high humidity, temperature range from 18-32° and clay-loams, sandy loams and loam soils. It is reproduced by seeds. Seedlings may be raised in nursery beds. The seeds germinate within a week. Transplanting is done when seedlings are 4-5 months old. Adequate shade is necessary for the establishment of young trees.

Collection and Preparation : The plant is a small evergreen with a dense rounded crown tree attaining the height of about 12 meters. The small flowers arise from the older branches or trunk. They are succeeded by large ovoid, fleshy red fruit which has ten longitudinal furrows and five rows of seeds, 10 or 12 in each row. Thus 40-50 colourless, fleshy seeds embedded in a scanty, mucilaginous pulp are present. The seeds are separated from the pod and packed in boxes, in which they undergo a process of fermentation at 42°C. They are then dried in the sun. At the end of these processes the seeds acquire a reddish–brown colour, and the taste, at first astringent and bitter, and becomes mild and oily. They are then roasted (140°C), lossing water and developing distinct odour and taste. The roasted seeds are passed through a "nibbling" machine to crack the seed coats which are separated from the kernels by air. The broken kernels (nibs) are ground between hot rollers to yield a paste containing up to 50% of fat, called *Cacao Butter*. At room temperature the paste is congealed to yield *Bitter Chocolate*. When sugar and flavouring substances, like vanilla, are added to the *Bitter Chocolate* it is known as *Sweet Chocolate*. After expressing Cacao butter, the marc, retaining some oil, is powered which is called as *Prepared Cacao* or *Breakfast Cocoa*.

Description : Cocoa seeds are flattened-ovoid, about 20-30 mm long, 15 mm wide and 7 mm thick. The seed-coat is chocolate brown in colour, brittle and thin. The kernel consists of two irregularly folded, chocolate-coloured cotyledons.

Theobroma oil is yellowish-white solid, brittle below 25°; chocolate odour and taste. m.p. 30°-35°C; insoluble in water; slightly soluble in alcohol; soluble in boiling alcohol, very soluble in chloroform, ether and benzene.

Chemical Constituents : Cocoa butter consists of the glycerides of stearic, (34%), palmitic (26%), arachidic, oleic, (37%) and other acids. These glycerides are present in the form of simple and mixed glycerides. Mono-oleo-disaturated glycerides, mainly oleo-palmitostearin, are the major constituents.

The seeds contain 35-50% of a fixed oil, 15% of starch, 15% of proteins, 1-4% of the alkaloid theobromine and 0.07-0.36% of caffeine. Cocao-red is formed by the action of a ferment on a glyceride and gives red colour to the seeds.

Theobromine is present in the kernel (1-1.7%) and the shell (0.19-2.98%).

Uses : Theobroma oil is used as lubricant in massage, base for suppositories and ointments, in manufacturing chocolate, toilet soaps, creams, etc. Cocoa, called "breakfast Cocoa" is a popular beverage.

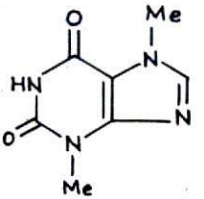


Fig. 9.3. *Theobroma cacao*

COTTONSEED OIL

Biological Source : Cottonseed oil is obtained by expression of seeds of *Gossypium harbaceum* Linn. in hydraulic or other presses.

Family : Malvaceae.



Theobromine

Characters : The crude oil is amber to deep red or black in colour with a characteristic odour, sp. gr. 0.92, saponification value 192-200, iodine value 100-115 and unsaponifiable matter 0.6-2.0 per cent. Refined Cottonseed oil is pale yellow in colour with a bland nutty taste and nearly odourless. The oil is a semi-drying substance. On cooling a sediment of olein or liquid glycerides separates out which may be collected by filtration in the cooled condition.

Cottonseed oil is graded on the basis of its acidity; refining loses flavour. Refined oil is graded according to the colour, odour and flavour.

Chemical Constituents : The important constituents of the glycerides of Cottonseed oil are linoleic (45-50%), oleic (23-29%), palmitic (20-23%), myristic (1.5-3.5%), stearic (1.1-2.7%) and arachidic acids (1.0%). The glycerides present are palmito-oleolinoleins (35-40%), palmitodioleins (20%) and trioleo- or lineo-disaturated (12-13%). The unsaponifiable fraction contains β-sitosterol, ergosterol, vitamin E and tocopherols. The phosphatides present are lecithin (29%) and cephalins (71%). The minor constituents present in the oil are free fatty acids (0.3-5.6%), gossypol (0.05%), raffinose,

pentosans, resins, wax, proteoses, peptones, phospholipids, inosite phosphates, phytosteroline, xanthophyll, chlorophyll and muscilage substances.

Uses : Cottonseed oil is used for edible purposes. The oil possesses emollient properties and is used in liniments, in several pharmaceutical preparations, as a substitute of Olive oil and in large doses as lubricant cathartic. Low grade oil is used in the manufacture of soaps, lubricants, sulphonated oils and protective coatings.

Cottonseed oil is detected when present in admixture with other oils by the Halphen colour test. The oil (1 ml) is dissolved in equal volume of amyl alcohol. A 1% solution of flowers of sulphur (1 ml) in carbon tetrachloride is added and the mixture heated for two hours on water bath. A red colour indicates the presence of Cottonseed oil.

WAXES

Waxes are the esters of higher straight-chain fatty acids with long-chain or high molecular weight monohydric alcohols, some containing more than 30 carbons in the chain. Waxes may be of plant origin such as Carnauba wax or of animal origin such as Beeswax, Wool-fat, Spermaceti, etc.

In many ways, waxes are identical to fats, but they are more difficult to saponify. Fats may be saponified by aqueous or alcoholic alkalies but waxes are only saponified by alcoholic alkalies. Waxes are distinguished from fats and oils by their low saponification values and very low iodine value due to the presence of saturated acids.

Waxes usually contain esters of the free acids, hydrocarbons, free alcohols and sterols. The hydrocarbons and sterols are unsaponifiable. In plants, waxes are present on the outer cell walls of epidermal tissue. They protect the loss of water or its penetration to the inner part. Waxes are used in pharmaceuticals for hardening cosmetic creams and ointments and in preparation of cerates.

LANOLIN

Synonyms : Wool fat; Oesipos; Agnin, Alapurin; Agnolin; Lanum; Lanain; Lanalin; Lanesin; Lanichol; Anhydrous lanolin; Adeps lanae; Laniol.

Biological Source : Lanolin is the "fat like" purified secretion of the sebaceous glands of sheep, *Ovis aries* Linn. (Family

Bovidae) which is deposited into the wool fibres. It contains about 25-30% water.

Preparation : Wool is cut and washed with a soap or alkali. An emulsion of wool fat, called as wool grease, takes place in water. Raw lanolin is separated by cracking the emulsion with suphuric acid. Wool grease floats on the upper layer and fatty acids are dissolved in the lower layer. Lanolin is purified by treating with sodium peroxide and bleaching with reagents.

Characters : Lanolin is a yellowish white, tenacious, unctuous mass; odour is slight and characteristic. Practically, it is insoluble in water, but soluble in chloroform or ether with the separation of the water. It melts in between 34-40°. On heating it forms two layers in the beginning, continuous heating removes water. Lanolin is not saponified by an aqueous alkali. However, saponification takes place with alcoholic solution of alkali.

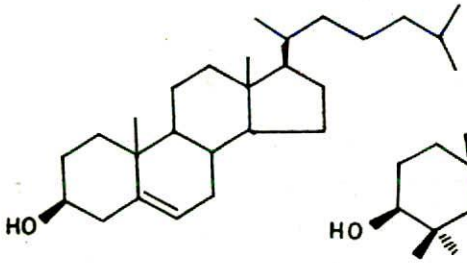
Anhydrous lanolin is a yellowish tenacious, semisolid fat, slight odour, mp 38-42°. Practically insoluble in water but mixes with about twice its weight of water without separation. It is sparingly soluble in cold, more in hot alcohol, freely soluble in benzene, chloroform, ether, carbon disulphide, acetone and petroleum ether.

Chemical Constituents : Lanolin is a complex mixture of esters and polyesters of 33 high molecular weight alcohols, and 36 fatty acids. The alcohols are of three types: aliphatic alcohols, steroid alcohols, and triterpenoid alcohols. The acids are also of three types : saturated nonhydroxylated acids, unsaturated nonhyroxylated acids and hydroxylated acids. Liquid Lanolin is rich in low molecular weight, branched aliphatic acids and alcohols while waxy Lanolin is rich in high molecular weight, straight-chain acids, and alcohols.

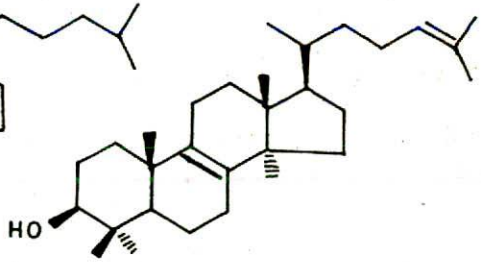
The chief constituents of Lanolin are cholesterol, isocholesterol, unsaturated monohydric alcohols of the formula $C_{27}H_{45}OH$, both free and combined with lanoceric($C_{30}H_{60}O_4$), lanopalmitic ($C_{16}H_{22}O_3$), carnaubic and other fatty acids. Lanonin also contains esters of oleic and myristic acids, aliphatic alcohols, such as cetyl, ceryl and carnaubyl alcohols, lanosterol, and agnosterol.

Uses : Lanolin is used as an emollient, as water absorable ointment base in many skin creams and cosmetic and for

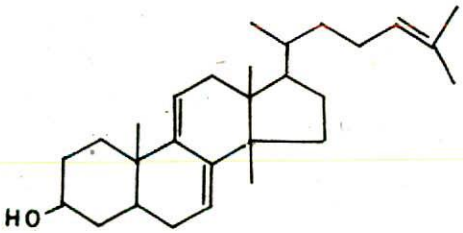
hoof dressing. Wool fat is readily absorbed through skin and helps in increasing the absorption of active ingredients incorporated in the ointment. However, it may act as an allergenic contactant in hypersensitive persons.



Cholesterol



Lanosterol



Agnosterol

BEESWAX

Synonyms : Yellow beeswax, White beeswax; Cera flava; Cara alba.

Biological Source : Beeswax is obtained by purifying the honeycomb of *Apis mellifica* or *A. mellifera* and other bees.

Family : Apidae.

Geographical Source : The beeswax is prepared in West Indies, California, Chile, Africa, Jamaica, Madagascar and India.

Preparation : Yellow Beeswax : Wax is secreted in cells on the ventral surface of the last four segments of the abdomen of worker bees. The wax comes out through pores in the chitinous plates and is used to form the comb for storing the honey. After separation of the honey, the honeycomb is melted in water and cooled. The water-soluble impurities are removed, stained and allowed to solidify in suitable moulds to get yellow beeswax.

White Beeswax : It is prepared from the yellow beeswax by bleaching with charcoal, potassium permanganate, chromic acid, chlorine, etc. or slow bleaching with sunlight, air and water. For slow bleaching the melted wax is fell on a revolving moist cylinder. Ribbon-like strips of wax are formed which are exposed to sunlight and air. The strips are frequently moistened and turned until the outer surface is bleached.

Characters : The beeswax is yellowish to brownish-yellow, or white, pieces or plates, translucent when thin, soft to brittle, honey-like odour, slight balsamic taste, density 0.95-0.96, mp 62-65°. It is practically insoluble in water, slightly soluble in cold alcohol, soluble in hot alcohol, chloroform, benzene, ether, and carbon disulphide. It is soft and brittle, but becomes plastic on warming. On cooling it hardens and breaks with a flaky granular surface.

Chemical Constituents : Beeswax consists mainly of myricyl palmitate (myricin) (~80%), myricyl stearate, free cerotic acid (15%) and its homologues, an aromatic substance cerolein, hydrocarbons, (~12%), lactones, moisture, cholesteryl ester, pollen pigments, and propolis (bee glue). The colour of the wax is due to the presence of pollen pigments and propolis. The esters consist of straight-chain monohydric alcohols with even-numbered carbon chains from C_{24} to C_{36} esterified with straight-chain acids also having even number of carbon atoms up to C_{36}. The other examples of esters are triacontanol hexadecanoate and hexacosanol hexacosanoate. These esters are mixed with about 20% of hydrocarbons having odd numbered straight carbon chains from C_{21} to C_{33}.

The other constituents are 1, 3-dihydroxyflavone, w-myristolactone, lacceryl palmitate, myricyl cerotate, myricyl hypogaeate, and ceryl hydroxypalmitate. The main components are hentriacontane and nonacosane. The unsaturated hydrocarbon, melene, is also present. The free acids present are lignoceric, cerotic, montanic and psyllic; cerotic acid being the predominant saturated free acid. Palmitic, hydroxypalmitic and hypogaeic (7-hexadecenoic) acids are also reported.

Uses : Beeswax is used to prepare plasters, ointments, cerates, face creams, wax paper, candles, modelling artificial fruits and flowers, in process engraving, shoe polish, etc.

A beeswax and vegetable oil mixture is used as a vehicle for the administration of respiratory forms of certain medicaments such as penicillin and curare. It is used in the

formulation of medicinal preparations for treating skin cracks. A combination containing of tallow, olive oil, camphor, beeswax and common salt is used for ulcer and external tumour treatment.

$C_{15}H_{31}COOC_{30}H_{61}$ — Myricin

$C_{26}H_{53}COOH$ — Cerotic acid

Adulterants : Beeswax is adulterated with chief substances such as solid paraffin, ceresin, carnauba wax, Japan wax (Fat of the fruits of *Rhus* species; family Anacardiaceae), stearic acid and colophony.

Detection of Adulteration

1. On heating the wax with aqueous sodium hydroxide, cooling and acidifying, there should be no turbidity. Beeswax is a true wax and on saponification the cerotic acid does not form soap. The adulterated substances form water soluble soap on treatment with alkali.
2. Wax is hydrolyzed with alcoholic alkali by heating, and cooled by stirring. It should be cloudy between 59-61°C and not above 61°.

QUESTIONS

1. Give official source, chemical constituents and uses of: (a) Chaulmoogra oil (b) Linseed (c) Castor oil (d) Beeswax.
2. How are fixed oils formed in the plants ? Give method of preparation and chemical tests for identification of Olive oil. What are its common adulterants and how are they detected ?
3. Give the source, preparation, chemical constituents and uses of Arachis oil.
4. How will you differentiate among fixed oils, fats and waxes. Discuss the pharmacognosy of Arachis oil.
5. Describe biological source, chemical constituents and uses of the drugs belonging to the following families : (a) Euphorbiaceae (b) Leguminosae (c) Pedaliaceae (d) Flacourtiaceae (e) Malvaceae.

10

VOLATILE OILS

Volatile or essential oils are mono- and sesquiterpenes obtained from the sap and tissues of certain plants. They are flavouring compounds and have been used in perfumery from the ancient times. On exposition to air at room temperature they evaporate. Chemically, they are composed of hydrocarbons of the general formula $(C_5H_8)_n$ and their oxygenated, hydrogenated, and dehydrogenated derivatives. All the volatile oils are of vegetable origin.

The thermal decomposition of volatile oils gives isoprene as one of the products. Therefore, essential oils are built up of isoprene units. These units are joined 'hand-to-tail' in natural terpenoids.

In most instances the volatile oil pre-exists in plant. Volatile oils may be present in particular secretory parts such as glandular hairs, parenchyma cells, vittae or oil tubes, in mesophyll (Eucalyptus leaves), sub-epidermal tissues of Lemon and Orange, in lysigenous or schizogenous passages, in all tissues (Conifers), in petals (Orange, Rose), in bark and leaves (Cinnamon), in pericarp (Umbelliferous fruits), in glandular hairs of the stems and leaves (Mint), and in rind (Orange). Plants containing essential oils usually have the greatest concentration at some particular time, e.g., jasmine at sunset. In some cases volatile oil does not pre-exist, but is formed by the decomposition of a glycoside (in Black Mustard).

Four general methods of extraction of volatile oils are as :

1. steam distillation,
2. expression,
3. extraction by means of volatile solvents and
4. Adsorption in purified fat.

Steam distillation is one of the most widely used. In this method the plant is macerated and then steam distilled to get the oil. If some compounds are decomposed under these conditions, they may be extracted with light petrol at 50° and the solvent is removed by distillation under reduced pressure. Adsorption in fat is the alternate method used for isolation of volatile compounds. In this method, the fat is heated to 50°C and the flower petals are spread on the surface until it becomes saturated with essential oils. Then the petals are removed to dissolve the oils present in fat. Fat is removed by cooling the alcohol at 20°C. The alcoholic extract is fractionally distilled under reduced pressure to remove the solvent.

Volatile oils are colourless liquids and are lighter than water. They possess distinct odours, have high refractive indices, generally are optically active. They are immiscible with water, but the water shaken with an essential oil possesses its flavour due to slight solubility of the oil. Volatile oils are freely soluble in ether, alcohol, chloroform, acetone, etc.

