UNIT-II 14 Hours
General introduction, composition, chemistry & chemical classes, biosources, therapeutic uses and commercial applications of following secondary metabolites:
Alkaloids: *Vinca, Rauwolfia, Belladonna, Opium,*
Phenylpropanoids and Flavonoids: *Lignans, Tea, Ruta*
Steroids, Cardiac Glycosides & Triterpenoids*: Liquorice, Dioscorea, Digitalis*
Volatile oils*: Mentha, Clove, Cinnamon, Fennel, Coriander,*
Tannins: *Catechu, Pterocarpus*
Resins: *Benzoin, Guggul, Ginger, Asafoetida, Myrrh, Colophony*
Glycosides: *Senna, Aloes, Bitter Almond*
Iridoids, Other terpenoids & Naphthaquinones: *Gentian, Artemisia, taxus, carotenoids*

Vinca

Synonyms

Vinca rosea, Catharanthus, Madagascar periwinkle.

Biological Source

Vinca is the dried entire plant of *Catharanthus roseus* Linn., belonging to family Apocynaceae.

Geographical Source

The plant is a native of Madagascar and is found in countries especially in India, Australia, South Africa and North and South America. The plant is cultivated as garden plant in Europe and India.

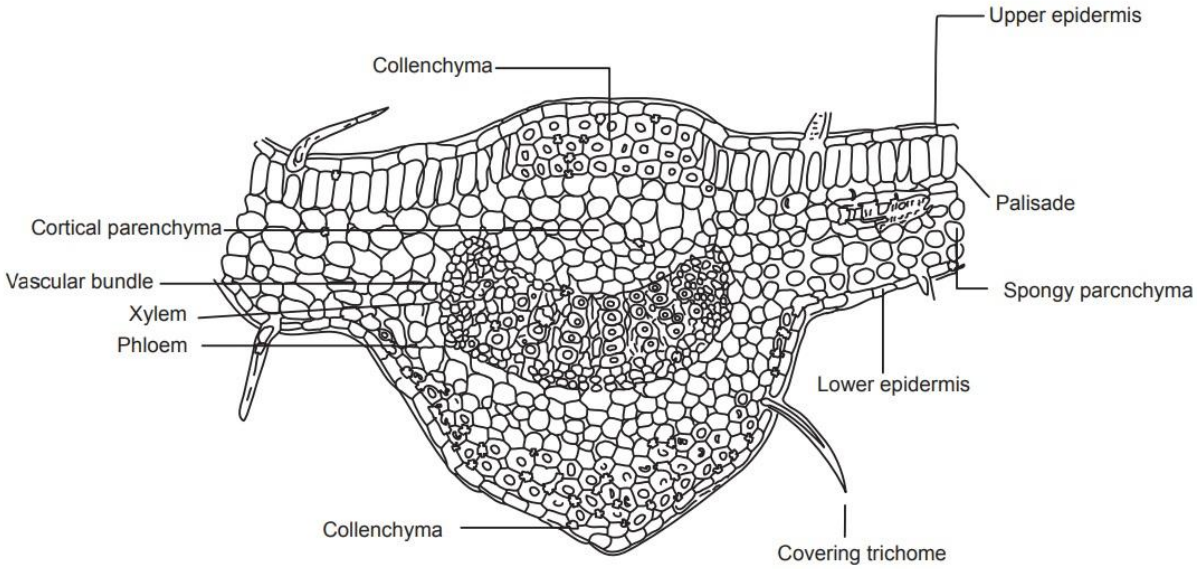
Characteristics

The leaves are green in colour, flowers are either violet, pinkish white or carmine red and roots are pale grey in colour. It has characteristic odour and bitter taste. The flowers are hermaphrodite (have both male and female organs) and are pollinated by bees. Leaves are petiolate, entire margin, ovate or oblong, glossy appearance and with acute apex. Fruit is follicles with numerous black seeds.

Microscopy

Vinca has dorsiventral leaf structure. Epidermis is a single layer of rectangular cells covered with thick cuticle. It consists of uni-cellular covering trichome and cruciferous stomata. In the mesophyll region single layer of elongated and closely packed palisade parenchyma cells are present just below the upper epidermis. In the midrib region two to three layers of collenchyma is present, both below the upper epidermis and above the lower epidermis. Vascular bundle consisting of xylem and phloem is present in the middle of midrib region and rest of the

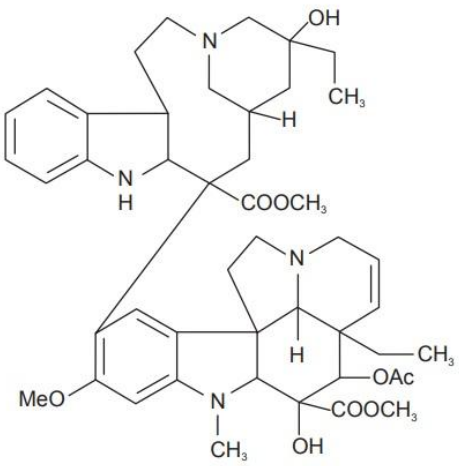
intercellular space is covered by five to eight layers of spongy parenchyma. Calcium oxalate crystals are absent.



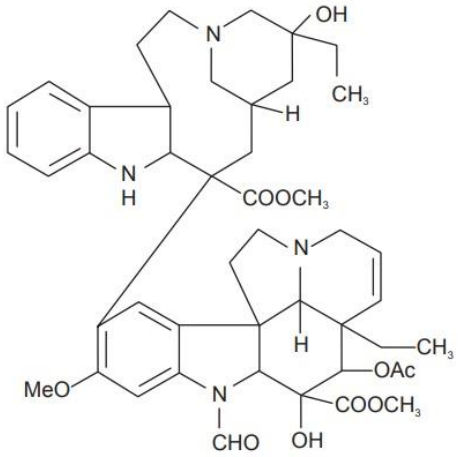
Transverse section of Vinca leaf

Chemical Constituents

Alkaloids are present in entire shrub but leaves and roots contain more alkaloids. About 90 alkaloids have been isolated from Vinca from which some like Ajmalicine, Serpentine and Tetrahydroalstonine are known and are present in other species of Apocynaceae. The important alkaloids in Catharanthus are the dimer indole indoline alkaloids Vinblastine and Vincristine and they possess definite anticancer activity. Vindoline and Catharanthine are indole monomeric alkaloids. It also contains monoterpenes, sesquiterpene, indole and indoline glycoside.



Vinblastine



Vincristine

Uses

Vinblastin is an antitumour alkaloid used in the treatment of Hodgkin's disease. Vincristine is a cytotoxic compound and used to treat leukaemia in children. Vinca is used in herbal practice for its astringent and tonic properties in menorrhagia and in haemorrhages generally. In cases of scurvy and for relaxed sore throat and inflamed tonsils, it may also be used as a gargle. For bleeding piles, it may be applied externally, as well as taken internally. It is also used in the treatment of diabetes.

Marketed Products

It is one of the ingredients of the preparation known as Cytocristin (Cipla).

RAUWOLFIA

Synonyms: Sarpagandha, Chandrika; Chootachand; Indian snake root.

Biological Source

Rauwolfia consists of dried roots of *Rauwolfia serpentina* Benth., belonging to family Apocynaceae.

Geographical Source

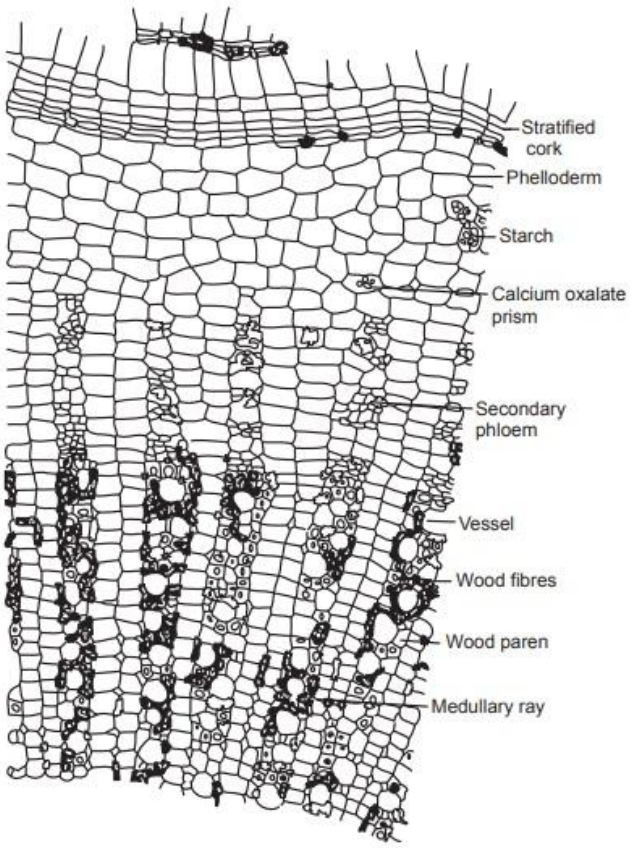
Burma, Thailand, Philippines, Vietnam, Indonesia, Malaysia, Paki-stan and Java. In India it occurs in the sub-Himalayan tracts from Sirhind eastwards to Assam, especially in Dehradun, Siwalik range, Rohelkhand, Gorakhpur, Tamil Nadu, Bihar,Karnataka and Bengal.

Characteristics

The roots and rhizomes are almost identical in external characters. The drug occurs in cylindrical or slightly tapering, tortuous pieces, 2–10 cm long, 5–22 mm in diameter. The roots are rarely branched. Rootlets, 0.5–1 mm in diameter, are rare. The outer surface is greyish-yellow, light-brown or brown. Slight odour is felt in recently dried drug which decreases with age; taste is bitter.

Microscopy

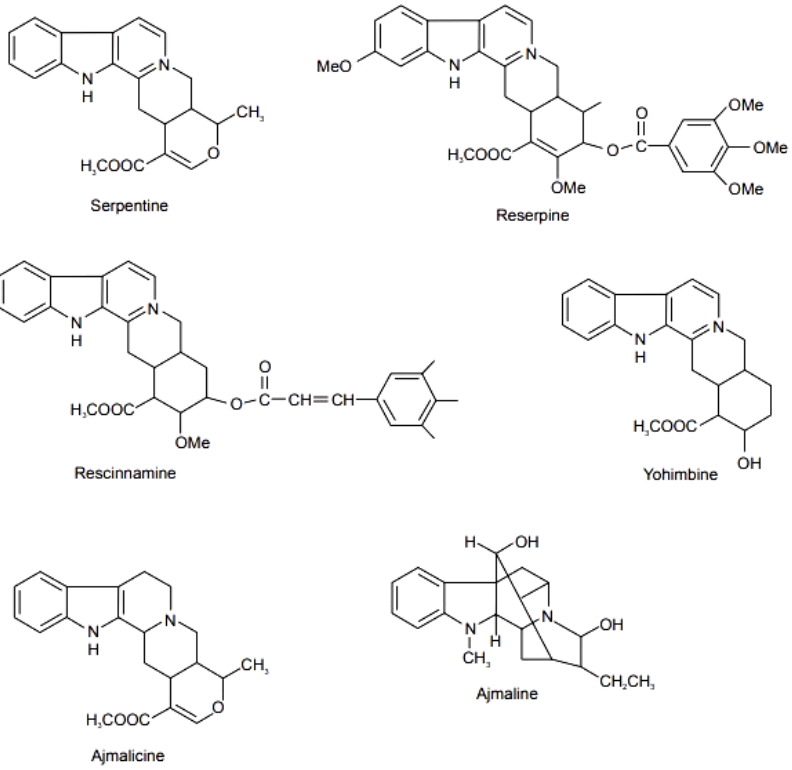
Transverse section of the root shows a stratified cork, which is divided, into two to eight alternating zones. It consists of one to seven layers of smaller and radially narrower, suberised, nonlignified cells alternating with one to three layers of larger radially broader, lignified cells. The phelloderm is composed of about ten to twelve layers of tangentially elongated to isodiametric, cellulosic parenchymatous cells. Cells of secondary cortex are parenchymatous and contain starch grains, simple and compound (two to four components), spherical with a distinct hilum in the form of a split. Phloem is narrow and consists of parenchyma with scattered sieve tissue; parenchyma alternate with broader medullary rays composed of large cells and usually two to four cells wide. Xylem is wide, entirely lignified and usually shows two to five annual rings. Medullary rays, one to five cells wide, contain starch grains and alternate with secondary xylem consisting of vessels, tracheids, fibres and parenchyma. Xylem vessels have pitted thickening.



Transverse section of Rauwolfia root

Chemical Constituents

Rauwolfia contains about 0.7–2.4% total alkaloidal bases from which more than 80 alkaloids have been isolated. The prominent alkaloids isolated from the drug are reserpine, rescinnamine, ψ-reserpine, rescidine, raubescine and deserpidine. The other alkaloidal components are ajmalinine, ajmaline, ajmalicine (8-yohimbine), serpentine, serpentinine, tetrahydroreserpine, raubasine, reserpinine, isoajamaline and yohambinine.