Each volatile oil differs widely in chemical composition. Usually hydrocabons, alcohols, ketones, aldehydes, ethers, oxides and esters are present in volatile oils. Some of the essential oils possess high percentage of a particular compound e.g., eugenol in Clove oil (85%), allylisothiocyanate in Mustard oil (93%), menthol in Peppermint oil (~70%), and α-terpineol in Pine oil (~65%).

Volatile oils differ from fixed oils in various ways. The former oils are evaporated at room temperature, and can be distilled from their natural sources. They are not glyceryl esters of fatty acids and, therefore, cannot be saponified with alkalies. Volatile oils are not rancidified like fixed oils. On exposure to air and light, they oxidize and resins are formed.

Volatile oil containing drugs are used in perfumery, cosmetic, as insect repellants and as flavouring agents to

mask the taste and smell of unpleasant medicines. They act as counterirritants in inflammation and rheumatism. They have carminative, digestive, spasmolytic, stimulant, bactericidal, antiseptic disinfectant, diuretic, expectorant and anthelmintic properties.

A volatile oil may contain hydrocarbons which are usually devoid of aroma. The other constituents of the oil are monoterpenes which are isomeric substances of the formula $C_{10}H_{16}$, but they vary considerably in structures. All terpenes are optically active. The important terpenes are pinenes, limonene, phellandrene and camphene. Sesquiterpenes of the general formula are also present in an essential oil. They are usually the highest-boiling fraction of the oil. The principal sesquiterpenes are caryophyllene and cadinene.

UMBELLIFEROUS PLANTS

Volatile oils are most frequently present in the pericarp of Umbelliferous fruits. The plants are erect and possess alternate, undivided or divided leaves, base of stalks often dilated and sheathing the stem. Flowers are small, usually less than 1.2 cm diameter, regular, polygamous, in umbels, rarely in heads. Umbels are compound or simple, with or without bracts and bracteoles at the base of the primary and secondary rays, respectively.

The Umbelliferous fruits are schizocarps (splitting), dried, consisting of two one-seeded, indehiscent carpels, which separate from a very slender, simple or forked, central axis.They have transversed longitudinal five ridges or wings, the central ridge being called the dorsal, two marginal the lateral and the remaining two the intermediate ridges.

The carpels are also often furnished with internal, longitudinal oils-canals or vittae, which are best seen in cross sections.

Schizocarps are simple dry indehiscent fruits. They split into partial fruits possessing seeds in each part. Umbelliferous fruits are cremocarps in which the fruits split into two partial fruits, called mericarps, and is derived from inferior bicarpellary biocular ovary. Each mericarp possesses a stylopod at it apex. Stylopod is a disc-like nectary with style and remains of calyx. There are two surfaces of mericarps-the outer dorsal or curved surface and the inner, ventral or

commissural surface. On the surface of mericarp five longitudinal, straight or wavy, conspicuous or inconspicuous ridges are present which join apex to the base. These ridges are called primary ridges due to the presence of vascular bundles below the ridges. In Coriander, secondary ridges are present alternatively with primary ridges. Vascular bundles are not present under the secondary ridges. In between primary ridges special secretory ducts, secreting volatile oils, called vittae, are found in the mesocarp. Each vitta runs from apex to the base longitudinally through the mesocarp.

Coriander, Fennel, Caraway, Dill, and Anise, are the important drugs belonging to Umbelliferae family.

CORIANDER

Synonyms : Coriander fruit, Dhaniya (Hindi); Fructus coriandri.

Biological Source : Coriander is the dried, ripe fruits of *Coriandrum sativum* Linn.

Family : Umbelliferae.

Geographical Source : Coriander is indigenous to Italy. It is extensively cultivated in Holland, central and eastern Europe, Morocco, Malta, Egypt, China, India and Bangladesh.

Collection : Coriander is an annual herb, about 0.7 m high with small white or pinkish flowers. Fruits are collected when ripe and dried. Aromatic odour is developed on drying the fruits.

Cultivation : Coriander is generally grown as a rain-fed crop. The time of sowing varies in different localities. Before sowing the fruits are rubbed till the two mericarps are separated and sown either broadcast or in rows. The crop requires 2 or 3 weedings and the field is irrigated whenever required.

The crop matures in about 3-3.5 months after sowing. The plants are then pulled out by the roots and after drying, the fruits are threshed out. They are further dried in the sun, winnowed and stored in bags.

Morphology : The drug consists of entire cremocarps, 2.3-4.3 mm in diameter, shape sub-spherical. Cremocarps consist of two hemispherical mericarps united by their margins. Two divergent styles present on the apex. On the surface there are ten primary ridges which are wavy and

inconspicuous. Alternating in primary ridges there are eight more prominent, straight, secondary ridges. The colour is straw-yellow, odour is aromatic and taste is spicy. Fresh plant emits a very disagreeable odour on rubbing.

Chemical Constituents : Coriander fruits contain volatile oil (1%). The prominent constituents of the volatile oil are (+)- linalool (65-70%) and pinene. Small amounts of geraniol, borneol, p-cymene, dipentene, phellandrene, terpinolene, hydrocarbons such α-and β-terpinene, geraniol, n-decylic aldehyde, fixed oils, malic acid, esters of acetic and decylic acids, tannins, and mucilage are also present. Coriander oil is a colourless, pale yellow liquid, having characteristic odour and taste. The seeds also contain fatty oil (19-20%) which is mixture of glycerides of palmitic, oleic, linoleic and petroselinic acids.

Uses : Coriander is aromatic, stimulant, carminative, antibilious, diuretic, tonic, stomachic, refrigerant and aphrodisiac. It is used as flavouring agent to conceal the odour of other medicines and to correct the griping qualities of Rhubarb and Senna.

FENNEL

Synonyms : Large Fennel; Sweet Fennel, Fennel fruit; Saunf (Hindi); Fructus Foeniculi.

Biological Source : Fennel is the dried, ripe fruits of *Foeniculum vulgare* Mill.

Family : Umbelliferae.

Geographical Source : Fennel is indigenous to Mediterranean region of Asia and Europe. It is widely cultivated in Russia, India, Japan, Southern Europe, China and Egypt.

Cultivation : Fennel is stout, glabrous, aromatic herb and cultivated as a garden or homeyard crop at all altitudes up to 2,000 m. It grows in any good soil, but thrives best in rich, well-drained loam or

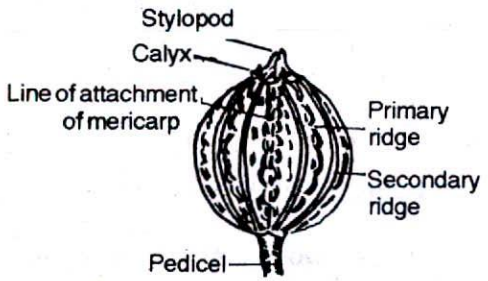


Fig. 10.1 Coriander fruit

black sandy soil containing sufficient lime. It is propagated readily by seeds, but can also be grown by root or crown division. Seeds are sown broadcast by hand or by shallow drill in October-November in the plains and March-April on the hills when 10 cm high.

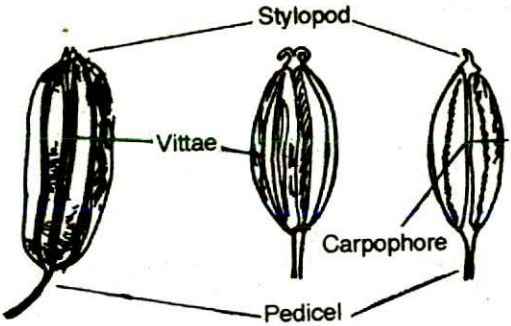


Fig. 10.2. Fennel fruit

The plants are thinned out to about 30 cm apart. Occasional weeding. and irrigation once a week are done. The crop is harvested before the fruits are fully ripe. The stems are cut with the sickle and spread out in loose sheaves to dry in the sun. The dried fruits are threshed out and cleaned by winnowing.

Fennel plant is stout, glabrous, aromatic herb, about 2 m high, leaves pinnately decompound; flowers small, yellow, in compound terminal umbels.

Morphology : The drug consists partly of whole cremocarps and partly of mericarps. The fruit is 0.5-1.0 cm long, 2-4 mm broad. Shape is slightly curved and oval. Surface is glabrous with 5 straight prominent straw-coloured primary ridges and bifid stylopod at the apex. Colour is greenish-brown, odour is aromatic and taste is distinct, sweet and aromatic.

Chemical Constituents : Fennel contains volatile oil (2-6.5%) and fixed oil (12%). The main constituent of the volatile oil are phenolic ether, anethole (50-60%) and the ketone, fenchone (18-20%) which give the fruit its distinct odour and taste; the other constituents of volatile oil are methyl chavicol, anisic aldehyde, anisic acid, α-pinene, dipentene, limonene, and phellandrene.

Uses : Fennel is used as stimulant, aromatic, stomachic, carminative, emmenagogue and expectorant. It is added to cough and stomach mixture. Anethole is used in mouth and dental preparations. Fennel is useful in diseases of the chest, spleen and kidney.

Adulterants : Fennel is generally adulterated with exhausted

Fennel. The alcohol-exhausted Fennel looks like fresh Fennel and contains 1-2% volatile oil. The steam-exhausted Fennel fruits are darker in appearance. They contain little volatile oil and are heavier than water. It is also adulterated with undeveloped or mould-attack fruits.

CARAWAY

Synonyms : Caraway fruit; Caraway seed; Carvi; Carum; Zira (Hindi); Fructus Carvi.

Biological Source : Caraway consists of the dried. ripe fruits of *Carum carvi* Linn.

Family : Umbelliferae.

Geographical Source : The plant is cultivated in European countries (Holland, Denmark, Germany, Russia, Finland, Norway, Sweden and England) and in China, Egypt, Morocco. In India the plant grows widely in northern Himalayan regions, and is cultivated in the plains as a cold season crop and in the hills of Kashmir, Kumaon, Garhwal and Chamba at altitudes of 3,000-4,000 m as a summer crop.

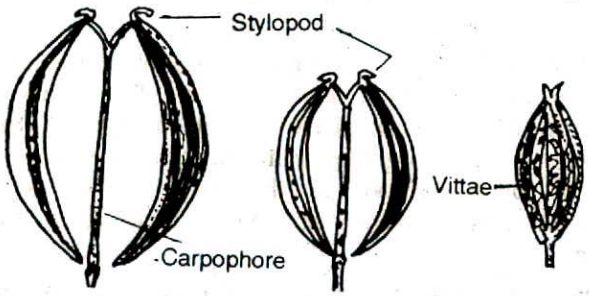


Fig. 10.3 Caraway fruit

Habitat and Morphology : Caraway is a perennial or biennial herb, about 1 m. high with thick tuberous roots and compound leaves. The fruits consist of mericarps without pedicels. They are 4-7 mm long, 1 mm broad, slightly curved, smooth and tapering at both ends. There are five primary ridges, stigma is attached and a stylopod at the apex. The colour is brown, odour and taste are characteristic and spicy.

It is cultivated in the plains as a cold season crop and in hilly areas as a summer crop. The plant requires a dry temperate climate and thrives well in soils rich in humus. The fruits may be sown either broadcast or in rows. The

fruits are collected before ripening. The plants are dried and the fruits threshed out, cleaned and stored in bags.

Chemical Constituents : Caraway contains volatile oil (3-7%), fixed oil (8-20%), proteins, calcium oxalate, colouring matter, resins, sugar, tannins, and mucilage. Monoterpenes identified in the volatile oil are carvone (50-60%), dihydrocarvone, limonene, carveol, and dihydrocarveol.

Uses : Caraway is used as aromatic, carminative, stomachic, lactagogue, flavouring agent and as a spice.

DILL

Synonyms : Dil fruit; Fructus Anethi.

Biological Source : Dill is the dried, ripe fruits of *Anethum graveolens* Linn. Indian Dill consists of dried ripe fruits of *Anethum sowa* Kurz.

Family : Umbelliferae.

Source : Dilli is cultivated in England, Germany, Rumania and U.S.A. Indian dill is grown throughout India.

Cultivation : *A. graveolens* is an annual, erect, glabrous herb, 1 m in height, cultivated to a small extent in the plains. It prefers sandy loam soil of moderate fertility and avoids low lying damp areas. It is grown as a cold weather crop in Indian plains. The seeds are sown in October in rows and the seed crop is harvested by the end of April. Germination takes in 7 to 9 days. Flowering commences between 40-67 days after germination. Application of nitrogenous and phosphatic fertilizers increases yield on medium fertile lands. The crop in given 4 to 6 irrigations. The harvested umbels are dried in shade for 2 to 3 days and threshed. The dried seeds are stored in gunny bags lined with polythene to reduce storage loss of oil.

Morphology : The drug consists of separate, broadly oval mericarps, 3-4 mm long, 2-3 mm wide, 1 mm thick. The fruit is dorsally compressed and has 5 primary yellow-coloured ridges. The two lateral ridges are extended as thin wings, the remaining three are inconspicuous. Stylopod is present at the apex of each mericarp. The colour is brown; odour and taste are aromatic and spicy.

Chemical Constituents : Dill contains volatile oil (3-4%) and the principal constituent of the oil is carvone (50-60%). The

other components of the oil are dihydrocarvone, d-limonene and phellandrene. The Indian variety contains essential oil from 2.5 to 6.0%, which consists of carvone (22-46%), dihydrocarvone (5-25%), dillapiol (12-15%), limonene (22-45%), isoeugenol, d-phellandrene, α-terpinene and carveol.

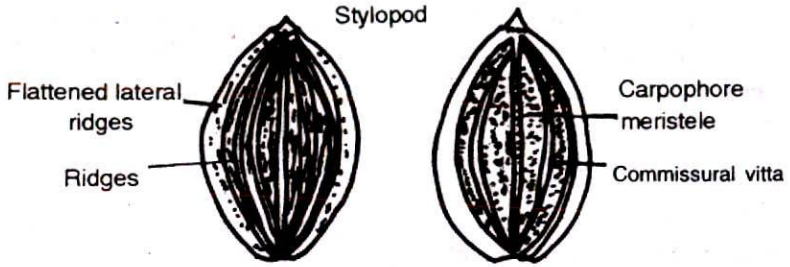


Fig. 10.4. Dill

In addition to volatile oil, the other compounds isolated from the fruits are myristicin, coumarins (bargapten, umbelliprenin scopoletin, esculetin), flavonoids (quercetin, isorhamnetin kaempferol, kaempferol-3-glucuronide, glucoflavone, dillanoside), phenolic acids (caffeic, ferulic and chlorogenic acids), sterols (γ-sitosterol, β-sitosterol glucoside) and phytofluene.

Uses : Dill is used as carminative stomachic, diuretic, anthelmintic, antiflatulant and flavour in gastric disturbances of children and for preparation of dill water and gripe water.

ANISE

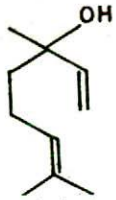
Synonyms : Anise fruit, Anise seed, Star anise; Fructus Anisi.

Biological Source ; Anise is the dried ripe fruit of *Pimpinella anisum* Linn.

Family : Umbelliferae.

Geographical Source : The plant is native to Asia Minor, Egypt and Greece and widely cultivated in Spain, Germany, Italy, Russia, Bulgaria, Chile and Maxico. In India the drug is grown in north-west region, U.P., Punjab and Orissa.

Morphology : The plant is an annual herb. The fruit is pear-shaped, entired compressed cremocarps attached to pedicles, 2-12 mm in length. Cremocarps are 3-6 mm long and 2-



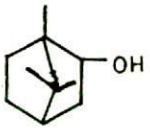
Linalool



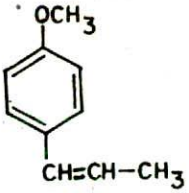
α-Pinene



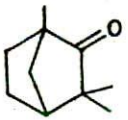
β-Pinene



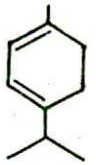
Borneol



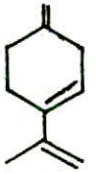
Anethole



Fenchone



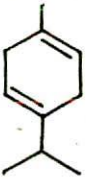
α-Terpinene



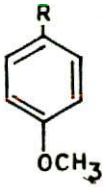
β-Terpinene



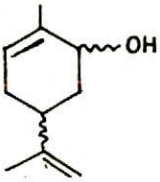
3-Carene



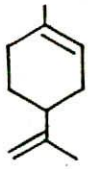
α-Terpinene



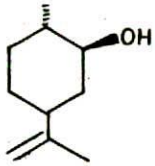
Anise aldehyde
(R = CHO)
Anisic acid
(R = COOH)



Carveol



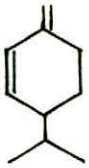
Limonene



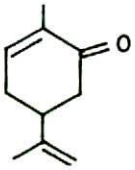
Dihydrocarveol



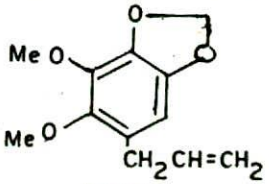
Cineol



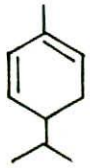
β-Phellandrene



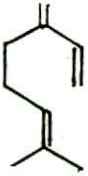
Carvone



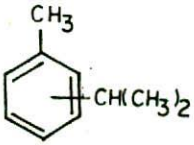
Dillapiole



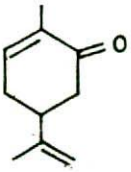
α-Phellandrene



Myrcene



Cymene



Carvone

3 mm broad. There are five wavy ridges on the mesocarp. Outer surface contains short, numerous, conical epidermal trichomes (papillae). Odour is aromatic and taste is sweet.