The other substances present are phytosterols, fatty acids, unsaturated alcohols and sugars.

Uses

Rauwolfia in used as hypnotic, sedative and antihypertensive. It is specific for insanity, reduces blood pressure and cures pain due to affections of the bowels. It is given in labours to increase uterine contractions and in certain neuropsychiatric disorders. Ajmaline, which has pharmacological properties similar to those of quinidine, is marketed in Japan for the treatment of cardiac arrhythmias.

Reserpine is a white or pale buff to slightly yellow, odourless, crystalline powder that darkens slowly when exposed to light and rapidly when in solution. Reserpine is an antihypertensive and tranquilizer.

Marketed Products

It is one of the ingredients of the preparations known as Confido, Lukol, Serpina (Himalaya Drug Company) and Sarpagandhan bati (Baidyanath).

BELLADONNA

Synonyms

Deadly night shade leaves; Banewort; Death's herb, Dwale; Poison black cherry

Biological Source

Belladonna consists of dried leaves and flowering tops of *Atropa belladonna* Linn. (European Belladonna), belonging to family Solanaceae. It contains about 0.35% of total alkaloids calculated as hyoscyamine.

Geographical Source

A. belladonna is cultivated in United States, Canada, UK, Germany and India.

Characteristics

The drug contains leaves, smaller stems of about 5 mm diameter, flowers and fruits. Leaves are stalked, brittle, thin, entire, long-pointed, 5–25 cm long, 2.5–12 cm wide, ovate lanceolate, slightly decurrent lamina, margine-entire, apex acuminate, colour dull-green or yellowish-green, surface glabrous, lateral veins join the midrib at an angle of 60°C, curving upwards and are anastomose. The upper side is darker than the lower. Each has a petiole about 0.5–4 cm long and a broadly ovate, slightly decurrent lamina about 5–25 cm long and 2.5–12 cm wide. The margin is entire and the apex acuminate.

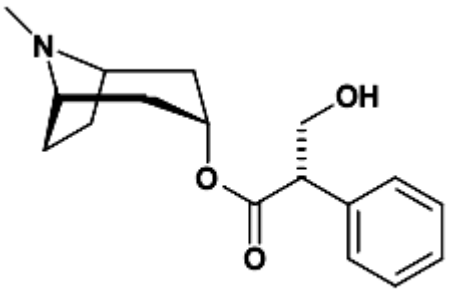
Microscopy

A transverse section of the leaf of *A. belladonna* has a bifacial structure. The epidermal cells have-wavy walls and a striated cuticle. Anisocytic type and some of the anomocytic type stomata arc present on both surfaces but are most common

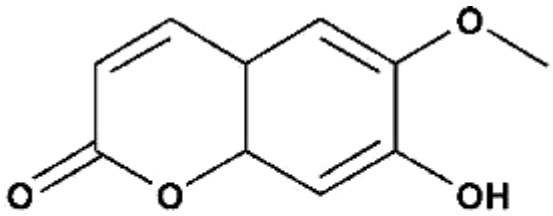
on the lower. Hairs are most numerous on young leaves, uni-seriate, two- to four-celled clothing hairs; or with a uni-cellular glandular head. Some hair has a short: pedicel and a multicellular glandular head. Certain of the cells of the spongy mesophyll are filled with micro-sphenoidal (sandy) crystals of calcium oxalate. The midrib is convex above and shows the usual bicollateral vascular bundle. A zone of collenchyma is present in epidermis near midrib.

Chemical Constituents

Belladonna contains 0.3–1.0% total alkaloids, the prominent base is l-hyoscyamine and other components are atropine, apoatropine, as choline, belladonnine, cuscohygrine, chrysatropic acid, volatile bases, such as atroscine, leucatropic acid; phytosterol, N-methylpyrroline, homatropine, hyoscyamine N-oxide, rutin, kaempferol-3-rhamnogalactoside and 7-glu-coside, quercetin-7-glucoside, scopoletin, calcium oxalate, 14% acid soluble ash and 4% acid-insoluble ash. Addition of ammonia to the alcoholic solution of scopoletin shows blue florescence. This test is useful to detect Belladonna poisoning. Atropine is formed by racemization during the extraction process.



Atropine



Scopoletin

Uses

The drug is used as adjunctive therapy in the treatment of peptic ulcer; functional digestive disorders, including spastic, mucous and ulcerative colitis; diarrhoea,

diverticulitis and pancreatitis. Due to anticholinergic property, it is used to control excess motor activity of the gastrointestinal tract and spasm of the urinary tract.

Belladonna is anticholinergic, narcotic, sedative, diuretic mydriatic and used as anodyne and to check secretion. Other uses are similar to Hyoscyamus. It relieves spasm of gut or respiratory tract. Consumption of Belladonna checks excessive perspiration of patients suffering from tuberculosis. Belladonna acts as a parasympathetic depressant.

Marketed Products

It is one of the ingredients of the preparation known as Belladona plaster (Surgi Pharma) for backache, stiffness of muscles and boil, swollen joints.

OPIUM

Synonyms

Crude Opium; Raw Opium; Gum Opium; Afim; Post.

Biological Source

Opium is the air dried milky latex obtained by incision from the unripe capsules of *Papaver somniferum* Linn, or its variety *P. album* Decand., belonging to family Papaveraceae.

Opium is required to contain not less than 10% of morphine and not less than 2.0% of codeine. The thebaine content is limited to 3%.

Geographical Source

It is mainly found in Turkey, Russia, Yugoslavia, Tasmania, India, Pakistan, Iran, Afghanistan, China, Burma, Thailand and Laos. In India, Opium is cultivated in M.P. (Neemuch) and U.P. for alkaloidal extraction and seed production.

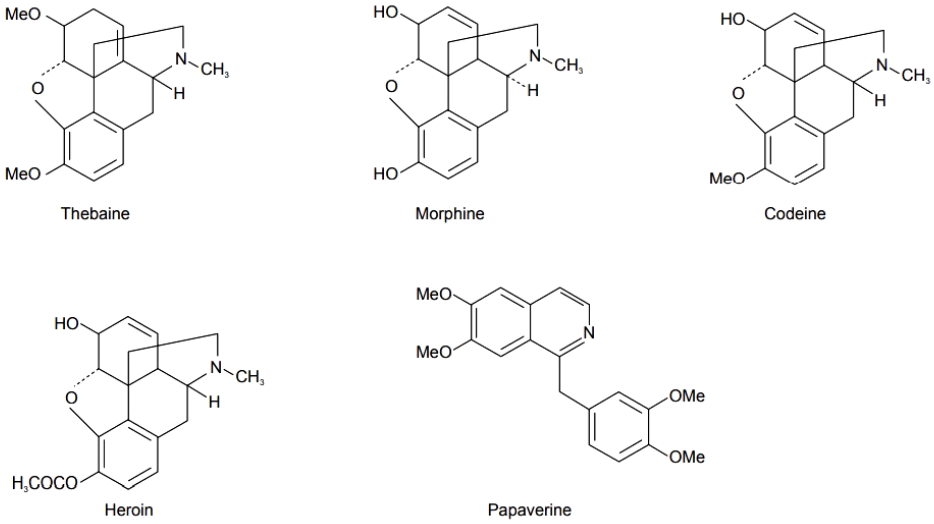
Characteristics

Opium occurs in rounded or flattened mass which is 8–15 cm in diameter and weighing from 300 g to 2 kg each. The external surface is pale or chocolate-brown, texture is uniform and slightly granular. It is plastic like when fresh and turns hard and brittle after sometime. Fragment of poppy leaves are present on the upper surface. Internal surface is coarsely granular, reddish-brown, lustrous; odour is characteristic; taste is bitter and distinct.

Chemical Constituents

Opium contains about 35 alkaloids among which morphine (10–16%) is the most important base. The alkaloids are combined with meconic acid. The other alkaloids isolated from the drug are codeine (0.8–2.5%), narcotine, the-baine (0.5–2%). noscapine (4–8%), narceine and papaverine (0.5–2.5%). Morphine contains a phenanthrene nucleus. The different types of alkaloids isolated are:

1. *Morphine Type:* Morphine, codeine, neopine, pseudo or oxymorphine, thebaine and porphyroxine. Morphine consists of alkaloids which has phenanthrene nucleus whereas those of the papaverine group has benzyliso-quinoline structure. Protopine and hydrocotamine are of different structural types. The morphine molecule has both a phenolic and an alcoholic hydroxyl group and acetylated form is diacetyl morphine or heroin. Codeine is ether of morphine (methyl-morphine). Other morphine ethers which are used medicinally are ethylmorphine and pholcodine.
2. *Phthalide Isoquinoline Type:* Hydrocotarnme, narcotoline, 1-narcotine, noscapine, oxynarcotine, narceine, and 5'-O-demethyl-narcotine.
3. *Benzyl Isoquinoline Type:* Papaverine, dl-laudanine, laudanidine, codamine and laudanosine.



Chemical Tests

Aqueous extract of Opium with $FeCl_3$ solution gives deep reddish purple colour which persists on addition of HCl. It indicates the presence of meconic acid.

Morphine gives dark violet colour with conc. H_2SO_4 and formaldehyde.

Uses

Opium and morphine have narcotic, analgesic and sedative action and used to relieve pain, diarrhoea dysentery and cough. Poppy capsules are astringent, somniferous, soporific, sedative and narcotic and used as anodyne and emollient. Codeine is mild sedative and is employed in cough mixtures. Noscapine is not narcotic and has cough suppressant action acting as a central antitussive drug. Papaverine has smooth muscle relaxant action and is used to cure muscle spasms. Opium, morphine and the diacetyl derivative heroin, cause drug addiction.

Tea

Tea, beverage produced by steeping in freshly boiled water the young leaves and leaf buds of the tea plant, *Camellia sinensis*. Two principal varieties are used, the small-leaved China plant (*C. sinensis sinensis*) and the large-leaved Assam plant (*C. sinensis assamica*). Hybrids of these two varieties are also grown. The leaves may be fermented or left unfermented.

Tea contains more caffeine than coffee by dry weight. A typical serving, however, contains much less, since less of the product is used as compared to an equivalent serving of coffee. Also contributing to caffeine content are growing conditions, processing techniques, and other variables. Thus, teas contain varying amounts of caffeine. Tea contains small amounts of theobromine and slightly higher levels of theophylline than coffee.

LIQUORICE

Synonyms:

Mulethi, Radix glycyrrhizae, Licorice, Jethi Madh, Yashtimadhu

Botanical source:

It consists of subterranean peeled and unpeeled stolons, roots, and subterranean stems of *Glycyrrhiza globra* Linn. **Family:** Leguminosae

Geographical source:

It is produced in a number of countries like Iran, Russia, Spain, Greece, U.S.S.R., and India.

Macroscopical characters:

Colour: Pale yellowish to Buff colour

Odour: Characteristics.

Taste: Sweet

Shape: Cylindrical.

Surface (Outer): Yellowish brown with longitudinal wrinkles (unpeeled); peeled ones are yellow coloured with fine longitudinal ridges. In case of stolons, scars of the buds can be seen.

Fracture: Coarsely fibrous in the bark region and splintery in the wood; fractured surface shows long fibres projecting outwards.

Microscopical characters:

1. Periderm: Phellem (cork):

Several layers with tabular cells, outer layers are filled with reddish brown contents and inner few are colourless.

Phellogen: Indistinct Phelloderm: 3-5 layered, immediately below cork, parenchymatous cells whose corners thickened with cellulose (collenchymatous); some cells contain prism of calcium oxalate and minute starch grain.

2. Secondary phloem:

Wide zone with numerous concentrically arranged bundles of phloem fibres each bundle is surrounded by a parenchymatous sheath whose cells contain prisms of calcium oxalate. Radially the fibre bundles alternated with soft phloem elements and tangentially with medullary rays.

3. Medullary rays:

Distinct, bi-to multiseriate, parenchymatous, in continuation with those of xylem however, the rays are narrower in the xylem region and become wider in the phloem region.

4. Secondary xylem:

Well represented, divided (like phloem) by large medullary rays at regular interval. Xylem consists of vessel, fibres and lignified wood parenchyma.

The vessels, fibres and lignified wood parenchyma the vessels, fibres and lignified wood parenchyma the vessels which are relatively wide show scalariform and bordered pitted thickenings.

Wood fibres are also unsheathed by a layer of parenchyma containing crystals. Starch is present in the wood parenchyma.

5. Pith:

Consist of large parenchyma with intercellular spaces and contain few starch grains. Pith absent in root.