The oil is a clear, colourless or pale yellow liquid, free from water, crushed fruit like odour and sweet and aromatic taste. It crystallizes on cooling.

Chemical Constituents : Anise fruit contains volatile oil (1.5-3.5%), starch, protein and fixed oil (30%). The principal constituent of the volatile oil is anethole (90%), rest being p-methoxyphenyl acetone, methyl chavicol, chavicol and some terpenic hydrocarbons.

Uses : Anise fruit is diuretic and carminative and used to prevent flatulence colic, as flavouring agent and in mouth and dental preparations. Anethole is employed as expectorant, aromatic, carminative and flavouring agent.

STAR-ANISE OIL

Biological Source : It is a volatile oil obtained from the fruits of the Chinese Star-anise, *Illicium verum* (Family : Illiciaceae).

Habitat : The Star-anise is an evergreen tree, about 4-5 m in height, indigenous to the south-west states of China and other tropical countries. The fruits are collected and the oil distilled locally in China and Vietnam.

The fruits consist mostly of eight one-seeded follicles. Each follicle is about 1.5 cm in length. The pericarp is reddish-brown, woody and slightly wrinkled. Each carpel has the seed which has a brittle, shining testa and oily kernel. The oil, present in both seed and pericarp, gives the drug an aromatic odour and spicy taste.

Chemical Constituents : The fruits yield a volatile oil (2.5-5%) which contains anethole (80-90%) as the main component. The other compounds present in the oil are chavicol methyl ether, p-methoxy-phenylacetone and safrole.

Uses : The oil is used as a flavouring agent and carminative.

PEPPERMINT

Synonyms : Brandy mint; Lamb mint.

Biological Source : Peppermint consists of dried leaves and flowering tops of *Mentha piperita* Linn. containing not less than 1.2 per cent of volatile oil.

Family : Labiatae.

Geographical Source : The plant is cultivated in Asian countries, Canada, Europe and North America. It is grown in gardens.

The plant is a perennial glabrous strongly scented herb, 40-70 cm in height, and cultivated in fertile soil having capacity of holding water. If rainfall is unsufficient, water is irrigated. Much sunlight is required for better crop. The plants are propagated by rhizome cuttings. At flowering stage plants are cut, dried for sometime in sunlight and stored. Several varieties of peppermint are cultivated in various countries, e.g., *Mentha arvensis* var. *piperascens* (Japan mint), *M. piperita* var. *vulgaris* (Black mint), *M. piperita* var. *officinalis* (White mint).

Peppermint thrives well in humid and temperate climates and is sensitive to drought. It grows well on high calcareous soil or deep rich loams in open sunny situations. The cuttings of rootstocks are planted in rows 30-90 cm apart.

Farmyard manure is applied as a basal dose before planting. Planted in February or March, the plants flower in July of the second year, when the crop is harvested; a second flush may be taken in September after the rain.

Peppermint oil is colourless, pale yellow or greenish yellow liquid with a strong agreeable odour and a powerful aromatic taste, followed by a cooling sensation when air is drawn into the mouth. On ageing, the oil darkens in colour and becomes viscous. When chilled, menthol separates out.

Chemical Constituents : Peppermint contains volatile oil, resin, tannins and gum. The predominent constituent of the oil is menthol (50-90%), the other compounds identified are l-and d-menthone (10%), menthyl acetate, menthyl valerate, menthofuran, jasmone, phellandrene, α-pinene, cineole, l-limonene, terpinene, cadinene, amyl alcohol, acetic acid, isovaleric acid, acetaldehyde, isovaleric aldehyde and piperitone. American peppermint also contains acetaldehyde, isovaleraldehyde, acetic acid, valeric acid, limonene, menthyl isovalerate, cadinene, amyl alcohol and dimethyl sulphide.

Uses : The herb is considered aromatic, stimulant, stomachic and carminative, and used for allaying nausea, flatulence and vomiting. Bruised leaves are employed as an external application for relieving local pain and headache. A hot

infusion in taken to allay stomach ache and diarrhoea. The drug is frequently adulterated with spearmint, which is difficult to detect.

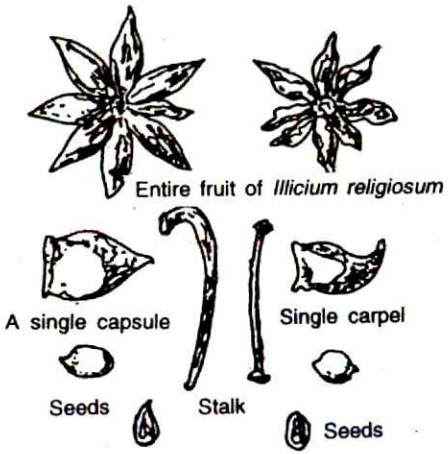


Fig. 10.5. Star Anise fruit

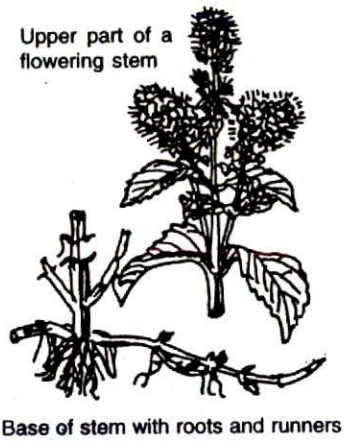
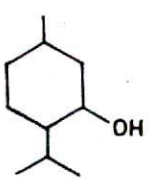


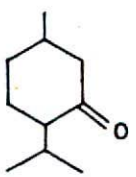
Fig. 10.6. Peppermint

Peppermint oil is used for flavouring in pharmaceuticals, dental preparation, mouth washes, cough, drops, soaps, chewing gums, candies, confectionery and alcoholic liquers. It is widely used in flatulence, nausea and gastralgia. The oil has mild antiseptic and local anaesthetic properties. It is used externally in rheumatism, neuralgia, congestive, headache and toothache.

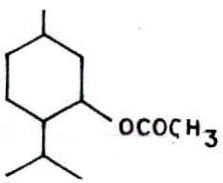
Menthol is antipruritic and used on the skin or mucous membrane as a counter-irritant, antiseptic and stimulant. Internally it has a depressant effect on the heart.



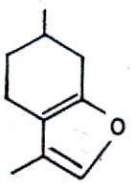
Menthol



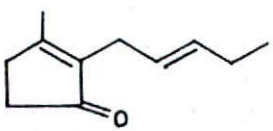
Menthone



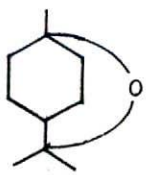
Menthyl acetate



Menthofuran



Jasmone



1, 8-Cineole

CINNAMON BARK

Synonyms : Ceylon Cinnamon; Dalchini (Hindi), Saigon Cinnamon, Chinese Cassia; Cortex Cinnamoni.

Biological Source : Cinnamon is the dried bark of *Cinnamomum loureirii* Nees or *C. zeylanicum* Nees.

Family : Lauraceae.

Geographical Source : Cinnamon is a native of China, Japan, and Formosa and found in Sri Lanka, Java, Vietnam, Sumatra, West Indies, Jamaica, Laos, Indonesia, Brazil, and Seychelles. In India the plant occurs widely in the southern coastal regions of western India up to an altitude of 2,000 meters.

Cultivation : Cinnamon is a large handsome, evergreen, 6-10 meter high tree. It is grown in rich but light soil. It requires a rainfall of nearly 200-300 cm and temperature 32°C. The fresh seeds are sown in seed beds. The plants are transplanted at a distance of 2-3 meter apart. Two or three years old trees are coppiced few inches above the ground. From each plant 5 to 6 straight shoots are allowed to grow. Bark is separated from shoots which are about 3 cm thick. Bark is collected from April to July after heavy rainy season. The shoots and twigs are removed with a brass knife-like instrument (Catty). Leaves and twigs are separated and bark is stripped off from shoots. The bark is kept in the shade for about 24 hours and then kept in the open air wood frames. The dried bark is sorted, put into bundles and enclosed in jute cloth.

The bark as it dries, contracts and forms a quill. During the drying process, which takes about 3 days, the quills are rolled by hand and pressed to prevent swelling and splitting. The bark obtained from the central branches is superior to that from the outer shoots. The quills are graded on the basis of appearance and aroma.

Macroscopic Characters : Cinnamon occurs in single or double compound quills. Length of quill is up to 1 meter, 6-10 mm in diameter and 0.5 mm thick. The external surface is yellowish brown and shows longitudinal wavy lines (pericyclic fibres) and occasional scars and holes. The inner surface is dark brown longitudinally straited. Fracture is short and splintery. Odour is aromatic; taste in warm, sweet and aromatic.



Fig. 10.7. *Cinnamomum zeylanicum* twig

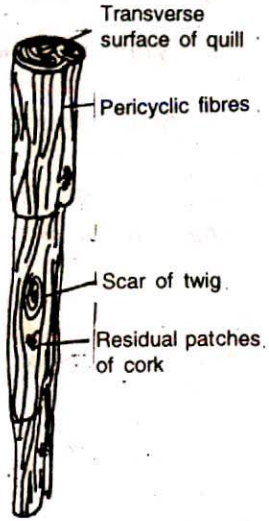


Fig. 10.8. Cinnamon bark

Chemical Constituents : Cinnamon contains volatile oil (1-6%), phlobatannin, mucilage, calcium oxalate, sugar and starch. The principal constituent of the volatile oil is cinnamic aldehyde, C_6H_5 CH=CH-CHO (60-75%). The other components identified are eugenol (4%), pinene, phellandrene, caryophyllene, cinnamyl acetate and small quantities of ketones and alcohols (benzaldehyde, methyl amyl ketone, cumic aldehyde) and esters of isobutyric acid.

Chemical Tests

1. Volatile oil (1 ml) is dissolved in alcohol (5 ml) and then a drop of $FeCl_3$ is added. Ferric chloride on reaction with cinnamic aldehyde and phenolic compound, eugenol, produces pale green colour.
2. Alcoholic extract of the bark (1 g) or volatile oil (1 ml) on treatment with phenylhydrazine hydrochloride forms red coloured phenylhydrazone of cinnamic aldehyde.

Uses : Cinnamon is pungent, aromatic, astringent, stimulant and carminative. It is useful for checking nausea and vomiting. It is employed as flavouring agent and it has antiseptic and antidiarrhoeal properties and is a powerful

germicide. It is employed as a counter-irritant in the treatment of muscular strains, rheumatism and inflammations.

Allied Drug : *Saigon Cinnamon* is obtained from wild trees of *C. loureirii Nees* grown in Annam. It contains numerous starch grains and volatile oil. It is used as flavouring agent and mild astringent.

Cassia or Chinese Cinnamon : Cassia bark is obtained from *Cinnamomum cassia* Blume (Fam. Lauraceae). The plant is grown in south eastern provinces of China and Cochin. Bark is removed from 6 years old tree.

Cassia yields volatile oil (1-2%) which contains cinnamic aldehyde, caryophyllene, methyl O-cumin aldehyde and coumarin.

Java Cinnamon : It is the bark obtained from *Cassia burmanii* Blume. It is used in Holland. Its powder contains tabular crystals of calcium oxalate. The oil contains about 75% cinnamic aldehyde.

Oliver Bark or Black Sassafras : It is obtained from the Brisbane 'white sassafras' tree, *C. oliveri* Bailey, found in Queensland. The bark occurs in flat strips about 20 cm wide, 4 cm long and 1 cm thick, brown coloured outer surface. It contains 1-2.4% volatile oil.

CASSIA OIL (CINNAMON OIL)

Biological Source : Cassia oil is obtained by steam distillation of the leaves and twigs of the plant *Cinnamomum cassia* Blume. It contains not less than 1.0% of volatile oil.

Family : Lauraceae

Habitat : The plant is indigenous to China. It also occurs in Sri Lanka and Burma. In India, it is cultivated in Cochin.

Characters : The oil is a yellowish to brownish liquid that becomes darker and thicker by age or by exposure to air. It contains the typical odour and taste of Cassia Cinnamon.

Chemical Constituents : The main constituent of the oil is cinnamic aldehyde (80-95%); the other components identified are limonene, p-cymene, linalool, β-caryophyllene and eugenol.

Uses : Cassia oil is used as a flavouring agent. It has carminative, pungent, antiseptic and aromatic properties.

It should be stored in well-filled, tight, light-resistant containers and protected from excessive heat.

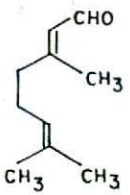
LEMON PEEL

Synonym : Fructus Limonis.

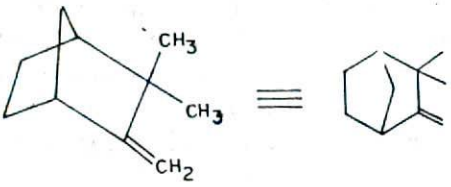
Biological Source : Lemon peel is obtained from the fresh ripe fruit of *Citrus limon* (L.) Burm. f. *(C. medica* var *Limon* Linn.).

Family : Rutaceae.

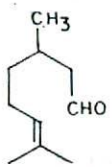
Geographical Habitat : It is cultivated in California. West Indies, Italy, Spain, Sicily, Portugal, Florida, California, Jamaica and Australia; grown all over India, particularly in home gardens and small-sized orchards.



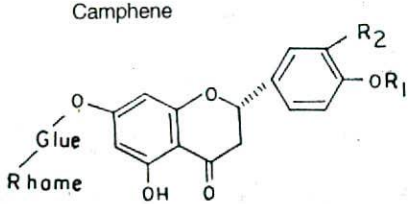
Citral



Camphene



Citronellal



Hesperidin (R_1=OCH_3, R_2=OH)
Neringin (R_1=R_2=H)

Collection : Lemon plant is a small, 3-5 m high, evergreen thorny tree with shining leaves. Fruits are collected before their green colour changes to yellow in January, August and November. The outer dark yellow peel is removed with a sharp knife. Dried lemon peel is spiral, 20 cm long, 1.5 wide, 2-3 mm thick, outer surface is rough and yellow, inner surface is pithy and white. Odour is strong and aromatic, taste is aromatic and bitter.

Chemical Constituents : Lemon peel contains volatile oil (2.5%), vitmain C, hesperidin and other flavone glycosides, mucilage, pectin, and calcium oxalate. The important constituents of the volatile oil are limonene (90%), citronellal, geranyl acetate, α-pinene, camphene, linalool, terpineol, methyl heptenone, octyl and nonyl aldehydes, etc.

Uses : Lemon peel is stomachic and carminative. It is used as a flavouring agent in medicine, also in beverages, confectionery, and cooking.

BITTER ORANGE PEEL

Synonyms : Fructus Aurantii; Seville Orange.

Biological Source : Bitter orange peel is the dried rind of nearly ripe fruit of *Citrus aurantium* var. *amara* L. and *C. aurantium* var. *sinensis L.*

Family : Rutaceae.

Geographical Source : Bitter orange is native of India. It is grown near Mediterranean Sea, Spain, West Indies, Florida, California, Sicily, Malta, etc.

Collection : Fruits are collected when they are about to ripe. The peel is removed in four 'quarters' or in a spiral band.

Characters : The bitter orange peel is spiral or irregular ribbons, 2-6 mm thick, brittle and hard, breadth is 6-12 mm. Outer surface is dark orange red, rough due to raising over oil glands, various small pits and reticulate ridges. Inner surface is yellowish white, pithy, fracture is hard and short. Odour is aromatic and taste is aromatic and bitter.

Chemical Constituents : Bitter orange peel contains volatile oil (1-2.5%), vitamin C, flavonoid glycosides hesperidine (vitamin P-factor), neohesperidine, naringin, aurantiamaric acid, aurantiamarin (1.5-2.5%); acrid resin, gum and tannin. The bitter taste of the peel is due to the presence of flavonoids aurantiamarin, aurantiamaric acid, naringin, hesperidine and isohesperidine. The dominant component of the volatile oil is limonene (90%) in addition to citral, citronellal and methyl anthranilate.

Chemical Test : Concentrated hydrochloric acid is put on a thick section of the drug. A dark green colour is obtained. This test is absent is sweet orange peel.

Uses : Bitter orange peel is used as flavouring agent, stomachic, and carminative.