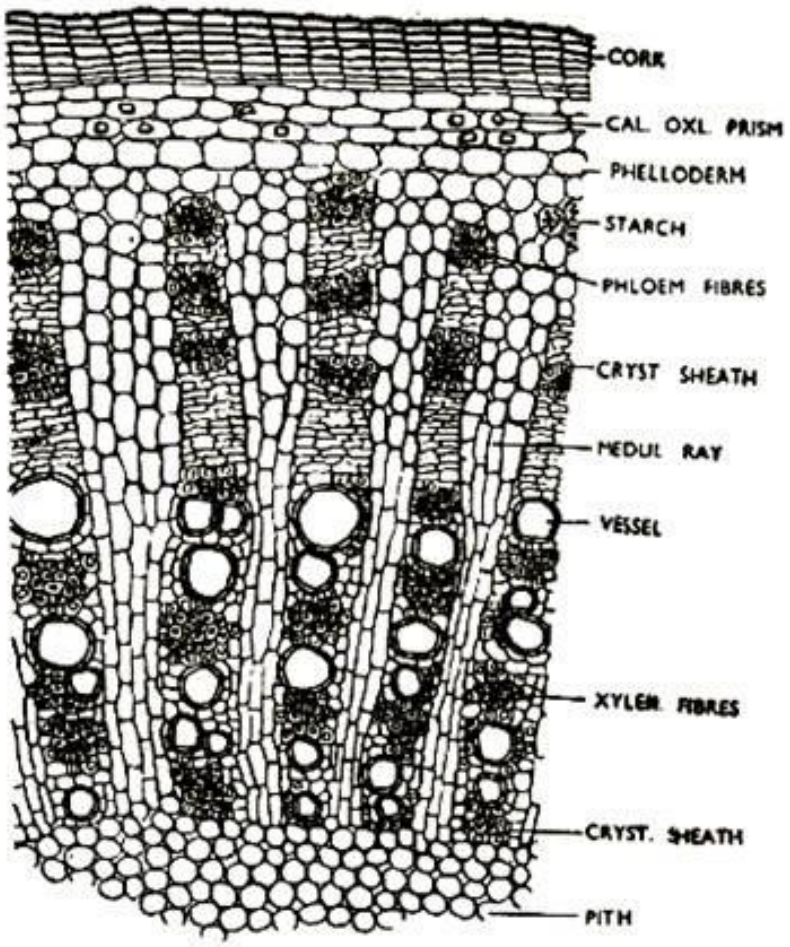
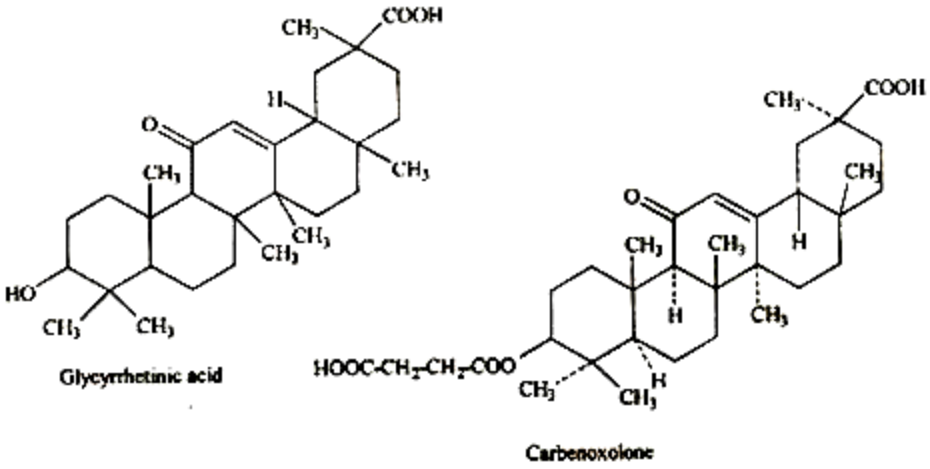


Fig. 1: T. S. of Glycyrrhiza root

Chemical constituents:

- Saponin glycosides: Glycyrrhizin and glycyrrhetic acid.
- Flavonoids: Liquiritin, liquiritigenin, isoliquiritin and isoliquiritigenin.

- Coumarin derivatives: Herniarin, umbelliferone.
- Bitter principle: glyceramarin.
- Asparase, β-sitosterol, starch, resin and malic acid



Uses:

1. Demulcent and expectorant.
2. Tonic.
3. Laxative.
4. Diuretic and emollient property.
5. Anti-inflammatory agent.
6. Spasmolytic agent.
7. Cough and peptic ulcer.
8. Chewing gums, chocolate candy, cigarette and chewing tobacco.

Substitutes and Adulterants:

Manchurian Licorice is obtained from *Glycyrrhiza uralensis*. Colour is chocolate brown and cork exfoliating. Anatomically also it shows peculiarities based on which one can distinguish.

The medullary rays are curved and presence of lacunae can be seen in wood. Being a substitute it does contain glycyrrhizin the active principle but very little of free sugars.

The common adulterant is wild licorice also called Indian licorice, derived from the root of *Abrus precatorius* (Leguminosae). The root is very toxic due to an alkaloid abrine and therefore should not be used in place of licorice.

The root possesses a peculiar disagreeable Odour and bitter acrid flavour leaving faintly sweet after taste. Microscopically the adulterants are characterized by stone cells.

DIOSCOREA

Synonym: Yam.

Biological Source

Dioscorea is the dried rhizome of several species of *Dioscorea* like *D. villosa, D. prazeri* Prain and Burk; *D. composite; D. spiculiflora; D. deltoidea* and *D. floribunda*, belonging to family Dioscoreaceae.

Geographical Source

It is mainly found in North America, Mexico, India (Hima-layas from Kashmir and Punjab up to an altitude of 3,000 m), Nepal and China.

Characteristics

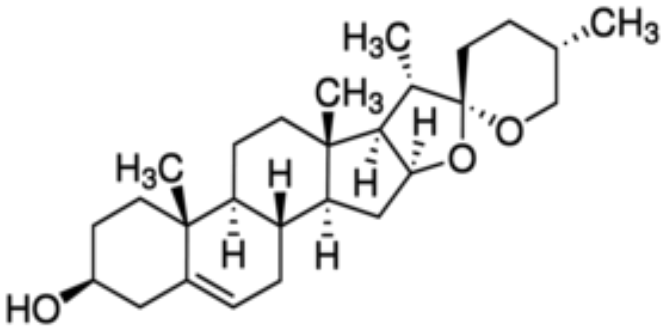
The colour of the plant is slightly brown, odourless with bitter taste and vary in size.

Microscopy

The transverse section of the drug when observed under the microscope shows the absence of epidermis, the cork is made up of few layers and next to cork it has corical parenchymatous tissue with thin wall. The major part of the drug is occupied by stele and consists of collateral type of fibrovascular bundles. The drug has indistinguishable endodermis and pericycle.

Chemical Constituents

The roots contain diosgenin (4–6%) a steroidal sapogenin and its glycoside smilagenin, epismilagenin and beta isomer yammogenin. It also contains sapogenase (enzyme), phenolic compounds and starch (75%).



Diosgenin

Uses

It is a main source of diosgenin. This is widely used in modern medicine in order to manufacture progesterone and other steroid drugs. These are used as contraceptives and in the treatment of various disorders of the genitary organs as well as in a host of other diseases such as asthma and arthritis.

Marketed Products

It is one of the ingredients of the preparations known as Explode (Herbotech Pharmaceuticals).

DIGITALIS

Biological source:

Digitalis consists of dried leaves of *Digitalis purpurea* Linn. After collection leaves are dried immediately at temperature below 60 C and they contain no more than 5% moisture. After drying leaves are stored in moisture proof container. **Family:** Scrophulariaceae

Geographical source:

It is found in European countries, England, France, Germany, North America and India. In India, it is cultivated in Kashmir and Nilgiri Hill.

Macroscopical characters:

(i) General appearance: Usually broken and crimped.

(ii) Shape: Ovate-lanceolate.

(iii) Size: 10 to 40-cm. Long and 4 to 10 cm.

(iv) Wide Margin: Crenate or dentate

(v) Apex: obtuse or rounded

(vi) Base: Tapering, decurrent

(vii) Upper Surface: Slight pubescent, dark green, little wrinkled, one water pore present near each tooth

(viii) Lower surface: Grayish-green, very pubescent

(ix) Venation: Pinnate, mid-rib, lateral vein, veinlet and still smaller vein lets prominent on the under- surface; lateral vein leaves the mid- rib, at an acute angle and anatomies on the margin.

(x) Petiole: Winged, 2.5 to 10 cm. long

(xi) Odour: Characteristic.

(xii) Taste: Bitter

Digitalis is dorsiventral and can be easily identified due to the presence of characteristic simple covering and glandular trichomes. The covering trichomes are uniseriate; usually three to four cells long, having collapsed cells, acute apex and finely warty cuticle. The glandular trichomes have a short unicellular stalk and bi-cellular or rarely unicellular head. These glandular trichomes are usually located over the veins. Further anomocytic (Ranunculaceous) type of stomata is also present mainly on the lower surface.

Microscopical characters:

1. Lamina:

a. Upper epidermis:

Single layered with more or less rectangular cells having a distinct cuticle. Abundant covering and glandular trichomes emerge from the upper epidermal layer. Covering trichomes are uniseriate, multicellular (3-6 Celled), mostly straight, warty and with blunt tips. Certain cells of the covering trichomes are collapsed, thus forming a diagnostic feature for the identification. Glandular trichomes are with either unicellular or bi-cellular terminal (through rare) stalk having unicellular or bi-cellular terminal gland few stomata are also seen on the upper epidermis.

b. Mesophyll:

It is differentiated into palisade and spongy parenchyma. Calcium oxalate crystals of any type are absent.

c. Palisade:

One layered, compact with radially elongated cells

d. Spongy parenchyma:

4-6 layered and many distinct obliquely cut out veinlet are seen.

e. Lower epidermis:

Similar to upper epidermis and has many stomata and more trichomes compared to those of upper epidermis.

2. Midrib:

The dorsal surface of the midrib is strongly convex and as usual the epidermal layers of lamina continue over the midrib. Below the upper epidermis and above the lower epidermis are seen thin strips of collenchymas. The vascular bundles are surrounded by a distinct endodermal layer, the cells of which contain abundant starch. Within the endodermis, appears a band of the collenchymatous pericycle. Distinct phloem tissue can be seen on the dorsal surface and well developed xylem tissue towards the ventral surface of the midrib