SWEET ORANGE PEEL

Biological Source : Sweet orange peel is the fresh rind of fruit of *Citrus aurantium* L. var. *sinensis* (Fam. Rutaceae). The plant is about 8 m in height, and found where the bitter orange grows.

Chemical Constituents : The volatile oil of sweet orange peel contains limonene (90%), citral (5%), methyl anthranilate, decyclic aldehyde, linalool, terpineol, etc. Other constituents isolated from the peel are flavonoids aurantin, hesperidine, 5-hydroxyaurantin and 5-O-desmethyl nobiletin.

Uses : The peel is aromatic and used as carminative, tonic and flavouring agent. Fresh rind is rubbed on the face as remedy for acne.

SAFFRON

Synonyms : Crocus, Spanish Saffron, French Saffron.

Biological Source : Saffron is the dried stigma and style-tops of *Crocus sativus* Linn.

Family : Iridaceae.

Geographical Source : The drug is native of south Europe and is found in Spain, France, Macedonia, Italy, Persia, Austria, China, Germany,Switzerland and Iran. In India the plant is cultivated in Kashmir.

Cultivation and Collection : The plant is small, perennial herb, 6-10 in high. The corms are planted in July-August in well-prepared soil. In the following year flowering takes place. Each corm is replaced by daughter corms. The flowers are collected early in the morning. The style of each flower is separated just below the stigma and dried by artificial heat for 30-45 minutes. The drug is cooled and stored in dry place. About 1 kg of drug is collected from nearly 100,000 flowers.

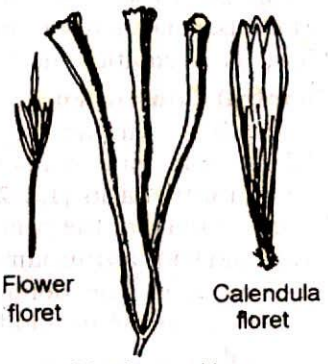


Fig. 10.9. Saffron

Saffron thrives well in cold regions with warm or sub-tropical climate. It requires a rich, well-drained, sandy or loamy soil. The plant is propagated by bulbs. No manure is applied or irrigation given once the plants are established. The bulbs continue to live for 10 or 15 years, new bulbs being produced annually and the old ones rotting away.

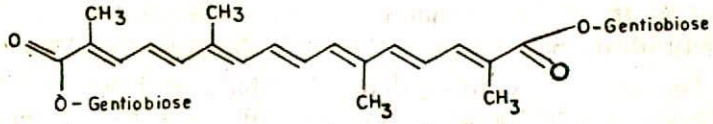
The plants flower in October-December. Heavy rains during this period are harmful. Styles and stigmas are

separated and dried in the sun or over low heat on sieves in earthen pots.

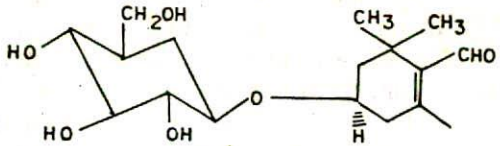
The tripartite stigmas plucked from freshly collected flowers and dried in the sun constitute Saffron of the best quality.

Characters : Saffron is flattish-tubular, almost thread like stigmas which are about 3 cm long with slender funnel having dentate or fimbricate rim. Colour is reddish-brown with some yellowish pieces of tops of styles. Odour is strong, peculiar and aromatic; taste is aromatic and bitter.

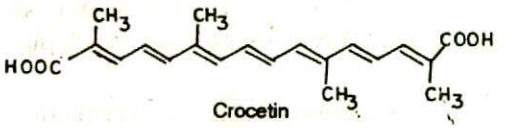
Chemical Constituents : Saffron possesses a number of carotenoid coloured compounds such as ester of crocin (a coloured glycoside), picrocrocin (a colourless bitter glycoside), crocetin (an aromatic compound), gentiobiose, α-and γ-carotenes, crocin-2, crocin-3, lycopene, zeaxanthin and crocin-4. Picrocrocin is made of Safranal (aldehyde) and glucose. The drug contains volatile oil (1.3%), fixed oil and wax. Crocin is the chief colouring principle in Saffron. On hydrolysis it yields, digentiobiose and the carotenoid pigment crocetin. The colourless glycoside, picrocrocin, gives on hydrolysis, glucose and the aldehyde, safranal. Stearoptene (m.p. 106°) has been isolated from the essential oil.



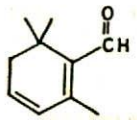
Crocin



Prcrocrocin



Crocetin



Safranal

About 34 more components, especially terpenes, terpene alcohols and esters, have been identified in the essential oil.

Uses : Saffron is used in fevers, cold, melancholia and enlargement of the liver; as colouring and favouring agent, catarrhal, snake bite, cosmetics and pharmaceutical preparation and as spice. Saffron has stimulant, stomachic,

tonic, aphrodisiac, emmenagogue, sedative and spasmolytic properties. Saffron has been employed as an abortifacient.

Adulterant : Saffron is frequently adulterated with styles, anthers and parts of carolla of Saffron. Exhausted Saffron, flowers and floral parts of some *Compositae* like *Calendula* species and *Carthamus tinctorius*, corn silk, and various materials coloured with coal tar dyes, are also used as adulterants. Water, oil or glycerine is added to increase the weight. Coke Saffron of commerce often contains safflower florets with adhesive sugary substances.

CAMPHOR

Synonyms : 2-Bornanone, 2-Comphanone, Gum Camphor, Japan Camphor.

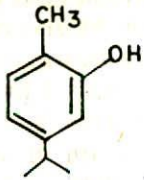
Biological Source : Camphor is a solid ketone obtained from the volatile oil of *Cinnamomum camphora* (L.) Nees et Eber.

Family : Lauraceae.

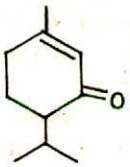
Geographical Source : The plant is a big tree native to Eastern Asia. It is found widely in Mediterranean region, Sri Lanka, Egypt, South Africa, Java, Sumatra, Brazil, Jamaica, Florida, Formosa, Japan, South China and California. In India the tree is planted in some gardens up to 1300 meters height in the N. W. Himalayas. It is successfully cultivated at Dehradun, Saharanpur, Calcutta, Nilgiris and Mysore.

The plant is cultivated at elevations of 1,500 - 2,000 m provided the temperature does not full below 15°F. A fertile, well-drained, sandy loam is needed for its successful cultivation. Manuring is recommended. The plants can be raised from seeds, layers, branch cuttings, roots cuttings, and root-suckers. For obtaining good seeds, ripe fruits should be collected directly from the tree. Seed should be sown immediately after collection. Germination takes place in about 3 months after sowing. Careful weeding is necessary. Six months after germination, the seedlings are transplanted into seeds baskets.

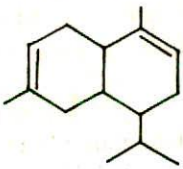
Preparation : Old trees possess high concentration of Camphor. The small wood chips are treated with steam. Camphor is sublimed and liquid volatile oil passed away into the receiver. Excess of Camphor is obtained from the volatile oil. Camphor is purified by treating it with lime and charcoal and resublimation into large chambers. The collected Camphor is made into blocks by hydraulic pressure.



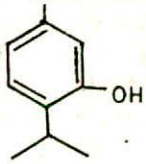
Carvacrol



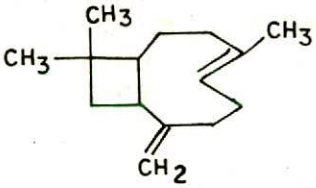
Piperitone



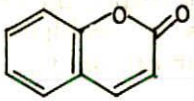
β-Cadinene



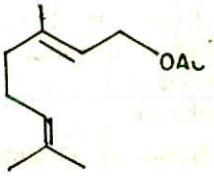
Thymol



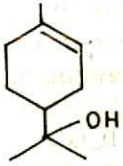
Caryophyllene



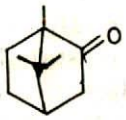
Coumarin



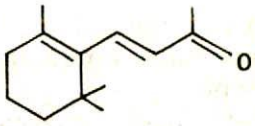
Geranyl acetate



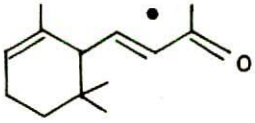
α-Terpineol



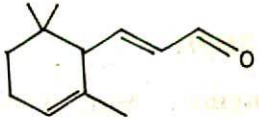
Camphor



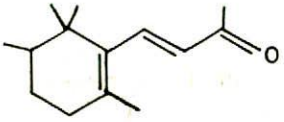
α-Ionone



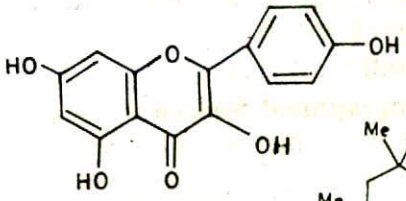
β-Ionone



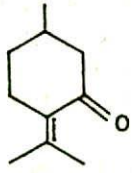
α-Irone



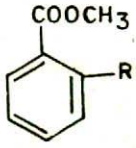
β-Irone



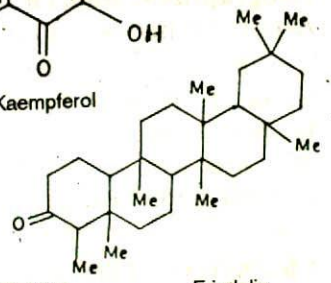
Kaempferol



Pulegone



Methyl anthranilate (R=NH_2)
Methyl salicylate (R=OH)



Friedelin

Characters : Natural Camphor is colourless translucent mass with crystalline fracture, rhombohedral crystals from alcohol, cubic crystals by melting and chilling. Odour is characteristic and taste is pungent and aromatic which is followed by cold sensation. It evaporates at room temperature and pressure, m.p. 180°, very volatile in steam. At 25°, one gram dissolves in about 800 ml water (giving a colloidal solution), in 1 ml alcohol, 1 ml ether, 0.5 ml chloroform, 0.4 ml benzene, 0.4 ml acetone, 1.5 ml of turpentine oil, and 0.5 ml glacial acetic acid. Camphor has a peculiar tenacity and cannot be powdered in a mortar unless it is moistened with an organic solvent.

Chemical Constituents : Comphor oil contains camphor, cineol, aldehyde, pinene, camphene, phellandrene, limonene and diterpenes. Camphor is entirely a monoterpenic ketone, $C_{10}H_{16}O$. Its basic carbon framework is related to borneol.

Uses : Camphor is used externally as a rubefacient, counter-irritant and internally as a stimulant, carminative, and antiseptic. It is a topical antipruritic and anti-infective, used as 1-3% in skin medicaments and in cosmetic. It is also used to manufacture some plastics, in lacquers, varnishes, explosives, pyrotechnics, as moth repellent and in embalming fluids.

SPEARMINT

Synonyms : Mint, Pudina (Hindi).

Biological Source : Spearmint consists of the dried leaf and flower tops of *Mentha spicata* L. (*M. viridis* L.) or *M. cardiata.* Gerard ex. Baker.

Family : Labiatae.

Geographical Source : The plant is found in European and Asian countries and widely cultivated in U.S.A.

Mentha is widely cultivated throughout the plains of India. It thrives best in heavy loams well supplied with farmyard manure. It is usually propagated by planting divisions of old plants in rows 30 cm apart. The field is weeded and watered during dry weather. The plants produce leaves for a number of years.

Characters : Mint is a glabrous herb identical to peppermint, 30-90 cm high, with creeping rhizomes, but the stems are usually more purple, leaves are more or less crumpled,

opposite, ovate-lanceolate, 3-7 cm long. The apex is acute or acuminate, and the margin unequally serrate. The leaves are almost sessile with bright green colour free from purple. Inflorescence is slender, interrupted cylindrical spikes or crowded lanceolate spikes with 7-10 mm long bracts. Odour and taste are aromatic and characteristic without any cooling sensation.

Chemical Constituents : Spearmint contains volatile oil (0.5%), resin and tannin. The principal component is carvone (50-55%) along with some other monoterpenic constituents like limonene, phellandrene, dipentene, dihydrocarveol, dihydrocarveol acetate, cineol, α-pinene, linalool, etc.

Uses : Spearmint is used as flavouring agent, spice and carminative. It has stimulant, digestive, spasmolytic and diuretic properties. It is given in fever, vomiting and bronchitis and employed as a lotion in aphthae.

Green leaves are used for making chutney and for flavouring clinary preparations, vinegar, jellies and cold drinks.

A soothing tea is brewed from the leaves. A sweetened infusion of the herb is given as a remedy for infantile troubles, vomiting in pregnancy and hysteria.

BUCHU LEAVES

Synonyms : Bucco; Bucku; Buku; Folia Buchu.

Biological Source : Buchu is the dried leaf of *Barosma betulina* Barti & Wendl (short or round Buchu) or of *B. crenulata* (L.) Hook. (oval Buchu) or of *B. serratifolia* Willd (long Buchu).

Family : Rutaceae.

Geographical Source : South Africa

Characters : Leaves of *B. betulina* are 12-20 mm long, 4-5 mm broad, rhomboid-ovate in shape, with a blunt and recurved apex. The margin is dentate towards upper side and serrate towards the base. Dried leaves are brittle and coriaceous. Odour and taste are strong and characteristic.



Fig. 10.10. Buchu Leaf of *Barosma betulina*

Chemical Constituents : Buchu leaves contain volatile oil

(30%), diosmin (flavonoid), mucilage, resin and calcium oxalate. The important constituent of the oil is a phenolic camphor, diosphenol (buchu camphor), d-limonene, dipentene, 1-menthone and p-menthane-8-thio-3-one. Diosmin on hydrolysis yielded diosmetin, glucose and rhamnose.

Uses : Buchu is used as a urinary antiseptic, diuretic and carminative.

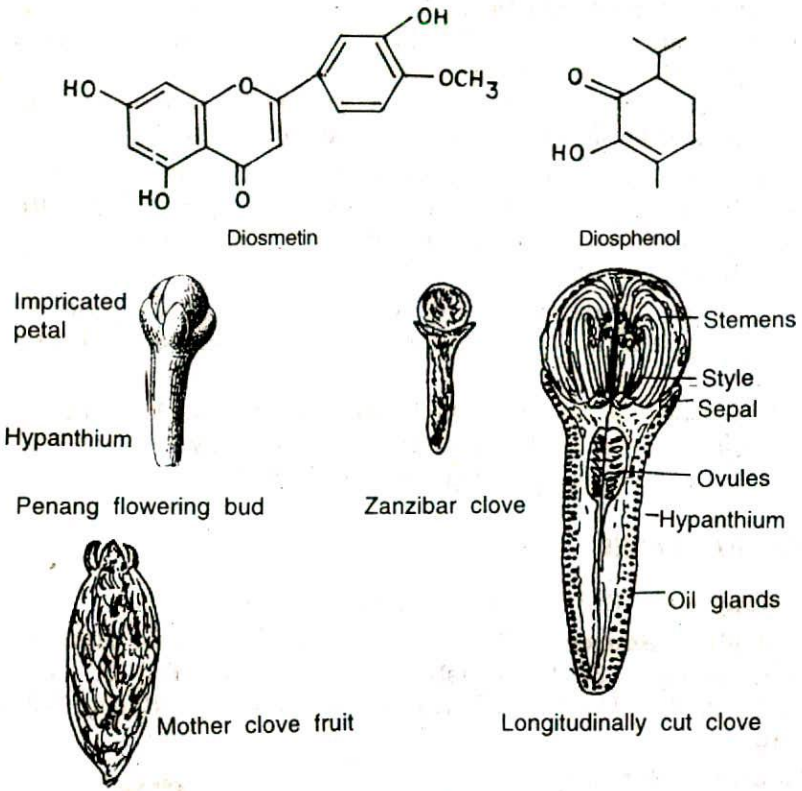


Fig. 10.11. Clove

CLOVE

Synonyms : Caryophyllus, Clove buds, Caryophyllum; Caryophylli; Laung (Hindi).

Biological Source : Cloves are the dried flower buds of *Eugenia caryophyllus* Bull. et Harri. (Syn. *Syzygium aromaticum* (L.) Merr.

Family : Myrtaceae.

Geographical Source : The clove tree is native of Molucca Island. It is cultivated in Zanzibar, Sumatra, South America, West Indies, Zanzibar, Brazil, Pemba, Ambon, Madagascar, Mauritius and South India.

Cultivation : Clove is pyramidal or conical evergreen plant, 10-20 meters in height, grown in well-drained soil. The plant is propagated from seeds sown during August-October. Dehusked seeds are immediately sown, as their viability deteriorates rapidly. Ripe fruits may be sown without removing the skin, but the germination is poor. Germination takes place in 4-5 weeks. Seedlings are transplanted when they attain a height of about 25 cm during rainy season.

It requires moist, warm and equable climate and suitable rainfall. The plants are protected from pests, diseases and direct sunlight. When seedlings are 9 months old, they attend the height of about 1 meter and then transplanted at a distance of 6 meters in the beginning of rainy season. The plants are shaded by banana planting up to 3 years.