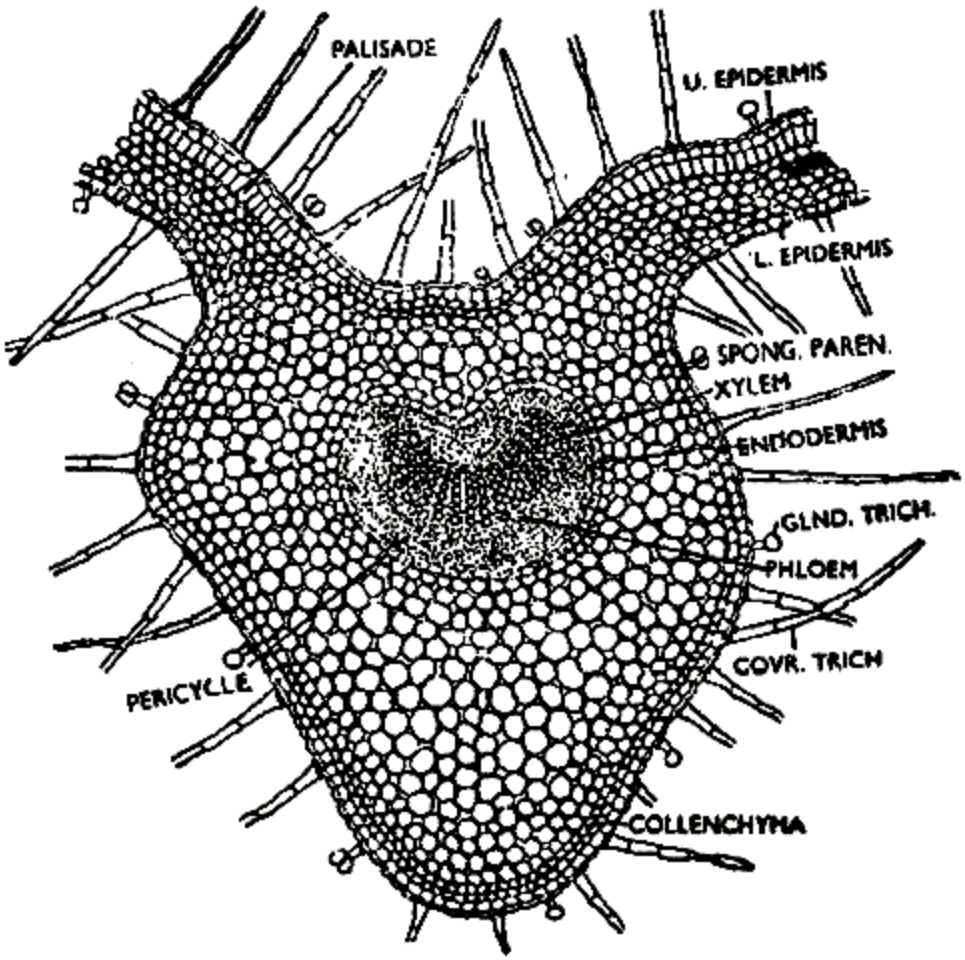
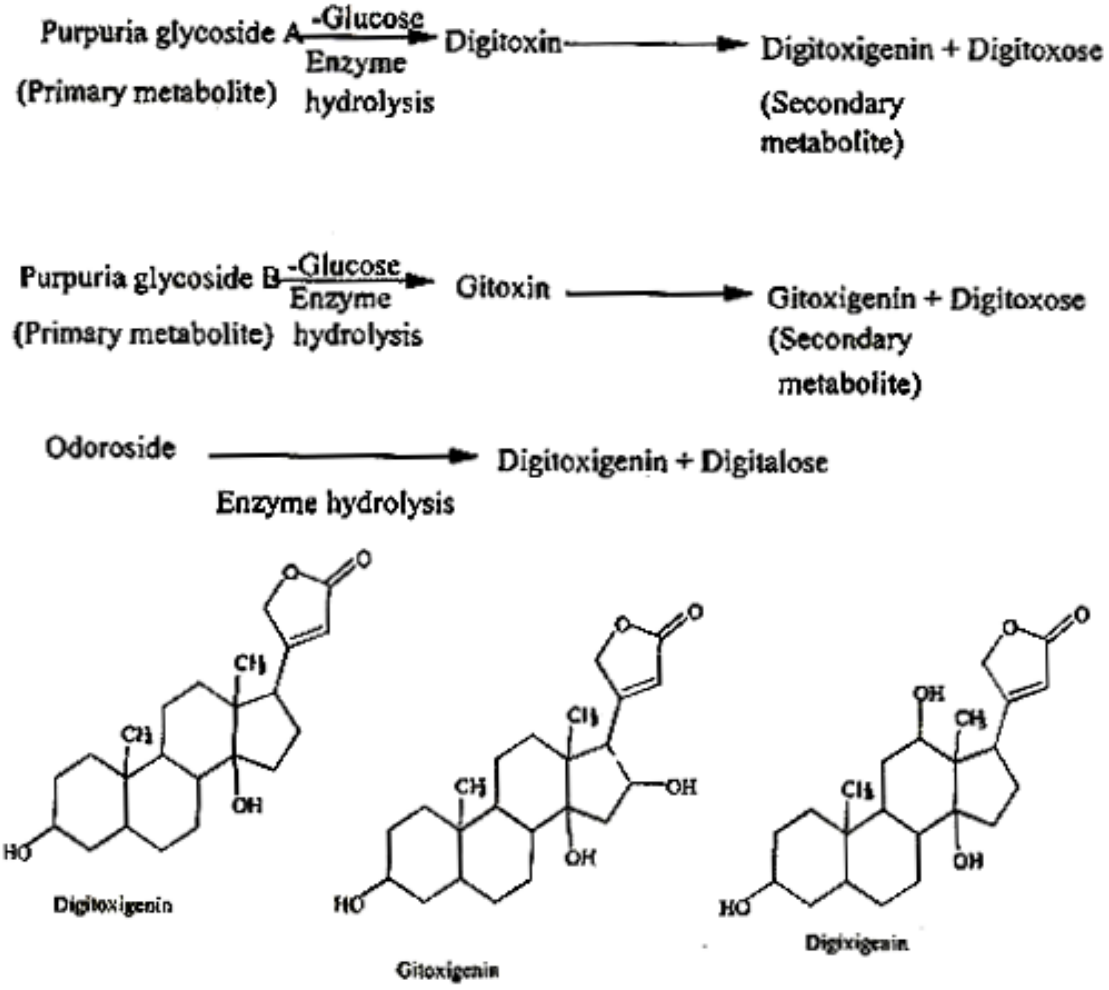


Fig. 3: T. S. of *Digitalis purpurea* leaf

Chemical constituents:

***Digitalis purpurea* contains 35 glycosides:**

1. The primary glycosides are purpurea glycosides A and B.
2. It also contains Odoroside H, glucogitaloxin.
3. Verodoxin and glucoverodoxin.
4. The digitoxigenin, Digitoxin, Gitoxigenin, gitaloxin are also important medicinal compounds. They are also called secondary glycosides.
5. They contain anthraquinones derivatives like digitolutin, methoxy-2 methyl anthraquinones, etc
6. Contains saponin, flavonoids.
7. Tannins and pectin.



Chemical tests:

1. Raymond's test:

To the drug, add a few ml of 50% ethanol and 0.1 ml of 1 % solution of m- dinitrobenzene in ethanol. To this solution, add 2-3 drops of 20% sodium hydroxide solution. Violet colours appears, this is due to presence of active methylene group.

2. Legal test:

To the drug, add few ml of pyridine and 2drops of nitroprusside and a drop of 20% sodium hydroxide solution. A deep red colour is produced.

3. Killer killiani test:

Glycoside is dissolved in a mixture of 1 % ferric sulphate solution in (5%) glacial acetic acid. Add one or two drop of concentrated sulphuric acid. A blue colour develops due to the presence of deoxy sugar.

Xanthydrol test:

The crude is heated with 0.1 to 5% solution of Xanthydrol in glacial acetic acid containing 1% hydrochloric acid. A red colour is produced due to the presence of 2-deoxysugar.

4. Baljet test:

Take a piece of lamina or thick section of the leaf and add sodium picrate reagent. If glycoside is present yellow to orange colour will be seen.

Uses:

1. Cardiotonic.
2. Used in various forms like tablets or capsules in the treatment of congestive cardiac failure, atrial flutter, trial fibrillation and peroxymal atrial tachycardia.
3. Diuretic in cardiac edema.

Adulterants:

1. Primrose leaves:

Leaves of *Primula vulgaris* Huds (Fam: Pimulaceae).

2. Mullein leaves:

Leaves of *Verbascum thapsus* Linn. (Fam: Scrophulariaceae).

PEPPERMINT (MENTHA)

Botanical Source

It is the oil obtained by the distillation of *Mentha piperita*, belonging to family Labiatae.

Geographical Source

It is mainly found in Europe, United States, and also in damp places of England.

Characteristics

The leaves are shortly and distinctly stalked, 2 inches long and 3/4 to 1.5 inches broad. The margins are finely toothed, with smooth upper and lower surfaces The stems are 2 to 4 feet high, frequently purplish in colour. The flowers are reddish-violet in colour, present in the axils of the upper leaves, forming loose, interrupted spikes. The plant has a characteristic odour and if applied to the tongue has a hot, aromatic taste at first and afterwards produces a sensation of cold in the mouth caused by menthol present in it.

Chemical Constituents

The chief constituent of Peppermint oil is Menthol, along with other constituents like menthyl acetate, isovalerate, menthone, cineol, inactive pinene, limonene, and other less important bodies. Menthol separates on cooling it to a low temperature (–22°C). The flavouring properties of the oil are due to both the ester and alcoholic constituents, whereas the medicinal value is attributed only due to the alcoholic components. The English oil contains 60 to 70% of Menthol, the Japanese oil containing 85%, and the American has only about 50%.

Uses

It is stimulant, stomachic, carminative, inflatulence, and colic; in some dyspepsia, sudden pains, for cramp in the abdomen and also in cholera and diarrhoea. Oil of peppermint allays sickness and nausea, as infants cordial. Peppermint is good to aid in raising internal heat and inducing perspiration. It is also used in cases of hysteria and nervous disorders.

CLOVE

Biological Source

Clove consists of the dried flower buds of *Eugenia caryophyllus* Thumb., belonging to family Myrtaceae.

Geographical Source

Clove tree is a native of Indonesia. It is cultivated mainly in Islands of Zanzibar, Pemba, Brazil, Amboiana, and Sumatra. It is also found in Madagascar, Penang, Mauritius, West Indies, India, and Ceylon.

Characterisitics

Clove is reddish-brown in colour, with an upper crown and a hypanthium. The hypanthium is sub-cylindrical and tapering at the end. The hypanthium is 10 to 13 mm long, 4 mm wide, and 2 mm thick and has schizolysigenous oil glands and an ovary which is bilocular. The Crown region consists of the calyx, corolla, style and stamens. Calyx has four thick sepals. Corolla is also known as head, crown or cap; it is doineshaped and has four pale yellow coloured petals which are imbricate, immature, and membranous. The ovary consists of abundant ovules. Clove has strong spicy, aromatic odour, and pungent and aromatic taste.

Microscopy

The transverse section should be taken through the short upper portion which has the bilocular ovary and also through the hypanthium region. The transverse section through the hypanthium shows the following characters. It has a single layer of epidermis covered with thick cuticle. The epidermis has ranunculaceous stomata. The cortex has three distinct region: the peripheral region with two to three layers of schizolysigenous oil glands, embedded in parenchymatous cells. The middle layer has few layers of bicollateral vascular bundle. In the inner portion it has loosely arranged aerenchyma cells. The central cylinder contains thick-walled parenchyma with a ring of bicollateral vascular bundles and abundant sphaeraphides. The T.S. through ovary region shows the presence of an ovary with numerous ovules in it.

Chemical Constituents

Clove contains 14–21% of volatile oil. The other constituents present are the eugenol, acetyl eugenol, gallotannic acid, and two crystalline principles; α- and β- caryophyllenes, methyl

furfural, gum, resin, and fibre. Caryophyllin is odourless component and appears to be a phytosterol, whereas eugenol is a colourless liquid.

Uses

Clove oil has 60–90% eugenol, which is the cause of its anesthetic and antiseptic properties. It is used in toothache.

Cinnamon

Synonyms

Cinnamon Bark, Ceylon Cinnamon, Cinnamomi Cortex

Botanical Source

Cinnamon consists of the dried inner bark of the shoots of coppiced trees of *Cinnamomum zeylanicum* Nees, Family Lauraceae.

Geographical Source

Cinnamomum zeylanicum· is a small evergreen tree indigenous to Sri Lanka and cultivated in Sri Lanka and South India.

Morphological Characters

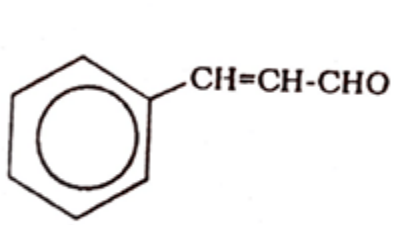
Odour is fragrant aromatic; taste warm, sweet and aromatic. Cinnamon bark occurs in single or double, closely packed, compound quilled pieces, up to 1 metre in length, 1 to 2 cm in diameter and about 0.5 mm in thickness, pale brown in colour.

Microscopical Characters

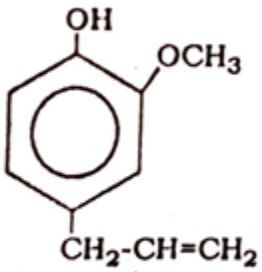
Cork and primary cortical cells are absent. except for occasional patches. Theoutermost layer consists of a 2 to 3 celled thick ban of pericyclic lignified sclerenchyma (similar to stone cells) associated with occasional groups of pcricyclic fibres. Each intact fibre is strongly thickened with pitted, lignified walls and concentric striations. Phloem parenchyma consists of elongated cell exhibiting numerous circular pits and containing acicular microcrystals of calcium oxalate and starch grains. Isolated or groups of fibres, similar to the pcricyclic fibres in structure, occur along with the phloem parcnchytna. Empty, elongated secretion cells occur in the phloem tissue. Two cells wide medullary rays traverse the phloem.

Chemical Constituents

Cinnamon contains 0.5 to 6.0 percent of volatile oil, the chief constituent of which is cinnamic aldehyde (60-70%) and eugenol (4%). Cinnamon also contains tannin and mucilage



Cinnamic aldehyde



Eugenol

Uses of Cinnamon

Cinnamon is chiefly used as a carminative and flavouring agent. It also possesses astringent and antibiotic properties. It is commercially used for extraction of Cinnamon oil and also as a spice.

Substitutes and Adulterants

The dried barks of other species Cinnamon, particularly Cinnamon cassia and C. Laure are used as substitutes and barks of other related plants adulterants of Cinnamon.

FENNEL

Synonyms

Sweet fennel, Wild fennel, Large fennel.

Biological Source

Fennel consists of the dried ripe fruits of *Foeniculum vulgare* Miller., belonging to family Umbelliferae.