Collections : Flower buds are collected when their base turns into crimson-red in colour in dry weather from August to December. Natives climb on the tree or put ladder for the collection. The cloves are dried in open air and their stalks are separated. On drying about 70% water is lost. Dried cloves are graded according to size, packed into bales and exported.

Morphology : Cloves are reddish-brown, 1-1.7 cm long, consisted of lower solid stalk called hypanthium and upper crown or cap. Hypanthium is swelling, subcylindrical, slightly flattened, tapering below, 10-13 mm long, 4 m wide and 2 mm thick. A bilocular ovary containing numerous ovules attached to axile placentae is present above the stalk. Various schizolysigenous oil glands are present in the hypodermis.

The crown consists of calyx, corolla, stamens and style. Calyx contains four slightly projecting teeth. Corolla is dome-shaped, which is made of four pale yellow-coloured, imbricate, immature, membraneous petals. Many free, introse and tetradelphous stamens are enclosed in the crown.

Ovary contains numerous ovules with axile placentation. A single, erect, firm style reaching up to corolla is present. A nectar-disc (nectary) is present at the base.

Clove has a strong fragrant and spicy odour and pungent, aromatic taste.

Chemical Constituents : Clove contains volatile oil (14-21%), tannins (10-13%), triterpenic acids (e.g. oleanolic acid) and esters, glucosides of sitosterol, stigmasterol and campestrol, vanillin, chromone, eugenin, gum and resin. The important chemical constituents of the volatile oil are eugenol (85-90), acetyl eugenol (3%), α- and β-caryophyllenes, methyl amyl ketone, methyl furfural, dimethyl furfural, carbinol, vanillin and methyl-n-heptyl ketone. Eugenol is a colourless or pale yellow liquid, b.p. 255°. It becomes dark and thick on exposure to air. It has the odour of cloves and spicy, pungent taste. Other substances present in traces are methyl salicylate, methyl benzoate, methyl alcohol, benzyl alcohol, furfuryl alcohol, furfural, methyl furfuryl alcohol, β-pinene, 2-heptanol and 2-nonanol.

Uses : Clove has antiseptic, aromatic, carminative and stimulant action. It is used in flatulence, dyspepsia, throat infection, baking, confections and as flavouring agent. Clove oil is used in toothache, dental preparation and in mouth washes.

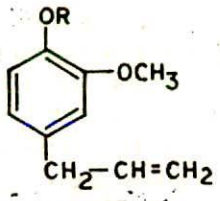
Chemical Tests

1. Treatment of hypanthium of Clove or clove oil with potassium hydroxide solution (50%) forms needle-shaped crystals of potassium eugenate.
2. To clove oil (1 ml) in alcohol (5 ml) add $FeCl_3$ solution (1 ml). The solution turns blue due the presence of phenolic hydroxyl group.
3. Add $FeCl_3$ solution to aqueous extract of Clove. Blue-black colour is formed due to the presence of tannins.

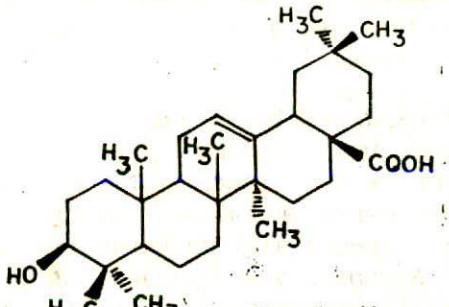
Adulterants

1. **Exhausted Clove** : Exhausted cloves are oilless, darker in colour, more shrunken, and float on water surface. The volatile oil is removed by distillation.
2. **Clove Stalks** : Clove stalks are subcylindrical, longitudinally wrinkled, jointed, sometimes branching, brown, and less aromatic than Clove. They contain 4-7% of volatile oil.

   During collection buds are collected along with stalks and some stalks remain attached to the buds after separation. Clove stalks contain calcium oxalate and stone cells which are not present in clove buds.

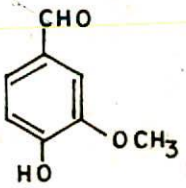


Eugenol (R=H)
Acetyl eugenol (R-$COCH_3$)

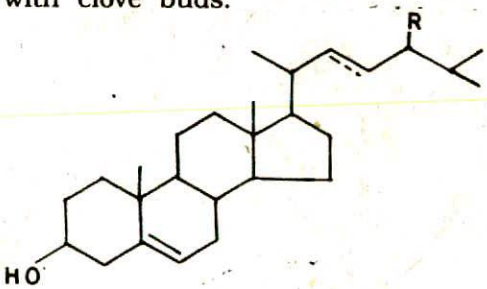


Oleanolic acid

3. **Clove Fruits :** Clove fruits are ripened fruits, about 2 cm long, ovate and tapering below, dark brown in colour with rough outer surface. Each fruit possesses a single firm seeds. It is slightly aromatic and contains starch. Small amount of volatile oil is present in the Clove fruit and adulterated with clove buds.



Vanillin



Campesterol (R=Me)
Sitosterol (R=Et)
Stigmasterol (R=Et, $\Delta^{22,23}$)

NUTMEG

Synonyms : Jaiphal; Jayepatri; Myristica; Nux moschata; Nuces (Semen) nucistae; Myristicae semina.

Biological Source : Nutmeg is the dried, ripe seed of *Myristica fragrans* Houtt deprived of its seed coat and with or without a thin coating of lime.

Family : Myristicaceae.

Natural Distribution : The plant is native of eastern Moluccas Island near Indonesia. Now it is cultivated in Malay, Sumatra, Java, Sri Lanka, West Indies and other tropical countries. In India it is found only as a specimen tree in southern region.

Cultivation and Collection : Nutmeg is a dioecious or occasionally monoecious evergreen aromatic tree, usually 9-20 m high. It is grown from fresh seeds which are germinated in about one month. The 6-months old plants are transplanted to the fields. Fruiting begins on 8-9 years old trees and continues up to 20-30 years. Fruits are 5-7 cm long, 4-5 cm wide, light yellow, drupaceous, ovoid, peach-like berries, and dehisce longitudinally when ripe. The seeds are exposed with its lobed, red arillus. Fruits are collected in November and December or in April-June. The seeds are dried in oven by keeping them in trays. The testa is separated with the help of a wooden mallet or special machine and the Nutmeg is extracted. After cracking, the Nutmeg are graded according to size and external appearance and exported in barrels.

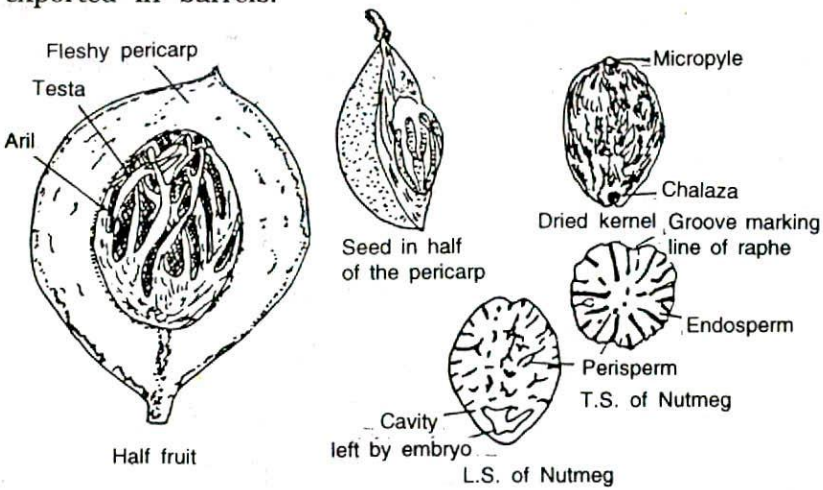


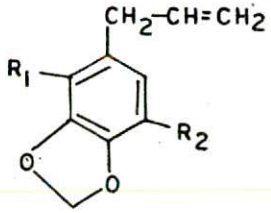
Fig. 10.12 Nutmeg

Morphology : The kernels consist of perisperm, endosperm and embryo. They are 2-3 cm long and about 2 cm in breadth. Shape is ovoid. Outer surface is rough, dark-brown with reticulate furrows. At one end there is a small projection. Micropyle and hilum are present near the projection. The hilum is surrounded by a raised ring. From hilum light furrow runs to chalaza which indicates the position of raphe. The odour is strong and aromatic, taste is pungent and slightly bitter.

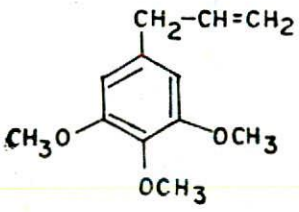
Chemical Constituents : Nutmegs contain volatile oil (5-10%), fat or nutmeg butter (30-40%), proteins, phytosterin,

starch, amylodextrin and colouring matter. The important constituents of volatile oil are myristicin, elemicin, eugenol, p-cymene and isoeugenol. The myristicin fraction of the volatile oil together with elemicin (>25%) is supposed to be responsible for the signified hallucinogenic properties of Nutmeg seed. Nutmegs contain 15% free myristic acid. Neolignans, polyphenols, tannins, epicatechin, cyanidin, thiamine, riboflavin and niacin have also been reported in Nutmegs.

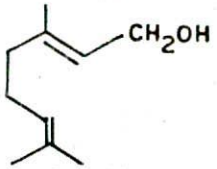
Uses : Nutmegs are carminative, astringent, aphrodisiac, and stomachic useful in flatulency, nausea and vomiting and as a source of myristica oil. The essential oil from *M. fragrans* showed antibacterial activity. Ingestion of large quantities causes drowsiness, stupor and death.



Safrol (R_1=R_2=H)
Myristicin (R_1=H, R_2=OCH_3)
Apiole (R_1=R_2=OCH_3)

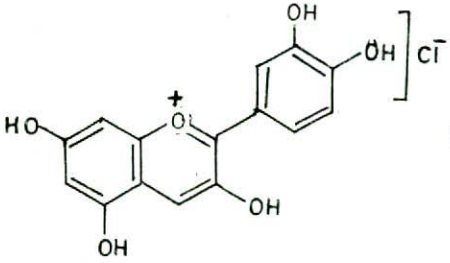


Elemicin

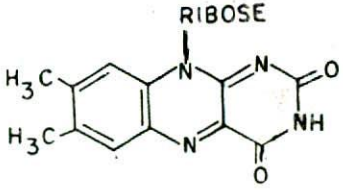


Geraniol

CH_3-$(CH_2)_{12}$-COOH
Myristric acid



Cyanidine chloride



Riboflavine

CALAMUS

Synonyms : Sweetflag; Bach (Hindi); Calamus rhizome; Vaj, Godavaj; Rhizoma Acori Calami.

Biological Source : Dried peeled or unpeeled rhizomes of *Acorus calamus* Linn. are called Calamus (Family Araceae).

Giographical Source : The plant widely occurs in Asia, Europe and North America. It is found throughout India and Sri Lanka.

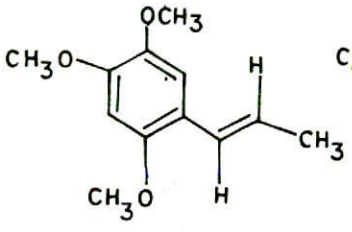
As a semi-aquatic, perennial, erect, aromatic herb with creeping rhizomes, it grows wild and also is cultivated. Rhizomes are horizontal, joined, somewhat vertically compressed.

The plant is grown in clayey loams and light alluvial soils of river banks. The field is irrigated and ploughed with green manure before planting. The crop is ready for harvest in about a year. The plants are dug out, rhizomes removed and the tops kept for the next planting. The rhizomes are cut into pieces of 5-8 cm and all fibrous roots are removed. The pieces are washed thoroughly and dried in the sun. The dried material is put into rough gunny bags and rubbed to remove the leafy scales.

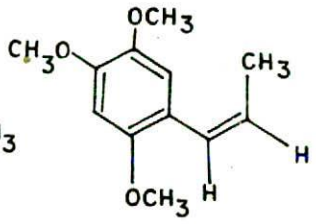
Morphology : The subcylindrical rhizome is up to 20 cm long and 2 cm in diameter, longitudinally furrowed on the upper surface with root scars on the lower surface.

Chemical Constituents : Calamus contains volatile oil (2-4%) from which α-asarone, β-asarone, calamene, calamenol and calamenone have been identified. Glucoside acorin has also been reported in the rhizome. Other constituents of Calamus oil are methyl eugenol, eugenol, α-pinene and camphene. The presence of small amounts of palmitic, heptylic and butyric acids, asaronaldehyde, calamol, calamone and azulene has also been reported. Sesquiterpenic ketones like acorone, calarene, calacone, calacorene, acrorenone, acolamone, isoacolamone, epishyobunone, shyobunone, isoshyobunone and acoragermacrone and alcohols like isocalamendiol and preisocalamendiol are also present. The hydrocarbons present in the oil are elemene, caryophyllene, calamenene, cadalene and humulene.

Uses : Calamus is nauseant, aromatic, antispasmotic, nervine stimulant, expectorant, carminative, emetic, stomachic, sedative drug and used in dyspepsia, colic,intermittent fevers, nervine tonic, in bronchitis, dysentery of children, insectifuge, in snake-bite, mental ailments, diarrhoea, bronchial catarrh, glandular tumors, and anthelmintic.



α-Asarone



β-Asarone

They are employed for kidney and liver troubles, rheumatism, and eczema. The rhizomes are used in the form of powder, balms, enemas and pills.

Calamus oil is credited with carminative, anti-spasmodic and antibacterial properties. Asarone is a mild sedative, tranquillizer and hypotensive substance. The powdered rhizome is used as an insecticide for the destruction of fleas, bedbugs, moths, lice, etc.

Substitution : They are sometimes substituted for the rhizomes of *Alpinia galanga* (Bach) and *Aconitum* species (Bish).



Fig. 10.13. *Acorus calamus*

EUCALYPTUS OIL

Synonyms : Gum wood oil; Australian fever tree oil; Blue-gum tree oil.

Biological Source : Eucalyptus oil is a volatile oil obtained by steam distillation of the fresh leaves of various species of *Eucalyptus* such as *E. globulus* Labill, *E. polybractea*, *E. smithii*, *E. viminalis*, and *E. australiana*. It contains not less than 65% of caneole.

Family : Myrtaceae.

Habitat : *E. globulus* is a native of Australia and Tasmania. Now it is cultivated in South France, Spain, Portugal, Brazil, Zaire and India (Nilgiri hills).

E. globulus is a large tree attaining a height of 100 m or more with a clean straight bole under forest conditions.

It grows well in Nilgiris (1,700-2,700 m), Annamalai and Palni hills in South India. A cool, moist, equitable climate and deep fertile soil, which is not calcareous or saline, are favourable for the growth of *E. globulus*. It is propagated by seeds.

Morphology : In *E. globulus* leaves are bifacial, lanceolate, scythe-shaped, glabrous, sessile, thin and wax-coated. A coating of wax is present over the thin cuticle, stomata of ranunculaceous type are present on the lower surface and few round internal oil glands are present. Prismatic and rosette type crystals of calcum oxalate are present.

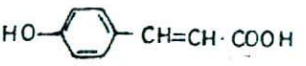


Fig. 10.14. Eucalyptus leaf

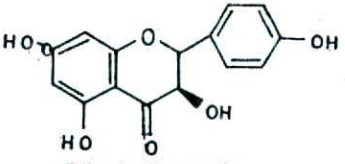
E. rostrata leaves are bifacial, lanceolar, sickle-shaped, coriaceous, petiolate, glaucous, ovate with distinct venation. Cuticle is papillate, stomata are of ranunculaceous type found on the both surfaces; many oil glands are present and also rosette crystals.

In *E. viminalis*, leaves are bifacial, elongated or falcate-lanceolate, glabrous, glaucous and sessile. Thick cuticle with minute papilla in upper and marked in lower surface is present; stomata are ranunculaceous present on both surfaces and oil glands are also present. Both types of crystals, prismatic and rosette, are present.

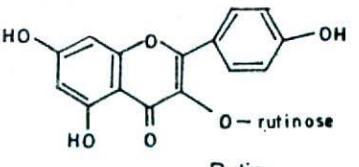
Chemical Constituents : Eucalyptus contains volatile oil (3-6%), resins, tannic acids, dihydroflavanol, aromadendrin-7-



p-Coumaric acid



Dihydroflavanol



Rutin

methyl ether, p-coumaric acid, cinnamic acid, eucalyptic acid and rutin.

Eucalyptus oil is a colourless or pale yellow liquid having a typical, aromatic, camphor-like odour and pungent, spicy cooling taste. The oil contains cineole (70-85%) as the predominent compound. Other components identified in the oil are pinene, camphene, butyric aldehyde, valerenic aldehyde, caproic aldehyde, aromadendrene, cuminaldehyde, pinocarveol, and phellandrene.