Geographical Source

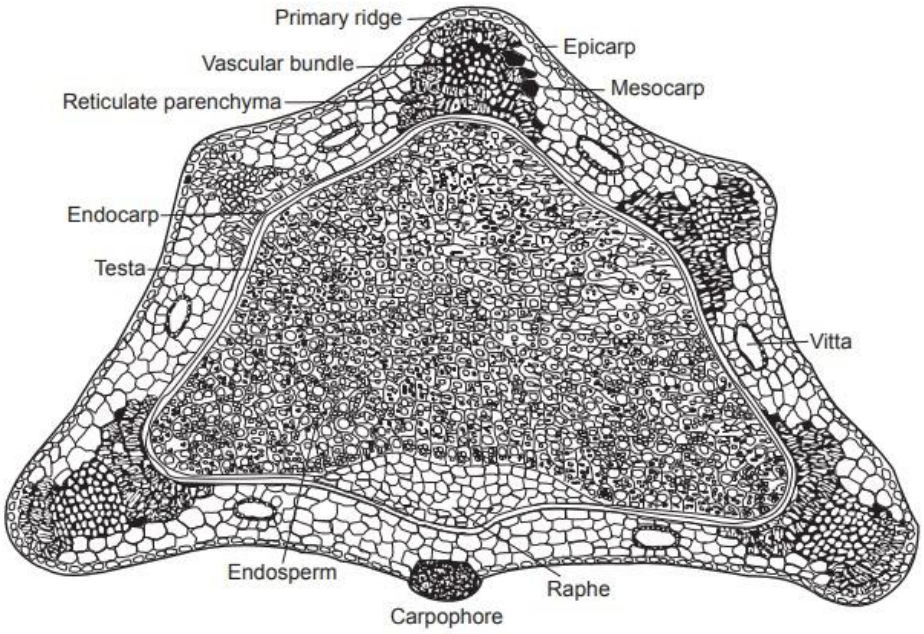
Fennel is indigenous to Mediterranean countries and Asia; it is largely cultivated in France, Saxony, Japan, Galicia, Russia, India, and Persia.

Characteristics

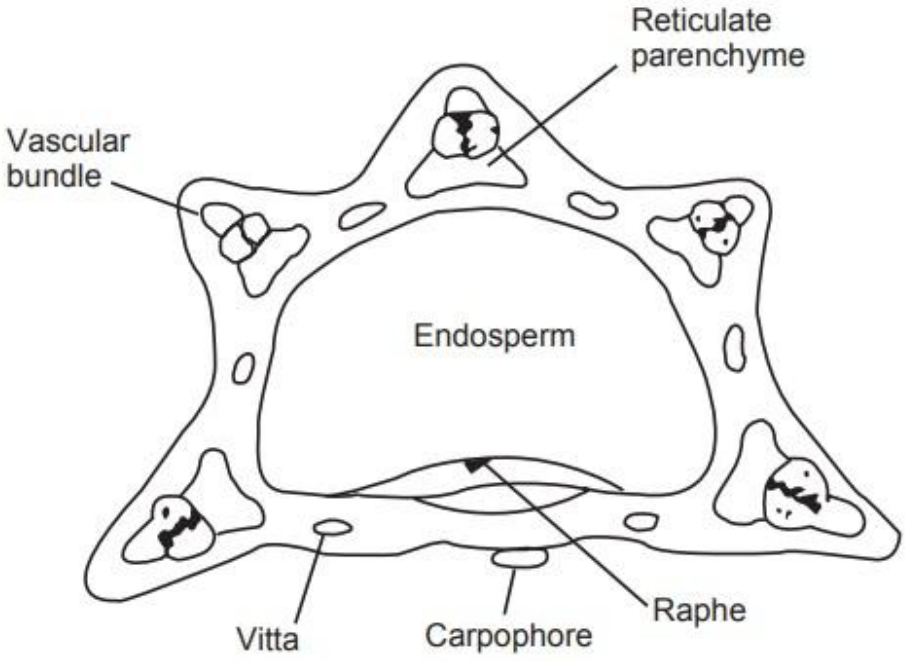
The fruit is an entire cremocarps with pedicels, oval-oblong and 5 to 10 mm long, 2 to 4 mm broad. It has greenish-brown to yellowish brown colour with five prominent primary ridges and a bifid stylopod at the apex.

Microscopy

The transverse section of mericarp region of fennel shows two prominent surfaces, the dorsal and the commissural surface. The commisural surface has a carpophore and two vittae, and the dorsal surface has a total of five ridges. The mericarp is divided into pericarp, consisting of the epicarp and mesocarp; the testa and the endocarp. Epicarp consists of polygonal cells of epidermis which are tangentially elon-gated and covered by the cuticle. Mesocarp has parenchyma cells with five bicollateral vascular bundles; below each primary ridge a lignified reticulate parenchyma surrounds the vascular bundles. There are four vittae on dorsal surface and two vittae on commisural or the ventral surface. Inner Epidermis or Endocarp shows parquetry arrangement (a group of four to five cells arranged parallelly at acute angles with groups of similar cells in different direction). Testa is a single-layered tangentially elongated cell with yellowish colour. Endosperm consists of thick-walled, wide polyhedral, colourless cells. Cells contain fixed oil, aleurone grains, and rosette crystals of calcium oxalate.



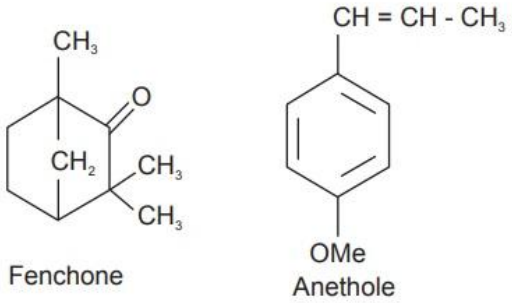
Transverse section of Fennel fruit (Mericarp)



T.S. (schematic) of Fennel fruit

Chemical Constituents

The best varieties of Fennel contain 4 to 5% of volatile oil. The primary constituents of volatile oil are 50 to 60% of **anethole**, a phenolic ester; and **18 to 22% of fenchone**, a ketone. Fenchone is chemically a bicyclic monoterpene which is a colourless liquid and the odour and taste is pungent and camphoraceous. The oil of Fennel has β-pinene, anisic acid, phellandrine, and anisic aldehyde. Fennel also contains about 20% fixed oil and 20% proteins.



Uses

- Fennel is used as stomachic, aromatic, diuretic, carminative, diaphoretic, as a digestive, pectoral, and flavouring agent.
- Anethole may have estrogen-like activity and inhibit spasms in smooth muscles.
- Fennel can increase production of bile, used in the treatment of infant colic, to promote menstruation in women, can increase lactation, act as antipyretic, antimicrobial and antiinflammatory.

Adulterants

Fennel is generally adulterated with exhausted fennel and due to improper caring during harvesting. They are also adulterated with sand, dirt, stem, weed seeds, etc in which part of volatile oil is removed either by extraction with alcohol or steam distillation. Fruits exhausted by water or steam are darker in colour, contain less essential oil and sink in water, but those exhausted by alcohol still hold 1 to 2% of oil in them.

Marketed Products

It is one of the ingredients of the preparations known as Abana, Shahicool, Anxocare (Himalaya Drug Company), Aptikid (Lubin Herbal Laboratory), Jalifaladi bati (Baidyanath), and Hajmola, Janum Gunti (Dabur).

CORIANDER

Synonyms

Fructus coriandri, Coriander fruits, Cilantro, Chinese parsley.

Biological Source

Coriander consists of dried ripe fruits of *Coriandrum sativum* Linn., belonging to family Umbelliferae.

Geographical Sources

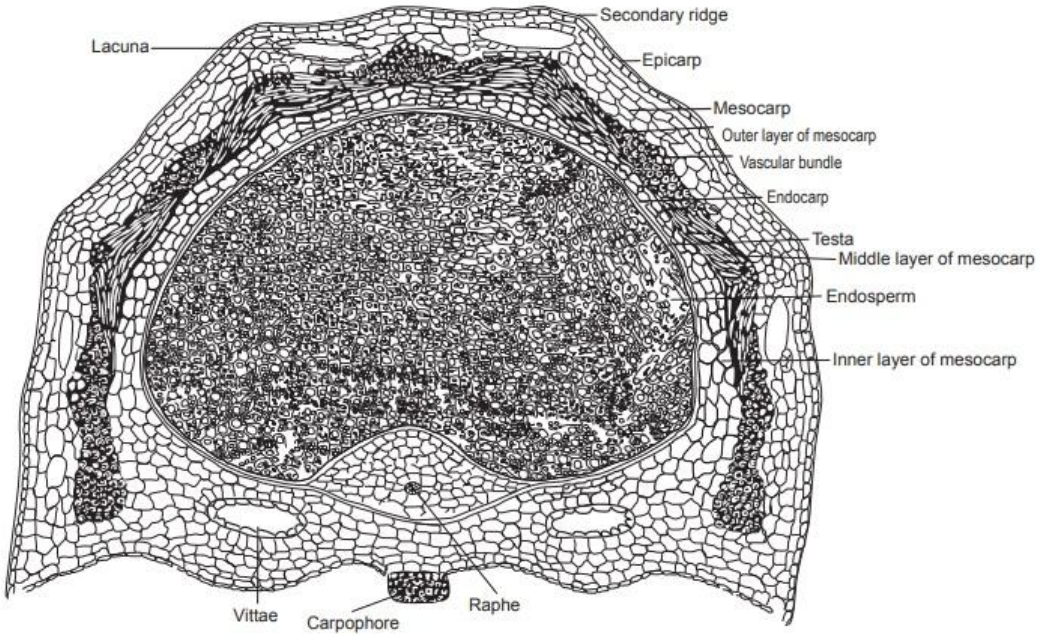
Cultivated in Central and Eastern Europe, particularly in Russia, Hungary, in Africa and India. In India it is cultivated in Maharashtra, U.P., Rajasthan, Jammu, and Kashmir. It is also found in a antiwild state in the east of England.

Characteristics

The fruit is a cremocarp, subspherical in shape, Yellowish-brown in colour. The size of the fruit is 3 to 4 mm in diameter, with aromatic odour, and spicy, aromatic taste.

Microscopy

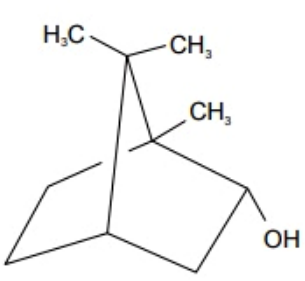
The transverse section of coriander shows the presence of a dorsal surface and a commissural surface. The dorsal surface consists of two vittae and a carpophore. The dorsal surface has five primary ridges and four secondary ridges. The epicarp consists of a single row of small thick-walled cells with calcium oxalate crystals. The mesocarp has an outer loosely arranged tangentially elongated parenchyma cells and the middle layer consisting of sclerenchyma. The middle layer is again divided into; the outer region of sclerenchyma is represented by longitudinally running fibres, whereas the inner region has tangentionally running fibres. The vascular bundles are present below the primary ridges. The inner layer has polygonal, irregularly arranged parenchyma cells. The endocarp has the parquetry arrangement. In the testa it has single-layered, yellowish cells, and the endosperm is thick, polygonal, colourless parenchyma with fixed oil and aleurone grains.



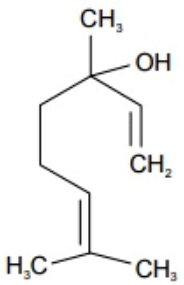
Transverse section of coriander fruit (mericarp)

Chemical Constituents

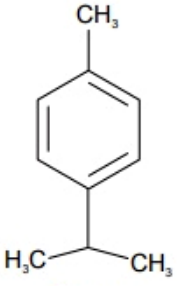
Coriander consist of about 1% of volatile oil the chief volatile components are D-(+)-linalool (coriandrol), along with other constituents like, borneol, p-cymene, camphor, geraniol, limonene, and alpha-pinenes. The fruits also contain fatty oil and hydroxycoumarins. The fatty oils include acids of petroselic acid, oleic acid, linolenic acid, whereas the hydroxycoumarins include the umbelliferone and scopoletine.



Borneol



Linalool



p-Cymene

Uses

Aromatic, carminative, stimulant, alterative, antispasmodic, diaphoretic and flavouring agent. It is also used as refriger-ant, tonic, appetizer, diuretic, aphrodisiac, and stomachic. Coriander can be applied externally for rheumatism and painful joints. The infusion of decoction of dried fruit of cardamom is useful for the treatment of sore-throat, indigestion, vomiting, flatulence, and other intestinal dis-orders.

Marketed Products

It is one of the ingredients of the preparations known as Cystone (Himalaya Drug Company), Bilwadi churna (Baidyanath), and Sage massage oil (Sage Herbals).

PTEROCARPUS

Synonyms

Bijasal, Indian kino tree, Malbar kino.

Biological Source

It consists of dried juice obtained by making vertical inci-sions to the stem bark of the plant *Pterocarpus marsupium* Linn., belonging to family Leguminosae.

Geographical Distribution

It is found in hilly regions of Gujarat, Madhya Pradesh, Uttar Pradesh, Bihar, and Orissa. It is also found in forests of Karnal, Kerala, West Bengal, and Assam.

Morphology

Colour	Ruby-red
Odour	Odourless
Taste	Astringent
Shape	Angular grains
Size	3 to 5 to 10 mm granules
Solubility	It is partly soluble in water (about 80—90%), completely soluble in alcohol (90%).
Extra features	The pieces of kino are angular, glistening, transparent, breaking with vitreous fracture.

Chemical Constituents

Kino contains about 70–80% of kinotannic acid, kino-red, k-pyrocatechin (catechol), resin and gallic acid. Kinotannic acid is glucosidal tannin, whereas kino-red is anhydride of kinoin. Kinoin is an insoluble phlobaphene and is produced by the action of oxydase enzyme. It is darker in colour than kinotannic acid.

Uses

Kino is used as powerful astringent and also in the treatment of diarrhoea and dysentery, passive haemorrhage, toothache, and in diabetes. It is used in dyeing, tanning, and printing. The aqueous infusion of the wood is considered to be of much use in diabetes. The alcoholic, as well as, aqueous extracts of heartwood are known to possess hypoglycaemic action. The cups made of wood are available with Khadi and Gramodyog commission for treatment of diabetes.

Marketed Products

It is the one of the components of the preparation known as Gludibit (Lupin Herbal Laboratory) and Diabecon (Hima-laya Drug Company) for *diabetes mellitus*.

BLACK CATECHU

Synonym

Cutch, black catechu, kattha.

Biological Source

Black catechu is the dried aqueous extract prepared from the heartwood of *Acacia catechu* Willdenow, belonging to family, Leguminosae.

Geographical Source

A. catechu is common throughout the tract from Punjab to Assam ascending to an altitude of 300 m. It is also quite common in drier regions of peninsula such as Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, Bihar, and Tamil Nadu.

Morphological characters

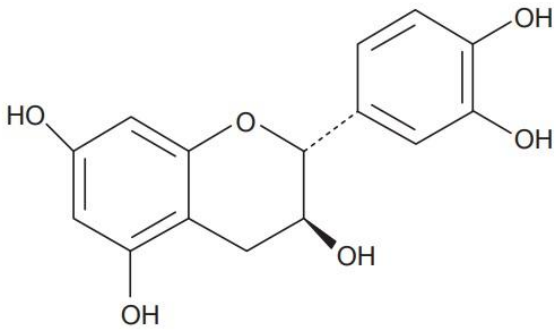
Colour	Black or brownish black mass
Odour	Odourless
Taste	Astringent and subsequently sweet taste
Size	Irregular mass
Extra features	Outer surface is firm and brittle. When broken the fractured surface appears glassy with small cavities

Microscopy

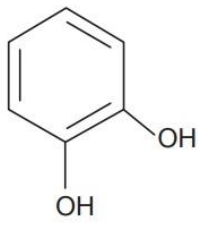
A transverse section of *A. catechu* heartwood shows numerous uniseriate and biseriate medullary rays, with vessels occurring isolated or in small groups of two or four. Xylem fibres with narrow lumen occupy major portion of wood and xylem parenchyma is usually predominantly paratracheal, forming a sheath around vessels. Wood consists of crystal fibres having prismatic crystals of calcium oxalate. A few tracheids with scalariform thickening and some cells including vessels are also present.

Chemical Constituents

Cutch or black catechu resembles pale catechu or gambier in its composition. It contains about 2–12% of catechin and about 25 to 33% of phlobatannin catechutannic acid. The principle fraction of cutch has been identified as a mixture of catechin isomers which includes (-) epicatechin, acatechin, DL-acacatechin, L-acacatechin and D-isoacacatechin. It also contains 20–30% gummy matter, catechin red, quercetin and querecitin. It yields 2–3% of ash.



Catechin



Catechol

Chemical Tests

1. Because of the presence of catechin, black catechu gives pink or red colour with vanillin and HCl.
2. Catechin when treated with HCl produces phlorogucinol, which burns along with lignin to give purple or magenta colour. For this purpose, tannin extract is taken on match stick dipped in HCl and heated near the flame.
3. Lime water when added to aqueous extract of black catechu gives brown colour, which turns to red precipitate on standing for some time.

Uses

Cutch is used in medicine as astringent. It cures troubles of mouth, diseases of the throat and diarrhoea. It also increases appetite. In India and eastern countries, it is used in betel leaves for chewing. In dyeing industries, cutch I used for dyeing fabrics brown or black.

Marketed Products

It is one of the ingredients of the preparation known as Koflet lozenge (Himalaya Drug Company) as cough expectorant, and Gum tone (Charak Pharma Pvt. Ltd.).

BENZOIN

Synonyms

Gum Benjamin; Benzoinum; Benzoin; Luban (Hindi).

Biological Source

Sumatra Benzoin is obtained from the incised stem of *Styrax benzoin* Dryander and *Styrax parallelo-neurus* Perkins., *Styrax tonkinensis* Craib. (Siam Benzoin), belonging to family Styraceae. It contains about 25% of total balsamic acids, calculated as cinnamic acid

Geographical Source

The trees are found in Sumatra, Malacca, Malaya, Java, and Borneo.

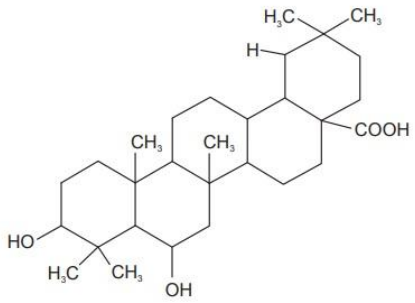
Characteristics

Sumatra benzoin occurs in brittle masses consisting of opaque, whitish, or reddish tears embedded in a translucent, reddish-brown or greyish-brown, resinous matrix. Odour, agreeable and balsamic, taste, slightly acrid. Siamese benzoin occurs in tears or in blocks. The tears are of variable size and flattened; they are yellowish-brown or reddish-brown externally, but milky-white and opaque internally. The block form consists of small tears embedded in a glassy, reddish-brown, resinous matrix. It has a vanilla-like odour and a balsamic taste.

When heated, benzoin evolves white fumes of cinnamic and benzoic acids which readily condense on a cool surface as a crystalline sublimate.

Chemical Constituents

Sumatra Benzoin consists of free balsamic acid (cinnamic and benzoic acids) (25%) and their esters. The amount of cinnamic acid is usually double that of benzoic acid. It also contains triterpenic acids like siaresinolic acid (19-hydroxy-oleanolic acid) and sumaresinolic acid (6-hydroxy-oleanolic acid); traces of vanillin, phenylpropyl cinnamate, cinnamyl cinnamate, and phenylethylene.



Siaresinolic acid

Uses

Sumatra Benzoin possesses expectorant, antiseptic, carminative, stimulant, and diuretic properties. It is used in cosmetic lotions, perfumery and to prepare Compound Benzoin. It forms an ingredient of inhalations in the treatment of catarrh of upper respiratory tract in the form of

Compound Benzoin Tincture. Benzoin is used as an external antiseptic and protective, and is one of the main ingredients of Friar's Balsam. It is also used to fix the odour of incenses, skin-soaps, perfumes and other cosmetics and for fixing the taste of certain pharmaceutical preparations. Benzoin retards rancification of fats and is used for this purpose in the official benzoinated lard, also used in food, drinks and in incense.

Allied Drug

Palembang benzoin, an interior variety produced in Sumatra is collected from isolated trees from which the resin has not been stripped for some time.

GUGGUL

Synonyms

Gumgugul, Salai-gogil

Biological Source

Guggal is a gumresin obtained by incision of the bark of *Commiphora mukul* (H. and S.) Engl., belonging to family Burseraceae.

Geographical Source

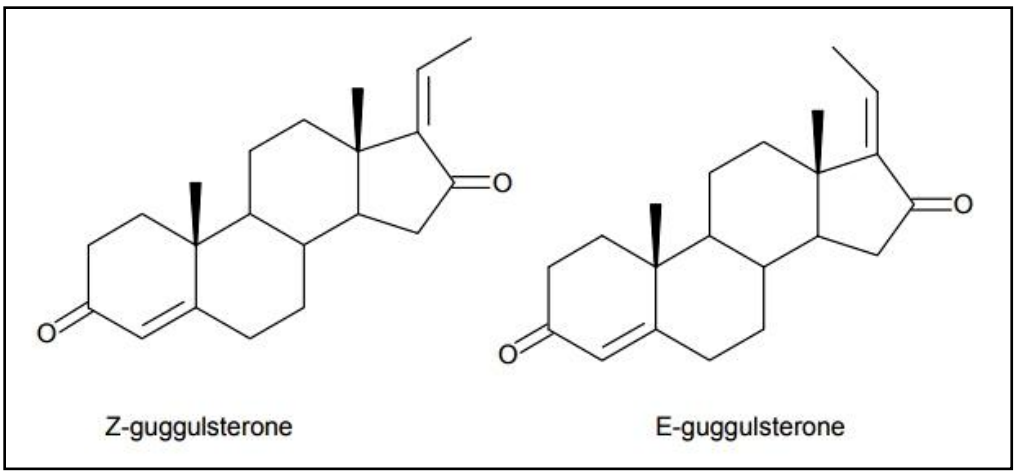
The tree is a small, thorny plant distributed throughout India.

Characteristics

Guggal occurs as viscid, brown tears; or in fragment pieces, mixed with stem, piece of bark; golden yellow to brown in colour. With water it forms a milk emulsion. It has a balsamic odour and taste is bitter, aromatic.

Chemical Constituents

Guggal contains gum (32%), essential oil (1.45%), sterols (guggulsterols I to VI, β-sitosterol, cholesterol, Z- and E-guggulsterone), sugars (sucrose, fructose), amino acids, α-camphorene, cembrene, allylcembrol, flavonoids (quercetin and its glycosides), ellagic acid, myricyl alcohol, aliphatic tetrols, etc.



Uses

Guggal significantly lowers serum triglycerides and cholesterol as well as LDL and VLDL cholesterols (the bad cholesterols). At the same time, it raises levels of HDL cholesterol (the good cholesterol), inhibits platelet aggregation, and may increase thermogenesis through stimulation of the thyroid, potentially resulting in weight loss. Also gum is astringent, aritirheumatic, antiseptic, expectorant, aphrodisiac, demulcent, and emmenagogue. The resin is used in the form of a lotion for indolent ulcers and as a gargle in teeth disorders, tonsillitis, pharyngitis, and ulcerated throat.

Marketed Products

It is one of the ingredients of the preparations known as Arogyavardhini Gutika (Dabur) and Abana, Diabecon, Diakof (Himalaya Drug Company).

GINGER

Synonyms

Rhizoma zingiberis, Zingibere, Adrak

Biological Source

Ginger consists of the dried rhizomes of the *Zingiber officinale* Roscoe, belonging to family Zingiberaceae.

Geographical Source

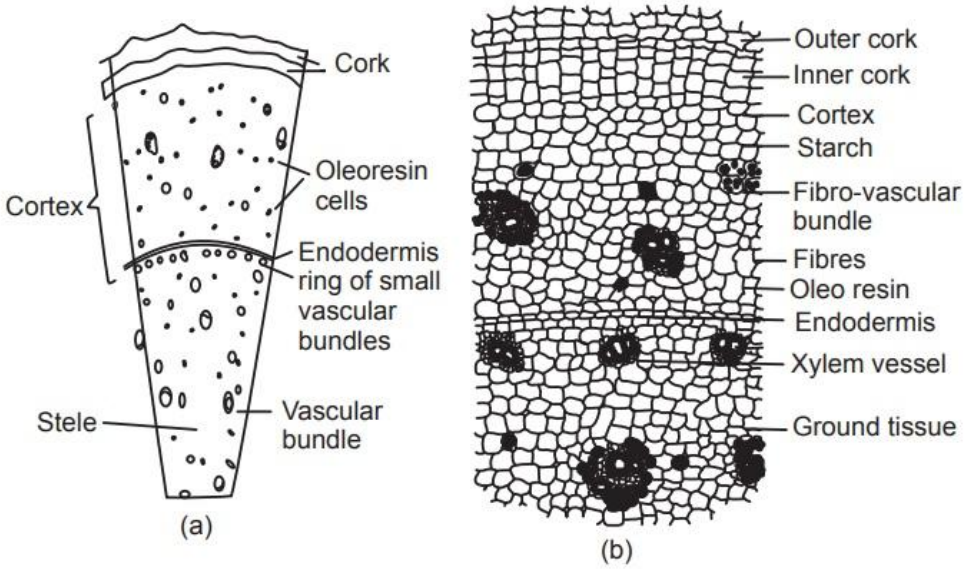
It is mainly cultivated in West Indies, Nigeria, Jamaica, India, Japan, and Africa.