Uses : Eucalyptus oil is antiseptic, disinfectant, diuretic, diaphoretic, expectorant, and flavouring agent. It is used in infections of the upper respiratory tract, malaria, certain skin diseases, in ointment for burns and as mosquito repellant. Internally, it is used as a stimulating expectorant in chronic bronchitis and asthma. Eucalyptus increases the flow of saliva, gastric and intestinal juices and thus increases appetite and digestion. It increases the rate of heart beats, lowers the arterial tension and quickens respiration. In toxic doses it is a narcotic poison. It paralyses the respiratory centre in the medulla. Oil obtained from Indian species does not contain butyric and valerinic aldehydes; it is less likely to produce cough and other unpleasant side effects. Mixed with an equal amount of olive oil, it is useful as a rubefacient for rheumatism.

CHENOPODIUM OIL

Synonyms : American Wormseed oil, Mexican Tea oil, Spanish Tea oil, Jerusalem Tea oil, Ambrosia oil.

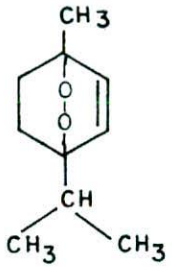
Biological Source : Chenopodium oil is the essential oil collected by steam distillation of fresh aerial parts of *Chenopodium ambrosioides* L. variety *anthelminticum*.

Family : Chenopodiaceae.

Habitat : Chenopodium plant is an erect, much-branched aromatic herb with glandular hairs, about 30-60 cm in height commonly found in eastern USA and cultivated in Maryland, Carroll Country and South India. It is indigenous to the West Indies. The oil is formed in glandular hairs occurring on the leaves, flowers, and fruits but it is found in excess on pericarp and ovary.

Chemical Constituents : Chenopodium contains volatile oil (1-4%) which is light yellow in colour with a characteristic

unpleasant odour and a bitter burning taste. The chief active constituent of the oil is ascaridol (70%) which is an unsaturated terpene peroxide. It explodes on heating or on treating with certain acids. Other constituents of the oil are limonene, myrcene, methyl salicylate, pinene, p-cymene, l-limonene and d-camphor.



Ascaridol

Uses : Chenopodium oil is an anthelmintic, particularly for roundworms, hookworms and intestinal amoebae. It is generally used in veterinary practice.

CARDAMOM

Synonyms : Grains of Paradise, Cardamom Fruit, Ilayachi (Hindi).

Biological Source : Cardamom consists of the dried ripe seeds of *Elettaria cardamomum* Maton var. *minuscula.*

Family : Zingiberaceae.

Geographical Source : Cardamom is cultivated in Sri Lanka, south India (Mysore and Kerala) and Guatemala.

Cultivation : Plant is reedlike 3-4 meters high herbaceous perennial herb. Seeds are planted in nurseries. After one year the young seedlings are transplanted in fields. Fruits are developed on 3-4 years old plants. The nearly ripe capsules, when their colour turns from green to yellow, are collected, washed to remove sand and dried quickly to get green Cardamom. Bleaching takes place when the fruits are dried for longer time in sunlight or by placing trays of the fruits over burning sulphur. Stalk, calyx and split fruits are removed and graded according to size and quality.


A. Mysore B. Mangalore C. Cochin D. Wild

Fig. 10.15. Cardamom fruits

Morphology : The Cardamom fruit is an inferior, ovoid or oblong, trilocular capsule, 1-2 cm long, apex is beak-shaped, base is rounded with remains of stalk, surface is longitudinally striated, and colour is light green. In each cell there is a double row of seeds attached to axial placenta. The seeds are up to 4 mm in length, irregularly angular, dark reddish brown and wrinkled surface. The odour is aromatic and taste is aromatic, pleasant and somewhat pungent.

Chemical Constituents : Cardamom contains volatile oil (3-8%), resin, fixed oil (1-2%), starch and calcium oxalate. The essential oil possesses eucalyptol (cineole) (50%), borneol, sabinene, terpineol and its acetate, limonene, terpinene, 1-terpinen-4-ol and its formate and acetate and dipentene. The fixed oil consists of the glycerides of oleic, stearic, linoleic, palmitic, caprylic and caproic acids. The unsaponifiable matter from the fixed oil contains β-sitosterol. The seeds contain vitamin B_1.

Uses : Cardamom is aromatic, stimulant, stomachic, carminative, diuretic and used as flavouring agent for pharmeceutical syrups, curries and cake and for preparation of Compound Cardamom Tincture.

Allied Drug

1. ***Elettaria cardamomum* var. major :** This species is the source of the long wild native Cardamom of Sri Lanka. They are 4 cm long, pericarp is dark brown and coarsely striated. Its volatile oil is used in liquors.
2. ***Amomum aromaticum* and *A. subulatum* :** *A. aromaticum* is obtained from Bengal and Assam and known as Bengal Cardamom. *A. subulatum* is obtained from Nepal, Bengal, Sikkim and Assam and known as Nepal or Greater Cardamom.

Malabar Cardamom is characterized by a short leafy shoot, 3 m in height, the fruit shape is roundish or elongated, smaller than the Mysore Cardamom.

Mysore Cardamom is a robust with leafy steam, up to 5 m high. Mysore Cardamom fruits are elongated, 1-2 inch long, yellowish green when ripe, slightly arched and darkish brown when dry; seeds are numerous, large and less aromatic. Ceylon Cardamom is also a robust variety with shorter pinkish stems and broader leaves.

Adulteration : Cardamom fruits are often adulterated with orange seeds and unroasted coffee grains. The adulterants of seeds are small pebbles and seeds of *Amomum* spp. Powdered seeds are adulterated with the powder of hulls.

VALERIAN

Synonyms : Valeriana; Valerian rhizome; Valerian root; European Valerian; Rhizoma Valerianae.

Biological Source : Valerian is the dried roots, rhizome and stolons of *Valeriana officinalis* L.

Family : Valerianaceae.

Habitat : England, Holland, Germany, France, Belgium, Japan, eastern U.S.A. and India (Kashmir).

Collection : Valerian is about 1 meter high glabrous and perennial herb. Valerian grows well in all ordinary soils, but prefers a rich and heavy loam with moisture. It is often found to flourish in damp and shady places. The plant is propagated by portions of the old rootstocks or from the seeds. The nursery - raised seedlings are first transplanted at a spacing of 18-20 cm in rows. Early in the spring, the seedings may be re-transplanted to their permanent sites at the same spacing. Application of farmyard manure favours the growth of the plants and roots.

The rhizomes and roots of the plants are harvested in the autumn, though the yield is low. The bud-raised plants do not attain a suitable size up to second year. Their tops are cut at the ground-level before the rhizomes are dug up. The rhizomes and roots are thoroughly washed, dried in the sun and the longer rhizomes are longitudinally cut into pieces and the drug is dried below 40°. Fresh drug is odourless but dried drug becomes darker in colour and develops a typical smell of isovaleric acid produced by hydrolysis of borneol isovalerianate which is one of a constituent of the drug.

Morphology : The drug consists of rhizomes, stolons and roots. The rhizomes are 2-4 cm in length and 1-2.5 cm wide. The roots are up to 10 cm in length and 2 mm in diameter, usually matted and broken. Longitudinal slices are also present. Roots are longitudinally striated. The fracture is short and horny. The odour is characteristic valerianaceous and taste is camphoraceous and slightly bitter.

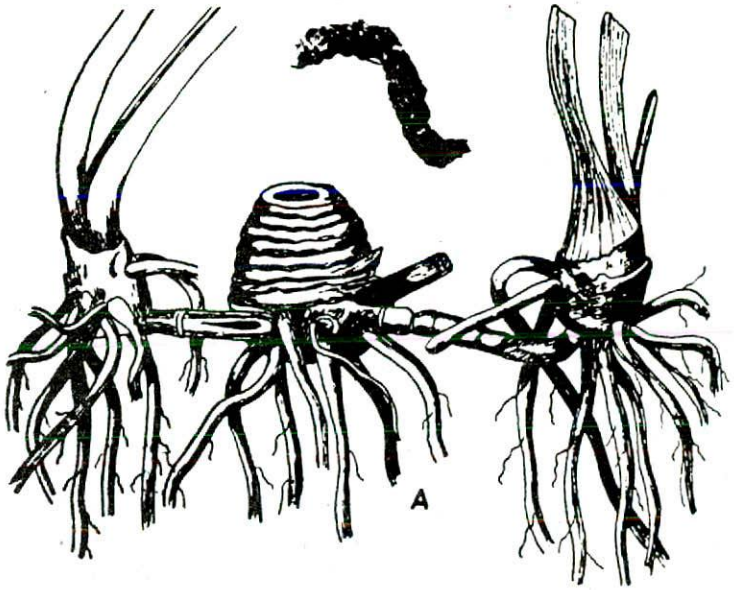
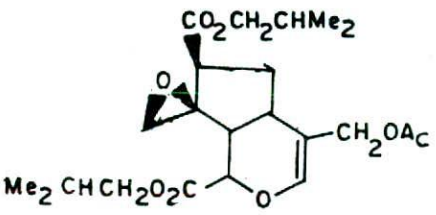


Fig. 10.16. *Valeriana officinalis* - Rootstock with two stolons.

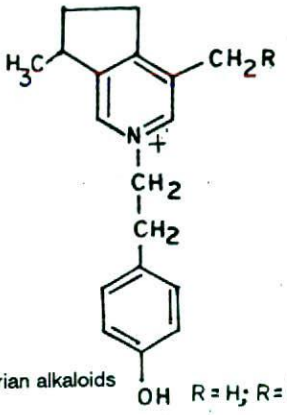
Chemical Constituents : Valerian contains volatile oil (1%), alkaloids (0.05-0.1%) like chatinine, valerine, 2-acetylpyrrol ketone and valerianine; valeric, formic and malic acids, tannins, resin and epoxy-iridoids called as valepotriates (e.g. valtrate, didrovaltrate, acevaltrate, and isovaleroxyhydroxy didrovaltrate). On prolonged storage, hydrolysis of these valepotriates takes place to yield isovaleric acid and activity of the drug is changed. The composition of the valeopotriate mixture differs greatly according to the variety. Valerenic and acetoxyvalerenic acids are the characteristic constituents of the official drug.

Volatile oil contains esters, like bornyl isovalerianate, bornyl acetate, bornyl formate, eugenyl isovalerate, isoeugenyl isovalerate, alcohols, eugenol, terpenes and a sesquiterpene alcohol (valerianol).

Uses : Valerian is carminative, antispasmodic, tranquillizer and sedative and used to cure hysteria, epilepsy, shell shock and neurosis, insomnia, nervous excitement and palpitation of heart. Valepotriates possess mild but definite tranquillizing activity in animals. The drug is also utilized in the perfumery industry, in fevers and for asthenic inflammations.



Valtrate



Valerian alkaloids R = H; R = OH

Allied Drug

Indian Valerian (Syn. Mushkbala or Tagar in Hindi). It consists of the dried rhizome and roots of *Valeriana wallichii* DC. It occurs in temperate Himalayas, from Kashmir to Bhutan and Khasia Hills. It consists of yellow-brown rhizomes, size is 4-8 cm long, about 1 cm thick. The size of roots is variable which may be up to 7 cm in length and 1-2 mm thick.

There is no branching of the rhizome and it is somewhat flattened dorsiventrally. Leaf scars are present on the upper surface while roots or root scars exist on the lower surface. The fracture is short. The odour is valerianaceous and the taste is bitter and camphoraceous. The drug possesses volatile oil (0.3-1.0%) which contains esters of isovalerianic and formic acids. Medicinal properties are similar to *V. officinalis* for which it is a good substitute.

Valepotriates of Valerian have also been isolated from *Centranthus ruber* root (Fam. Valerianaceae).

Japanese valerian or Kesso *(V. angustifolia)* contains about 8% volatile oil which is different from the oil of *V. officinalis*.

GARLIC

Synonyms: Allium; Lasan (Hindi).

Biological Source : Garlic is the ripe bulb of *Allium sativum* Linn. (Family Liliaceae).

Habitat : Garlic occurs in central Asia, Southern Europe, and U.S.A. It is widely cultivated in India.



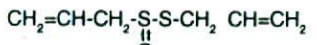
Fig. 10.17. Garlic bulb

Morphology : It is a perennial herb having bulbs with several cloves, enclosed in a silky white or pink membraneous envelop.

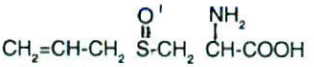
Cultivation : The cultivation of Garlic is similar to that of onion. It is generally grown as an irrigated crop throughout the year. It can be grown under a wide range of climatic conditions but it succeeds best in mild climates without extremes of heat and cold. It is grown on a wide variety of soils. It requires a rich well-drained clay loam to grow well. The land in well ploughed to a fine tilth and beds and channels are made. Garlic is planted during October-November in plains and during February-March in the hills. The cloves are separated and pressed lightly into the soil. Garlic requires heavy manuring.

Chemical Constituents : Allicin, a yellow liquid responsible for the odour of garlic, is the active principle of the drug. It is miscible with alcohol, ether and benzene and decomposes on distilling. The other constituents reported in Garlic are alliin, volatile and fatty oils, mucilage and albumin. Alliin, another active principle, is odourless, crystallized from water-acetone and practically insoluble in absolute alcohol, chloroform, acetone, ether and benzene. Upon cleavage by the specific enzyme alliinase, an odour of garlic develops, and the fission products show antibacterial action similar to allicin. Essential oil (0.06-0.1%) contains allyl propyl disulphide, diallyl disulphide and allicin. γ-Glutamyl peptides are isolated from the Garlic. The amino acids present in the bulb are leucine, methionine, S-propyl-L-cysteine, S-propenyl-L-cysteine, S-methyl cysteine, S-allyl cysteine sulphoxide (alliin), S-ethyl cysteine sulphoxide and S-butyl-cysteine sulphoxide.

Uses : Garlic is carminative, aphrodisiac, expectorant, stimulant and used in fevers, coughs, febrifuge in intermittent fevers, respiratory diseases such as chronic bronchitis, bronchial asthma, whooping cough and tuberculosis. It is also used in atherosclerosis and hypertension.



Allicin



Alliin

PYRETHRUM FLOWERS

Synonyms : Dalmatian insect powder; Persian insect powder, Pyrethrum Insect flowers; Pyrethrum; Flower Heads; Flores pyrethri.

Biological Source : Pyrethrum flowers are the dried flower heads of *Chrysanthemum cinerariaefolium* Visiani or *C. coccineum* Willd. (*C. roseum* Weber et Mohr.) or *C. marschallii* Asch.

Family : Compositae.

Habitat : The plant is indigenous to the Dalmatia (Yugoslavia-Balkans). It is widely grown in Kenya, Japan, Ecuador, Yugoslavia, east central Africa, Brazil, Tanzania, and Zaira. In India the plant is cultivated in Kashmir, Nilgiris and north-west Himalayas.

Cultivation and Collection : Pyrethrum is a 1 meter long glaucous perennial herb with finely cut leaves and numerous flower head. It is cultivated by planting seeds and transplating in calcareous soil. The plant grows better at an altitude of 1900-2700 m (as in Kenya) and annual rainfall of 76-180° cm. Pyrethrum thrives best in a dry climate on well-drained sandy soil. It can grow on mountain slopes and waste lands. Sowing is usually done in spring or in autumn in shade. Before sowing, the seeds are soaked in water, wrapped in cloth, and buried in damp sand. The seeds germinate in 10-15 days and the shading is removed after the shoots appear. The land must be well-drained. Application of excessive nitrogen manures suppresses flowering. The plants flower within one year of transplanting but the yield in poor. The flower heads are gathered when the last florets are about to open. The active principles in over-mature flowers decompose more rapidly than in immature or nearly mature flowers. A low night temperature (5-15°C) stimulates high bud production. Pyrethrum flowers are collected from 2-6 years old plants by hand. The flowers are immediately dried in sunlight or in ovens below

temperature 55°C. Fresh flowers are not toxic to insects. Dried flowers are packed tightly in bales and sent to the market.