Characteristics

The rhizomes are 5 to 15 cm long, 3 to 6 cm wide, and about 1.5 cm thick. The Jamaica ginger occurs as branches. It has a sympodial branching and the outer surface has buff yellow colour with longitudinally striated fibres. Small circular depressions at the portion of the buds are seen and fractured surface shows narrow bark, a well-developed endodermis, and a wide stele, with scattered small yellowish points of secretion cells and grayish points of fibrovascular bundles. The ginger has agreeable and aromatic odour and pungent and agreeable taste.

Microscopy

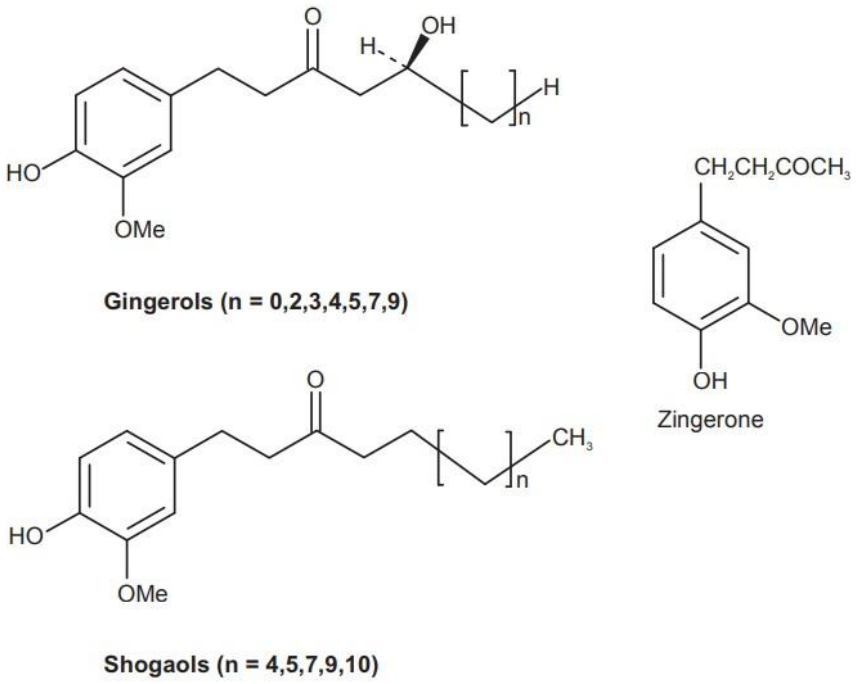
The cork is the outermost layer with irregular parenchymatous cells and dark brown colour. The inner cork is few layered, colourless parenchymatous cells arranged in radial rows. Cork is absent in Jamaica ginger. Phellogen is indistinct and the cortex consists of thin-walled rounded parenchyma with intercellular spaces consisting of abundant starch grains. The starch grains are simple, ovate, or sac shaped. Numerous yellowish brown oleoresin are also present along with the collateral fibro vascular bundles. The endodermis is distinct without starch and consists of single layer of tangentially elongated cells containing suberin. Just below the endodermis it has the ground tissue, a ring of narrow zone of vascular bundle which is not covered with sclerenchymatous fibres. The ground tissues contain the large parenchymatous cells rich in starch, oleoresin, fibrovascular bundles. The phloem has well-developed sieve elements, and the xylem consist of vessels, tracheids either annual or spiral, or reticular in nature without lignin. The fibres are unlignified, pitted, and separate.



(a) Schematic diagram (T.S.) and, (b) Transverse section of Ginger rhizome

Chemical Constituents

Ginger contains 1 to 2% volatile oil, 5 to 8% pungent resinous mass and starch. The volatile oil is responsible for the aromatic odour and the pungency of the drug is due to the yellowish oily body called gingerol which is odourless. Volatile oil is composed of sesquiterpene hydrocarbon like α-zingiberol; α-sesquiterpene alcohol α-bisabolene, α-farnesene, α-sesquiphellandrene. Less pungent components like gingerone and shogaol are also present. Shogal is formed by the dehydration of gingerol and is not present in fresh rhizome.



Uses

Ginger is used as an antiemetic, positive inotropic, spasmolytic, aromatic stimulant, carminative, condiment, and flavouring agent. It is prescribed in dyspepsia, flatulent colic, vomiting spasms, as an adjunct to many tonic and stimulating remedies, for painful affections of the stomach, cold, cough, and asthma. Sore throat, hoarseness, and loss of voice are benefited by chewing a piece of ginger.

Adulteration

Ginger may be adulterated by addition of 'wormy' drug or 'spent ginger' which has been exhausted in the extraction of resins and volatile oil. This adulteration may be detected by the official standards, for alcohol-soluble portion, water-soluble portion, total ash and water-soluble ash. Sometimes pungency of exhausted ginger is increased by the addition of capsicum.

Marketed Products

It is one of the ingredients of the preparations known as Pain kill oil, J.P. Liver syrup (Jamuna Pharma), Abana, Gasex (Himalaya Drug Company), Hajmola (Dabur), Strepsils (Boots Piramal Healthcare), and Sage Massaj oil (Sage Herbals).

SENNA LEAF

Synonyms

Alexandrian senna, Tinnevelly senna, Folia senna.

Biological Source

Senna leaf consists of the dried leaflets of *Cassia acutifolia* Delile (*C. senna* L.) known as Alexandrian senna and of *C. angustifolia* Vahl., which is commercially known as Tin-nevelly senna. It belong family Leguminosae.

Geographical Source

Alexandrian senna is indigenous to South Africa. It widely grows and sometimes is cultivated in Egypt and in the middle upper territories of Nile river. It is also cultivated in Kordofan and Sennar regions of Sudan. **Indian or Tinnevelly senna** is indigenous to southern Arabia and cultivated largely in Tinnevelly and Ramnathpuram districts of Tamilnadu. It also grows in Somaliland, Sindh and Punjab region.

Characteristics

Senna leaflets are 3–5 cm long, 2 cm wide and about 0.5 mm thick. It shows acute apex, entire margin and asymmetric base. Outline is lanceolate to ovate lanceolate. Pubescent lamina is found on both the surfaces. Leaves show greyish green colour for Alexandrian senna and yellowish green for Tinnevelly senna. Leaves of Tinnevelly senna are somewhat larger, less broken and firmer in texture than that of Alexandrian senna. Odour of leaves is slight but characteristic and the taste is bitter, mucilagenous. Both the types of leaflets show impression or transverse markings due to the pressing of midrib. Distingushing characters of Alexandrian and Indian senna are given in Table below.

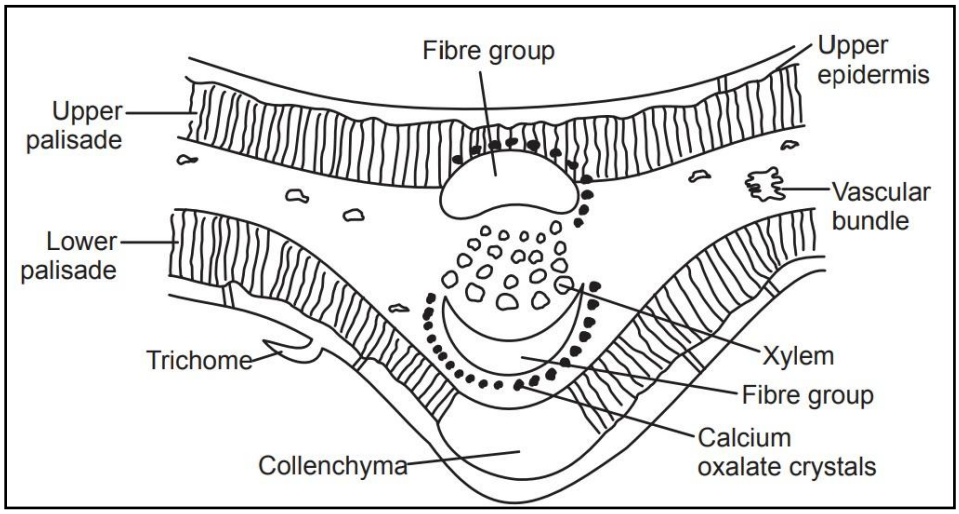
Table : Distinguishing characters of Alexandrian and Indian senna

Character	Indian Senna	Alexandrian senna
Appearance	Generally entire and less broken in good condition	Broken and brittle in nature
Size	2.5–5.0 cm long and 7–9 mm wide	2.4 cm long and 6–12 mm wide.
Shape	Lanceolate	Ovate lanceolate
Apex	Less acute with a sharp spine	Acute with a sharp spine
Margin	Entire, flat	Entire curled
Base	Less asymmetrical	Conspicuously asymmetrical
Veins	Pinnate, distinct towards the under surface and anastomosing towards margin	Pinnate, distinct towards the under surface and anastomosing towards margin
Surface	Transverse and oblique impressions, less pubescent (hairy)	Without transverse and oblique impressions and more pubescent
Texture	Flexible and less brittle	Thin more brittle
Odour	Faint	Faint
Colour	Light green	Light greyish green
Test	Bitter mucilaginous	Bitter mucilaginous
Vein Islet Number	19–22.5	25–29.5
Stomatal index	14–20	10–15
Palisade ratio	4–12	4.5–18

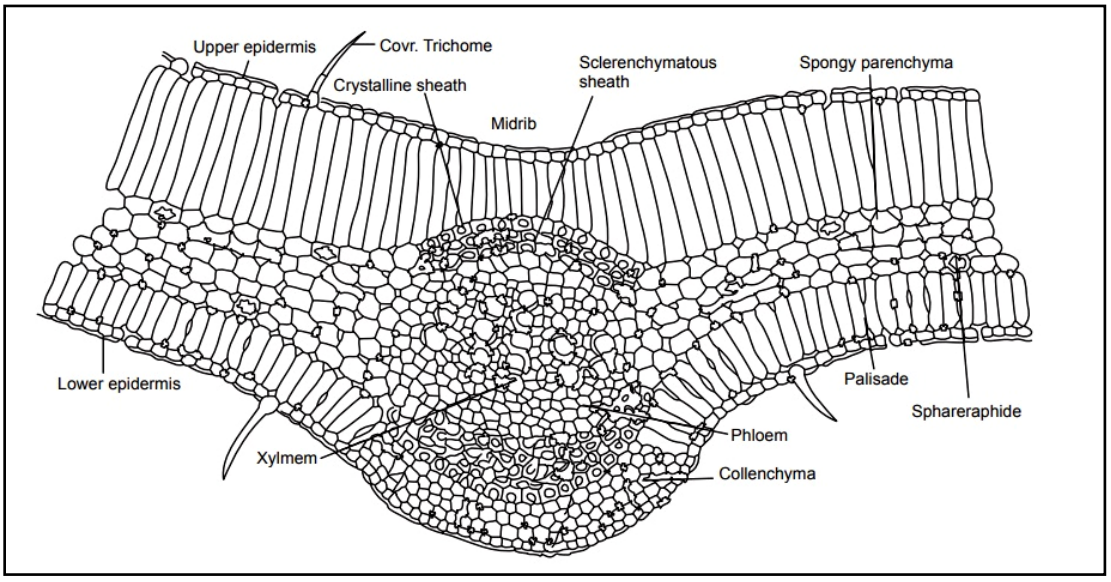
Microscopy

Being isobilateral leaf, senna shows more or less similar features at both the surfaces of leaf with few differences. Transverse section of leaf shows upper and lower epidermis with straight wall cells, few of which contain mucilage. Paracytic stomata and nonlignified unicellular trichomes are found on both the surfaces. A single layer of palisade parenchyma is observed at both the sides but it is discontinued in the midrib region of lower epidermis due to the zone of collenchymatous tissues. Palisade is followed by spongy mesophyll which contains cluster

crystals of calcium oxalate and vascular strands. Midrib shows the vascular bundle containing xylem and phloem, almost surrounded by lignified pericyclic fibres and a sheath of parenchyma which contains prismatic crystals of calcium oxalate.