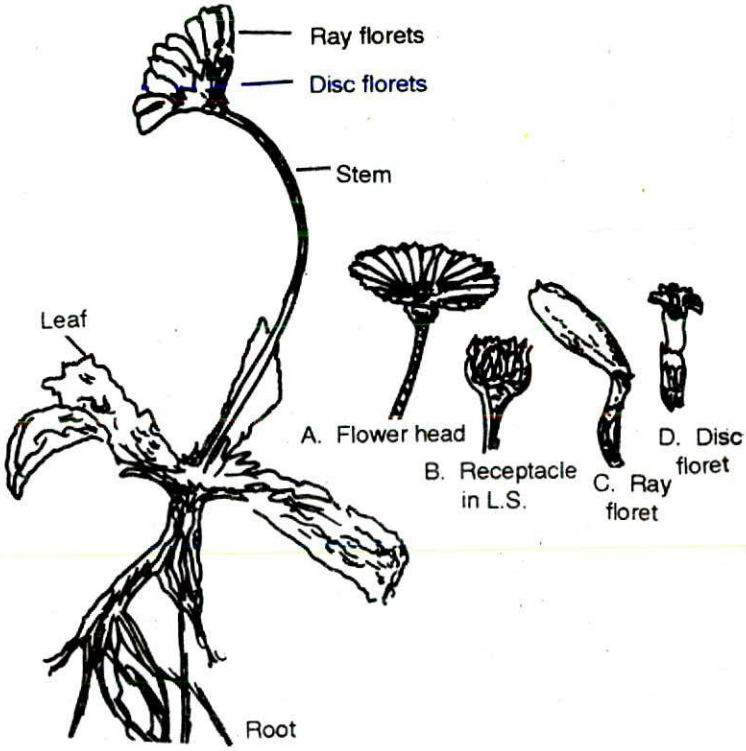


Fig. 10.18 Pyrethrum plant

Morphology : The closed heads of Pyrethrum flowers are nearly 6-9 mm in diameter and open-heads are 9-12 mm in diameter. Peduncle is short, striated longitudinally, receptacle is 4-8 mm in diameter, flat and without paleae, surrounded by an involucre of two or three rows of yellowish or greenish yellow lanceolate, hairy bracts with a membraneous margin. The receptacle contains various tubular florets and a single row of 15 to 23 white, cream or straw-coloured ligulate florets which are 10-20 mm in length and have about 17 veins and three rounded teeth. The central teeth is very small and suppressed. Calyx is tubular and membraneous. Ovary is inferior, achenes are 5-ribbed, style is filiform and stigma is bifid. Calyx and gynaecium in tubular florets are identical to ligulate florets.

The colour is rose-like of ray florets and ten-ribbed fruits. The odour is slightly aromatic and taste is bitter and acrid.

Chemical Constituents : Pyrethrum contains volatile oil (1-1.5%), esters of chrysanthemic acid (chrysanthemum monocarboxylic acid), pyrethric acid (mono-methyl ester of chrysanthemum dicarboxylic acid), sesquiterpene lactones, the triterpene pyrethrol, resin, pyretol, pyrethrotoxic acid, pyrethrosin, chrysanthemine and chrysathemumic acids, chrysanthin, palmitic, caproic, lauric, oleic, isovaleric, protocatechuic and linoleic acids. Choline and stachydrine are also present. Pyrethrin I, jasmolin I and cinerin I are esters of chrysanthemic acid while pyrethrin II, jasmolin II and cinerin II are esters of pyrethric acid. The alcoholic group of the pyrethrins is the keto-alcohol pyrethrolone and that of the cinerins is the keto-alcohol cinerolone. Pyrethrins are readily oxidized and become inactive in air. They are yellowish in colour, insoluble in water, soluble in alcohol, petroleum ether and carbon tetrachloride.

Uses : Pyrethrum flowers and pyrethrins are toxic and insecticidal and used as a contact poison for insects in the form of powder or spray. They can cause severe allergic reactions. Large amounts may cause nausea, vomiting, tinnitus, headache and other CNS disturbances.

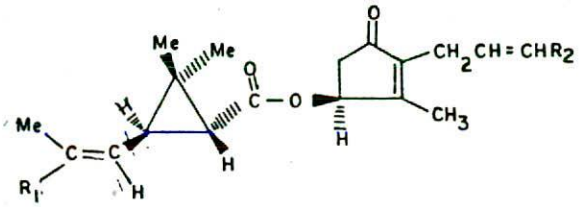
Pyrethrins are practically non-toxic to warm blooded animals when ingested, but if introduced into the blood circulation, they have a marked toxic effect. The principal site of action is the spinal cord. Cases of dermitis and other skin affections are reported.

Pyrethrum is a contact poison, highly toxic to insects. It is used as a livestock spray orgainst parasitic insects.

The efficacy of Pyrethrum compositions against specific organisms is greatly enhanced by certain additives. Sesome oil, sesamin, isosesamin and asarinin are effective activators against house flies. Derivatives of alkanamides, piperic and phthalic acids, and a number of other compounds function as synergists. Pyrethrum is effective as an external application in pediculosis and scabies.

Pyrethrum powder is adulterated with the stem and leaf of the pyrethrum plant, and powdered flowers of other members of *Compositae*, perticularly *C. laucanthemum* Linn. Lead chromate, Turmeric and fustic are used for imparting a yellowish tinge to the powder.

Pyrethrum concentrates should be stored after the addition of antioxidants in sealed containers.



	R_1	R_2
Pyrethrin I	Me	$CH=CH_2$
Jasmolin I	Me	CH_2-CH_3
Cinerin I	Me	CH_3
Pyrethrin II	CO_2Me	$CH=CH_2$
Jasmolin II	CO_2Me	CH_2-CH_3
Cinerin II	CO_2Me	CH_3

SANTONICA

Synonyms : Levant wormweed; Artemisia; Flores cinate; Santonica flowers; Semen cinae; Semen contra.

Biological Source : Santonica consists of the dried unexpanded flower heads of *Artemisia maritima* (Berg) Willkomm.

Family : Compositae.

Habitat : Santonica is found in Turkestan, Pakistan, Iran, Tibet, Nepal and India (from Kashmir to Kumaon) at altitudes of 2,100-2,700 m.

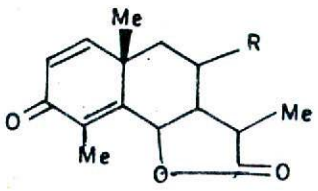
Collection : Santonica is a small decidous perennial shrub with much branched woody rootstalk, up to 100 cm in height. It is distinguished by its short, white-tomentose, 2-pinnatisect leaves with linear segments. Dried close flower heads are 2.4 cm long and nearly 1 mm broad, green. The unexpanded flower heads are collected in July-August and dried quickly.

Artemisias flower at different times in different areas. The age of the individual plant and stage of growth affects

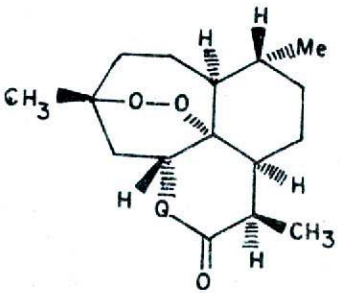
the santonin content. The plants should be harvested during spring and summer both for the luxuriant growth. Stripping the leaves and flower buds directly off the plant by hand is suggested. This enables the plants to put on fresh growth. It is bitter in taste.

Chemical Constituents : Santonica possesses α-santonin (2-4%), volatile oil (2-3%), artemisin,and resin. Santonin is the principal anthelmintic constituent which is a sesquiterpene lactone. Its concentration is maximum in closed flower heads and decreased quickly in mature and developed flower heads. It becomes yellow on exposure to light and is insoluble in water, but slightly soluble in alcohol, ether and chloroform. Indian plant besides santonin contains two more constituents, β-santonin with very weak anthelmintic properties and pseudo-santonin devoid of anthelmintic properties. Artemisin (8-hydroxysantonin) is responsible for the bitter taste of the drug and resin.

Uses : Santonica is anthelmintic and santonin is more effective on roundworms than threadworms. It is used as deobstruent, stomachic, laxative and tonic. A decoction of the fresh plant is used to treat intermittent and remittent fevers.



Santonin (R=H)
Artemisin (R=OH)



Sesquiterpene lactone

SAUSSUREA

Synonyms : Kuth, Kut, Costus.

Biological Source : Saussurea is the dried roots of *Saussurea lappa* C.B. Clarke.

Family : Compositae.

Habitat : The plant is found in Kashmir at altitudes from

2700 m to 4300. It is cultivated in the Himalayan region of Kullu, Manali, Lahul and Garhwal.

Cultivation : Saussurea is a robust, erect, perennial herb, 1-2 meters in height, with large cordate, radical and alternate leaves. It requires a cool and humid climate. A deep rich porous soil is preferred and plants growing on such soils develop long and thick roots. It can be propagated either by root cuttings or by seeds. Seeds for propagation purposes are collected in September from the crop. The seeds retain their viability for a year or more. In nature kuth seed is shed in autumn, lies under the snow in winter and begins to sprout during April-June as the snow melts. For propagation by seed under cultivation the same time table is adopted or seed can be sown in spring also. Seeds can be sown in a nursery and the seedlings transplanted at a spacing of 8.9 m x 0.9 m when they are one year old. Direct sowing also gives successful results. The shoots die back each winter and recommence growing when the winter snow melts in the following spring. Roots are harvested during October. They are dried and cut into pieces 10 cm long and dried in the sun.

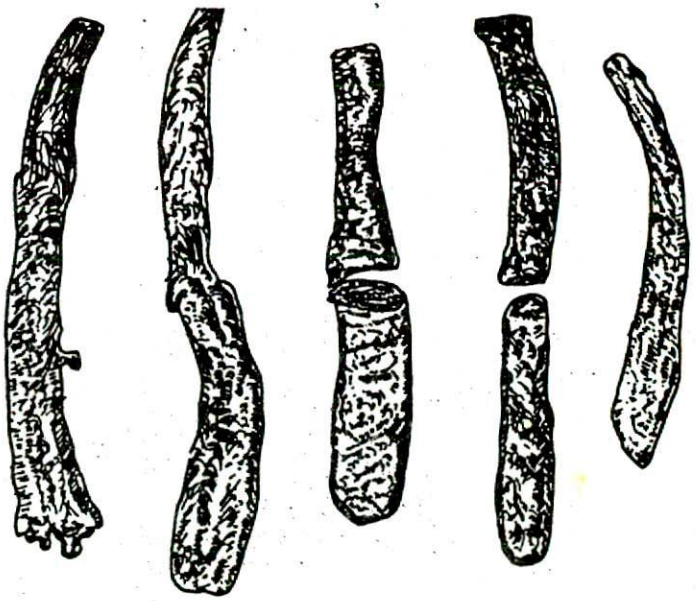


Fig. 10.19. *Saussurea lappa* root

Morphology : Saussurea roots are 7-15 cm long, 1-5.5 cm wide. The roots are fusiform or conical and tapering, collapse in the centre; thin roots are cylindrical, broad, light and stout, usually contain longitudinal wrinkles with anastomose or ridges running straight or spiral; fresh roots are dirty grey to light yellow, dried ones are brown or dull-red; fracture is short and horny; odour is strong, sweet and aromatic and taste is bitter.

Chemical Constituents : Saussurea contains volatile oil (1.5-2.5%), nitrogenous base saussarine (0.05%), inulin (15%), potassium nitrate, sugars, kushtin, and bitter resin. The essential oil is the mixture of sesquiterpene lactones like costuslactone and its dihydro derivatives, costusic acid, 12-methoxy dihydrocostunolide, costol, aplotoxin, α-and β-costenes, phellandrene, camphene, and terpene alcohol. Saussurea also contains β-sitosterol, stigmasterol, betulin, aplotaxene, β-selinene, β-elemene, α- and β-ionones, etc.

The oil is a pale yellow to brownish, very viscous liquid. It has a peculiar soft but tenacious odour. The oil blends well with α-decanolide and its isomers, cinnamic alcohol, isoeugenol, methylionones, etc.

The essential oil is valued in high class perfurmery and cosmetics where it is used for blending purposes. The oil is expensive, and is therefore. extensively adulterated with elecampane oil.

The essential oil of Kuth has strong antiseptic and disinfectant properties especially against *Streptococcus* and *Staphylococcus*. It has marked carminative properties.

Extraction of the root with benzene or petroleum ether produces a concrete of rich and true natural odour. It is commercially called the costus resinoid. Alcoholic extract of the root contains the alkaloid saussurine.

Uses : Saussurea roots have tonic, disinfectant, stomachic, spasmolytic, carminative and stimulant properties and are used as spasmodic in asthma, cough and cholera and as alterative in chronic skin diseases and rheumatism. It is also used for preserving silk and expensive wool fabrics, as an incense in religious ceremonies and as insect repellent.

LEMONGRASS OIL

Synonyms : East India lemongrass, Malabar or Cochin Lemongrass.

Biological Source : Lemongrass oil is obtained from *Cymbopogon flexuosus* Stapf. (syn. *Andropogon nardus* var. *flexuosus* Hack.). It contains not less than 75% of aldehydes calculated as citral.

Family : Gramineae.

Habitat : Lemongrass is indigenous to India and is found in Tinnevelli, Travancore, and Cochin. Two principal varieties of Lemongrass are recognized as the red-stemmed variety, the true *C. flexuosus*, which is a source of East Indian Lemongrass oil and the white-stemmed variety which is designated as *C. flexuosus* var. *albescens*. The oil from the latter is low in aldehyde content and is slightly soluble in 70% alcohol.

Cultivation : Lemongrass grows best in well-drained sandy loam or in light sandy soil. Dark, heavy, rich soil, gives a higher yield of grass, but the oil obtained from it has a lower citral content. Warmth and sunshine favour oil development. The grass grown on lower slopes, less exposed to heavy rains, is rich in oil content.

The grass is cultivated in forest clearings or on hill slopes at an altitude of about 2,000 ft. The ground is ploughed in March-April and seeds are sown at random. The grass come up with the first shower of the monsoon. Weeding is carried out systematically in the plantation. Protection against grazing is necessary. The grass is ready for cutting at the end of May or early in June and may be harvested every 35-40 days till November or December. The citral content of the oil is high (83%) when it is obtained from grass harvested during September-December. After cutting, the stubbles are burnt before the sporadic April monsoon shower. Fresh shoots come up from the roots with the start of regular monsoon, and the grass is ready for harvesting by the end of May. Plantations are renewed every 6-8 years.

Characters of Oil : A light coloured oil, rich in citral content, is obtained by steam distillation. The yield varies form 0.25 to 0.5% per acre.

Chemical Constituents : Lemongrass oil is the principal source of citral (68-85%) from which ionone is derived. The oil also contains methyl heptanone, decyl aldehyde, geraniol, linalool, limonene and dipentene.

Uses : The oil is used in perfumery, soaps, and cosmetics and as a mosquito repellent. Ionones obtained from citral are required for synthetic violet perfumes.

SANDALWOOD OIL

Synonyms : Chandan oil, Sandal oil; Yellow Sandalwood oil; Liginum.

Biological Source : Sandalwood oil is obtained by distillation of sandalwood, *Santalum album* Linn.

Family : Santalaceae.

Habitat : Sandal is a small to medium sized, evergreen semi-parasitic tree found in the dry regions of peninsular India from Vindhya Mountains southwards, especially in Mysore and Tamil Nadu. It has also been introduced in Rajasthan, parts of U.P., M.P. and Orissa.

Cultivation : Sandal tree grows mostly on red, ferruginous loam overlying metamorphic rocks, chiefly gneiss, and tolerates shallow, rocky ground and stony or gravelly soils, avoiding saline and calcareous situations. It is not found on the black-cotton soil. The growth is luxuriant on rich and fairly moist soils, such as garden loam and on well-drained deep alluvium along the river banks, but the heartwood from these trees is deficient in oil. The trees grown on poor soils, particularly on stony or gravelly soil, produce more highly scented wood, giving a better yield of the oil.

It reproduces from seeds dispersed by birds. Germination is profuse in the forests immediately after the monsoons. For artificial regeneration, it is necessary to provide suitable climatic, and ecological conditions. For procuring seeds, the fruits are collected during January-March. Germination is up to 80%. Just after the first monsoon showers, the sandal seeds are dibbed and protected by thorny bushes. The seeds germinate in about 8-14 days. The seedlings grow rapidly, i.e. up to 20-30 cm high, at the end of the first year.

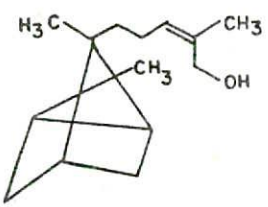
Properties : Sandalwood oil is viscous, yellowish liquid having a peculiar, heavy, sweet and very lasting odour. It has sp. gr. 0.97-0.98, viscosity 1.5, and acid value 0.5-0.8.

Chemical Constituents : The main odorous and medicinal constituent of Sandalwood is santalol ($C_{15}H_{24}O$). This primary sesquiterpene alcohol forms more than 90% of the oil and is present as a mixture of two isomers, α-santalol and β-santalol, the former predominating. The other constituents reported are hydrocarbons santene, nor-tricycloekasantalene, α- and β- santalenes, the alcohols santenol and teresantalol, the aldehyde nor-tricyclo-ekasantalal, and isovaleraldehyde,

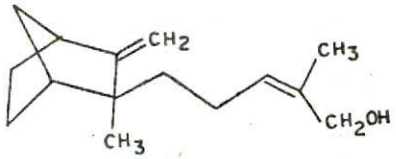
the ketones l-santalone and the acids teresantalic acid and α and β-santalic acids.

Uses : Sandalwood oil is highly used in perfumery creations and finds an important place in soaps, face creams, toilet powders etc.

Substitutes and Adulterants : Oil from several plant sources are either used as substitutes for or as adulterants of natural sandalwood oil. Oil obtained from the Australian plant *Fusanus spicatus* is used as a substitute for genuine Sandalwood oil. Wood and oil of *Santalum yasi* have a feeble odour which is not delicate like that of Indian Sandalwood oil. East Africa markets the wood and oil derived from *Osyris tenuifolia*, the wood is similar to sandal and is used as an adulterant. An oil from Mauritius is reported to possess most of the characteristics of the Indian oil. In West Indies an oil derived from *Amyris balsamifera* Linn. is marketed as a cheap substitute for Indian Sandalwood oil. In India, the wood of *Erythroxylum monogynum* Roxb is used as an adulterant. The wood of *Mansonia gagei* Drum. resembles Sandalwood closely in its physical and other characteristics. Another species, which is common in southern India and used as an adultrant, is *Ximenia americana* Linn.



α-Santalol



β-Santalol

BLACK PEPPER

Synonyms : Kalimirch; Golmirch.

Biological Source : Black pepper consists of the dried, fully developed unripe fruits of *Piper nigrum* L.

Family : Piperaceae.

Habitat : Pepper is cultivated in the hills of south-western India from North Kanara to Kanyakumari.

Cultivation : Black pepper is cultivated mostly as a mixed crop in homestead gardens. The pepper plant is a climbing

vine found growing up to an altitude of 1,500 m. Supports or standards have to be provided for the plant to grow on. The standards usually preferred are quick growing trees, which not only provide support but also shade. Planting is done in April-May during the early rains so that their standards grow sufficiently to allow pepper vines to be planted in July-September. When planted as a mixed crop in coconut, arecanut, tea or coffee plantation, the main crop or the shade trees serve as standards besides providing the shade.

The Pepper vine can be propagated either vegetatively or by seeds. The planting of the pepper vine is done either in July or August. The pits for planting are made perferably on the north and north-eastern sides of the standard so that the severe western sun is avoided. Pepper is an exhausting crop and the soil needs high level of nitrogenous substances.

The wilt and *pollu* are the two important diseases of Pepper. The Pepper vine starts bearing from the third year of its growth. Usually there are two crops in a year, one in August-September and the other in March-April. The harvest season of Pepper extends from the middle of December to the middle of March in coastal areas.

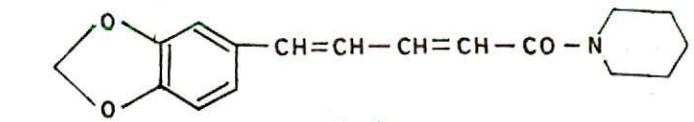
Morphology : It is nearly globular in shape, about 4-5 mm in diameter with a characteristic coat with deep set wrinkles. The pericarp is thin and encloses a single seed with a hollow centre. The perisperm is horny in the outer part and floury around the central cavity.

For preparing Black Pepper, the freshly harvested spikes are spread on mats or concrete floors and dried in sun for about a week with frequent turning over to prevent infection by mildew. During drying, the green or red fruits gradually change in colour to dark brown or almost black and their skin becomes tough and wrinkled. The fruits are detached from the stalks by beating the heaped up material with sticks or treading upon it barefood. Impurities are picked by hand.

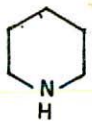
Composition : Black Pepper contains the alkaloids piperine, chavicine, piperidine and piperetine. The characteristic aromatic odour of Pepper is due to the presence of a colourless volatile oil (1-2.6%) in the cells of pericarp which contains phellandrene, caryophyllene, piperonal, dihydrocarveol, caryophyllene oxide, cryptone, α-and β-pinenes, epoxydihydro-caryophyllene, phenylacetic acid, and

citronellol. Starch (45-63%) is the predominant constituent of pepper. It also contains thiamine, riboflavin, nicotinic acid, ascorbic acid and carotene.

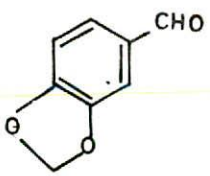
Uses : Black Pepper is mostly used for its characteristic delicate penetrating aroma and pungent, biting taste. It is employed as an aromatic stimulant in cholera, weakness following fevers, vertigo, coma, etc., as a stomachic in dyspepsia and flatulence, as an antiperiodic in malarial fever and as an alterative in paraplegia and arthritic diseases. Externally it is valued for its rubefacient properties and as a local application for relaxed sore throat, piles and some skin diseases.



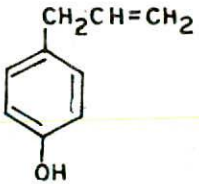
Piperine



Piperidine



Piperonal



Chavicol

CANTHARIDES

Synonyms: Spanish fly; Blistering fly; Blistering beetle, Russian flies; Cantharizo.

Biological Source : Cantharides are the dried insects, *Cantharis vesicatoria* (Linn.) De Geer.

Family : Meloidae.

Habitat : Spain, Italy, Poland, Sicily, South Russia, and Romania.

Collection : Cantharides are found on some shrubs of the families Caprifoliaceae and Oleaceae. The mature insects have brilliant green colour with metallic luster. They appear in June-July and their presence can be detected from a distance due to strong unpleasant odour. Due to cold night, the insects become sluggish in the early morning. A large piece of cloth is spread under plants and the shrubs are shaken or beaten with a stick. The insects fall on the cloth

and are collected. As the insects cause irritation on touching, the collector protects his body parts from them. The insects are killed by putting them in dilute vinegar, chloroform or ether or by exposing to the fumes of ammonia or sulphur dioxide. Then the insects are dried carefully below 40°C, stored in air tight containers and preserved from attack of other insects by adding few drops of chloroform or carbon tetrachloride.

Characters : Cantharides are 1.5-2.5 cm long, 5-8 mm broad, wings are brown, transparent and membraneous and protected by wing covers known as elytra which are copper green in colour; their body consists of three parts, *viz*, head, thorax and abdomen. A pair of antennae and two small black eyes are present on the head. Three pairs of legs are attached to the thorax. Abdomen is covered completely with wings. Dried Cantharides have strong unpleasant typical odour.

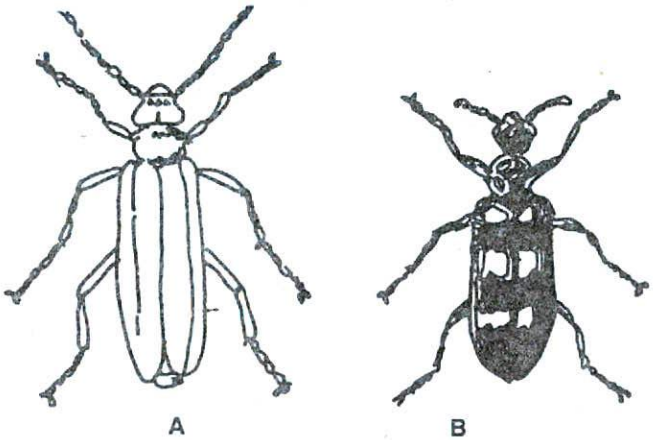
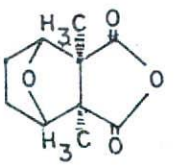


Fig. 10.20. (A) *Cantharis vesicatoria* (B) *Mylabris sidoe.*

Chemical Constituents : Cantharides contain the vesicating principle cantharidin (0.6-1%), fat (10-15%), resinous mass, acetic and uric acids. Cantharidin, mp 218°C, is a crystalline lactone or anhydride of cantharidic acid, sublimes at about 110°, insoluble in cold water, soluble in acetone, chloroform, ether and ethyl acetate.



Cantharidin

Uses : Cantharides are vesicant, counter-irritant and rubefacient. Cantharidin is used externally in a solution form as a counter-irritant and to remove certain types of warts,

in some hair tonic formulations and as an aphrodisiac.

Allied Drug

Mylabris (syn. Chinese Cantharides, Chinese blistering flies) is the dried blistering bettle of *Mylabris sidoe* Fabr (Fam. Meloidae). The beetles are found in China and some parts of eastern India and used as substitute for cantharides. These beetles are blackish brown in colour, cylindrical body, rounded above, flattish below; two black antennae with eleven segments at the globular head and abdomen containing black wings covered with black elytra with three tawny bright yellow bands and wing cases marked with a spot at point of insertion. Mylabris contains cantharidin (1-2%) and fixed oil. It is used as a substitute of cantharides.

AJOWAN

Biological Source : Ajowan is the ripe dried seeds of *Trachyspermum ammi* (L.) Spr. (syn. *Carcum copticum).*

Family : Umbelliferae

Habitat : It is a native of Egypt and grown through out India, Mediterranean region and in south-west Asian countries such as Iraq, Iran, Afghanistan and Pakistan.

Ajowan is an erect, glabrous or minutely pubescent, branched annual herb, up to 90 cm tall. The crop is grown in cold weather, both as a dry crop and under irrigation. It grows on all kinds of soil, but does well on loams or clayey loams. Seeds are sown broadcast in the moist soil from September to November. Germination takes in 5-15 days, depending upon climatic conditions. First irrigation should be light. The flowering takes place in about two months. The harvesting period is February or March. The fruits become ready for harvesting when the flower heads turn brown. The plants then pulled out by the roots and dried. The dried fruits are separated by carefully rubbing with hands or feet.

The drug occurs as entire cremocarps or separated mericarps. Cremocarps are ovoid-cordate to ovate, laterally compressed; 1.7 - 3.0 mm long; 1.5 - 2.4 mm broad, dirty yellow to yellowish brown in colour and half to two-thirds apical portion has slight purplish tinge. At the top of the cremocarp is a bifid stylopod surrounded by five minute

sepals. Each mericarp shows five light-coloured ridges and is covered with light yellow protuberances. The drug has an aggreeable odour and aromatic and warming taste.

Chemical Constituents : Ajowan contains an essential oil (2-3.5%), protein (17.1%), and fat (21.8%). Ajowan oil is a colourless or brownish yellow liquid possessing a characteristic odour of thymol and a sharp taste. The principal constituents of the oil are phenol, mainly thymol (35-60%), carvacrol, p-cymene, γ-terpinene, α- and β-pinenes and dipentene. The fatty oil is composed of palmitic, petroselinic, oleic, linoleic and 5, 6-octadecenoic acids.

Uses : Ajowan is widely used as a spice in curries; in pickles, certain types of biscuits, confectionery, beverages and in *pan*-mixtures. It is valued for its antispasmodic, stimulant, tonic and carminative properties. It is given in flatulence, atonic dyspepsia, diarrhoea and cholera. It is used most frequently in conjunction with asafoetida, myrobalans and rocksalt. Ajowan is also effective in relaxed sore throat and in bronchitis, and often constitutes an ingredient of cough-mixture. It is taken with buttermilk for relieving difficult expectoration due to dried up phlegm. Externally, a paste of the crushed fruit is applied for relieving colic pains, and as a hot and dry fometation of the fruits on the chest in asthma. It is also used to prepare lotions and ointments and applied for checking chronic discharge. It has antibiotic activity.

Ajowan oil is used as an antiseptic and aromatic carminative, for perfuming disinfectant soaps and as an insecticide. The action of the oil and its uses are similar to those of thymol. The oil is useful as an expectorant in emphysema, bronchial pneumonia and some other respiratory ailments.

The fatty oil is recommended as an external application in cases of rheumatism.

TURPENTINE OIL

Synonyms : Oleum Terbinathae; Rectified oil of Turpentine.

Biological Source : Turpentine oil is obtained by distillation of oleoresin of *Pinus palustris* (long leaf pine) and other species of *Pinus* such as *P. longifolia* Roxb., *P. elliottii*, *P.*

radiata, etc.

Family : Pinaceae

Geographical Source : The oil is prepared on commercial scale in India, France, Russia and U.S.A.

Cultivation and Collection : In India *Pinus longifolia* and *P. insularis* are found naturally in Himalayas from Kashmir to Bhutan. *P. longifolia* is cultivated in Himachal Pradesh, Jammu, Punjab and Uttar Pradesh. The plant grows well at altitude 600 to 2400 m, in rainfall between 100 to 175 cm, temperature 30 to 38°C and on variety of soils like limestone, quartz and clay, stand stone and on bare rocks. It is grown by seed germination in March and April. The 20-25 year old plants are used for the collection of the Colophony (resin) and the volatile oil.

Preparation : Suitable number of blazes are made and then heavy tapping is done. The resin flows which is collected in earthenware or other suitable containers. It continues for 8 to 10 years. This type of tapping produces schizogenous ducts. The crude oleo-resin is purified by heating in a steam jacketed vessel with spiral tube. Vegetable debris, sand particles and other impurities are removed by setting or floating. The clear resin is re-distilled in a distillation plant after treatment with sodium hydroxide or lime water to remove resins, acids, phenols, etc. It is then dried over sodium sulphate and packed in suitable containers. The oleoresin produces Turpentine oil (25%) and Colophony (70%). The Terpentine oil after treatment with alkalies is known is *rectified turpentine oil.* U.S.A. is main producer of the total world production which is about 70%.

Description : The oil is colourless or slightly yellow in colour, clear, transparent liquid. Odour is strong, characteristic and becomes much stronger on storage with less pleasantness; taste is bitter and pungent. It is insoluble in water, soluble in alcohol, chloroform, carbon disulphide, glacial acetic acid, benzene, petroleum ether and fixed oils.

Chemical Constituents : About 40 monoterpenes are reported in the oil. The major components are α-pinene (20-30%), β-pinene (5-10%), camphene, β-phellandrene, δ-3-carene, p-cymene, longifoline, estragol, limonene, etc. Americal oil contains α-pinene (65%) and β-pinene (30%) as the principal constituents.

Uses : Externally it is used as a counter-irritant and rubefacient. For inhalation, terebene is used which is prepared from the oil by the action of cold sulphuric acid. It is used in the treatment of chronic bronchitis. Commercially, it is used to prepare synthetic pine oil, disinfectants, denaturants, insecticides, paints, varnishes fragrances, vitamins, etc.

Adulterants : The common adulterants are resin oil, wood turpentine and petroleum jelly. The last adulterant is detected low weight per ml of the oil and resin oil leaves the stain of fatty matters on staining on a paper.

CITRONELLA OIL

Biological Source : It is a volatile oil obtained by steam distillation from the fresh leaves of *Cymbopogon nardus* (Linn.) Rendle.

Family : Gramineae.

Habitat : The plant is native of Sri Lanka and now cultivated in Burma, Malaysia, Indonesia, Fiji and India.

Cultivation and Collection : It is tall, 1.75 m high, perennial plant with throwing dense leaves growing from a short rhizome. The leaves are linear and tapering, up to 60-70 cm long, glabrous green and lower ribs are red in colour. It is cultivated by vegetative propagation. Regular irrigation is required during winter and summer. The crop is ready for harvesting after 8 months and it can be harvested several times with regular intervals. About 20 tonnes of grass can be harvested per hectare. It contains about 0.5% of volatile oil.

Description : The oil is pale-greenish yellow in colour. It has pungent taste. It is insoluble in fixed oils.

Chemical Constituents : Citronella grass contains 0.3 to 0.9% of volatile oil. The main constituents of the oil are geraniol (40-60%) and citronellal (15-20%). Other constituents are d-camphene, limonene, dipentene, borneol, linalool, cadinene, elemicin, and methyl eugenol. Java variety possesses citronellal (25-50%), geraniol (25-40%), camphene, limenene and dipentene.

Uses : The oil is used as perfume for soap, brilliantines, in mosquito-repellent ointments and sprays and as a flavouring agent for liniments, lotions and cosmetics.

QUESTIONS

1. How are volatile oils prepared ? Give a general scheme for the biosynthesis of volatile oil components.
2. What are umbelliferous fruits ? Describe the morphological and anatomical features of Cardamom. Mention its chemical constituents and uses (Jamia Hamdard, 1994).
3. Give the structural formula of the following constituents. Mention the source and uses of drugs in which these constituents are found (a) Menthol (b) Citral (c) Dil-apiole (d) Carvone (e) Podophyllotoxin (f) Piperine (g) Abietic acid (h) Curcumin (Jamia Hamdard, 1994).
4. Mention plant sources of the following terpenes : (a) α-Pinene (b) α-Ionone (c) Citronellal (d) Cineol (e) Car-3-one (f) Carvone (g) Fenchone (h) β-Ionone.
5. Give the comparative account of umbelliferous fruits you have studied (Delhi university, 1987).
6. Write structural differentiation of the following phytoconstituents and give the major plant source of each constituent : (a) α-Pinene and α-terpineol (b) Linalool and linalyl acetate (c) Citronellol and citral (d) Eugenol and thymol (C.C.S.U., Meerut, 1995).
7. (a) Name the volatile oil drugs which contain phenolic esters. Give the constituents of Fennel and Nutmeg.
   (b) Give official source, chemical constituents and uses of Clove and Cardamom. (Delhi University, 1988)
8. What are essential oils ? How are they isolated ? Give source, constituents and uses of Lemongrass oil.
9. Describe Cardamom under suitable pharmacognostical scheme.