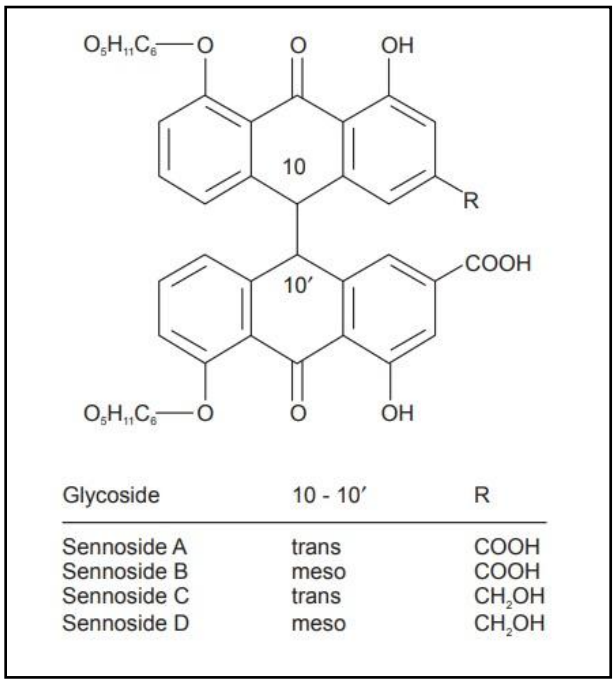
Transverse section of senna leaf (schematic)



Transverse section of senna leaflet

Chemical Constituents

Senna contains sennosides A and B (2.5%) based on the aglycones sennidin A and B, sennosides C and D which are glycosides of heterodianthrones of aloe-emodin and rhein are present. Others include palmidin A, rhein anthrone and aloe-emodin glycosides. Senna also contains free chryso phanol, emodin and their glycosides and free aloe-emodin, rhein, their monoanthrones, dianthrones and their glycosides. Mucilage is present in the epidermis of the leaf and gives red colour with ruthenium red.



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

Chemical Test

Borntrager test for anthraquinones: The leaves are boiled with dilute sulphuric acid and filtered. To the filtrate organic solvent like benzene, ether or chloroform is added and shaken. The organic layer is separated, and to it add ammonia solution. The ammoniacal layer produces pink to red colour indicating the presence of anthraquinone glycoside.

Uses

Senna leaves are used as laxative. It causes irritation of large intestine and have some griping effect. Thus they are prescribed along with carminatives. Senna is stimulant cathartic and exerts its action by increasing the tone of the smooth muscles in large intestine.

Adulterants

Cassia obovata (Dog Senna): They occur as small pieces with Alexandrian senna but can be easily identified by its obovata shape and obtuse and tapering apex. It has only 1% anthraquinone derivatives. The presence of *Cassia auriculata* (Palthe senna) can be identified by treating it with 80% sulphuric acid. It gives red colour.

ALOE

Biological Source

Aloe is the dried juice collected by incision, from the bases of the leaves of various species of Aloe. *Aloe perryi* Baker, *Aloe vera* Linn or *Aloe barbadensis* Mil and *Aloe ferox* Miller., belonging to family Liliaceae.

Geographical Source

Aloes are indigenous to East and South Africa, but have been introduced into the West Indies and into tropical countries, and will even flourish in the countries bordering on the Mediterranean.

Cultivation and Collection

It is an evergreen perennial growing to 0.8 m by 1 m at a slow rate. The plant prefers light (sandy) and medium (loamy) soils, requires well-drained soil and can grow in nutritionally poor soil. The plant prefers acid, neutral and basic (alkaline) soils. It cannot grow in the shade. It requires dry or moist soil and can tolerate drought. They are xerophytic plant. It can be propagated by seeds. Seeds are sown in the spring in a warm green house. The seed usually germinates in 1–6 months at 16°C. The seedlings are transferred to the pots containing well-drained soil. They are allowed to grow in sunny part for at least their first two winters. The offsets will be available, usually in spring. The plants produce offsets quite freely and they can be divided at any time of the year as long as it is warm enough to encourage fresh root growth to allow reestablishment of the plants. Young offsets are planted in the soil after the rainy season in rows situated at a distance of 60 cm.

In the second year leaves are collected by the natives by protecting their hands because of the spiny nature of leaves. The leaves are cut near the base, kept inside of kerosene tins and taken them to a central place for the preparation of aloe. Juice of aloe is present in parenchymatous cells of pericycle that are mucilage cells. In a single incision mucilage cells exert pressure on pericycle cells and the entire juice from the leaves is drained out.

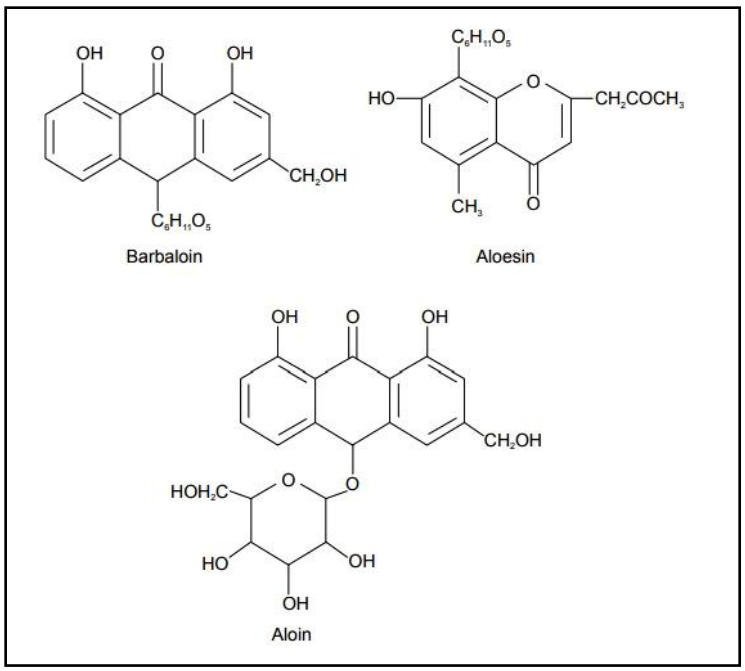
Characteristics

Curacao aloe

It is usually opaque and varies in colour from bright yellow-ish or rich reddish brown to black. Sometimes it is vitreous and small fragments are then of a deep garnet-red colour and transparent. It is then known as 'Capey Barbados' and is less valuable, but may become opaque and more valuable by keeping. Curacoa Aloes possesses the nauseous and bitter taste that is characteristic of all Aloes and a disagreeable, penetrating odour. It is almost entirely soluble in 60% alcohol and contains not more than 30% of substances insoluble in water and 12% of moisture. It should not yield more than 3% of ash. The fracture is waxy.

Chemical Constituents

The most important constituents of Aloes are the three isomers of Aloins, Barbaloin, β-barboloin and Isobarbaloin, which constitute the so-called 'crystalline' Aloin, present in the drug at from 10 to 30%. Other constituents are amor-phous Aloin, resin, emodin and Aloe-emodin. Barbaloin is present in all the varieties; it is slightly yellow coloured, bitter, water soluble, crystalline glycoside. Isobarbaloin is a crystalline substance, present in Curacao aloe and in trace amount in Cape aloe and absent in Socotrine and Zanzibar aloe. The chief constituents of Socotrine and Zanzibar aloe are Barbaloin and β-Barbaloin.



Chemical Tests

Boil 1 gm of drug with 100 ml water, allow it to cool; add 1 gm kieselguhr, stir it well and filter through filter paper.

1. *Borax Test:* Take 10 ml of aloe solution and to it add 0.5 gm of borax and heat; a green coloured fluorescence is produced indicating the presence of aloe-emodin anthranol.
2. *Modified Anthraquinone Test:* To 0.1 gm of drug, 5 ml of 5% solution of ferric chloride is added followed by the addition of 5 ml dilute hydrochloric acid. The mixture is heated on water bath for 5–6 min and cooled. An organic solvent (benzene or chloroform) is added and shaken. Separate the organic solvent layer and add an equal volume of dilute ammonia. The ammoniacal layer produces pinkish red colour.
3. *Bromine Test:* To 5 ml of aloe solution, add equal volume of bromine solution; bulky yellow precipitate is formed due to the presence of tetrabromaloin.
4. *Nitrous Acid Test:* To 5 ml of aloe solution, add little of sodium nitrite and few drops of dilute acetic acid; it produces Pink or purplish colour. Zanzibar and Socotrine aloes give negative test.
5. *Nitric Acid Test:* 2 ml of concentrated nitric acid is added to 5 ml of aloe solution; Curacao aloe gives deep reddish-brown colour, Socotrine aloe gives pale yellowish-

brown colour, Zanzibar aloe gives yellowish-brown colour and Cape aloe first produces brown colour which on standing changes to green.

6. *Cupraloin Test:* 1 ml of the aloe solution is diluted to 5 ml with water and to it 1 drop of copper sulphate solution is added. Bright yellow colour is produced which on addition of 10 drops of saturated solution of sodium chloride changes to purple and the colour persist if 15–20 drops of 90% alcohol is added. This test is positive for Curocao aloe, faint for Cape aloe and negative for Zanzibar and Socotrine aloes.

Uses

The drug Aloes is one of the safest and stimulating purga-tives, in higher doses may act as abortifacient. Its action is exerted mainly on the large intestine; also it is useful as a vermifuge. The plant is emmenagogue, emollient, stimu-lant, stomachic, tonic and vulnerary. Extracts of the plant have antibacterial activity. The clear gel of the leaf makes an excellent treatment for wounds, burns and other skin disorders, placing a protective coat over the affected area, speeding up the rate of healing and reducing the risk of infection. To obtain this gel, the leaves can be cut in half along their length and the inner pulp rubbed over the affected area of skin. This has an immediate soothing effect on all sorts of burns and other skin problems.

Substituents and Adulterants

A. candelsbmm (Natal aloes) is dull greenish black to dull brown in colour, opaque. When scraped it gives a pale greyish green or a yellow powder. It can be distinguished as it gives negative test to borax test and produces a deep blue colour. Jafferabad aloes and the Mocha aloes are the other two type of aloe which is used as adulterant.

Marketed Products

It is one of the ingredients of the preparations known as Diabecon, Evecare (Himalaya Drug Company), Mensonorm (Chirayu Pharma) and Kumari Asava (Baidyanath).

ASAFOETIDA

Synonyms

Devil’s dung; food of the gods; asafoda; asant; hing (Hindi).

Biological Source

Asafoetida is an oleo-gum resin obtained as an exudation by incision of the decapitated rhizome and roots of *Ferula asafoetida* L, *F. foetida*, Royel, *F. rubricaulis* Boiss, and some other species of Ferula, belonging to family Apiaceae.

Geographical Source

The plant grows in Iran, Turkestan and Afghanistan (Karam and Chagai districts).

Characteristics

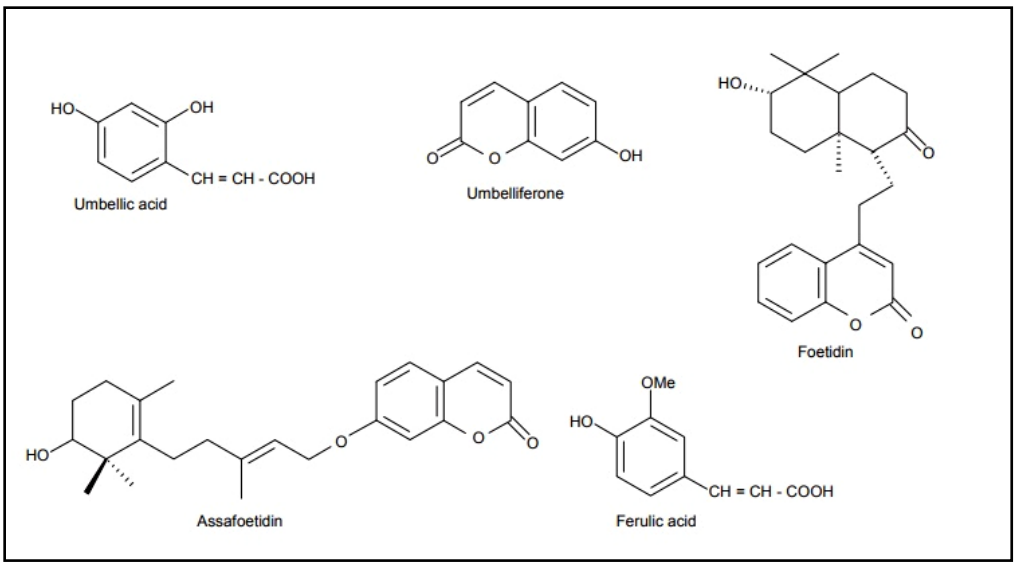
Asafoetida occurs as a soft solid mass or irregular lumps or 'tears', sometimes almost semiliquid. Tears are rounded or flattened and about 5–30 mm in diameter, grayish-white or dull yellow or reddish brown in colour.

Asafoetida mass is mixed with fruits, fragments of root, sand and other impurities. Asafoetida has a strong garlic-like (alliaceous) odour and a bitter, acrid and alliaceous taste. When triturated with water, it makes a milky emulsion. It should not have more than 50% of matter insoluble in alcohol (90%) and not more than 15% of ash.

Chemical Constituents

Asafoetida contains volatile oil (4–20%), resin (40–65%), and gum (25%). The garlic-like odour of the oil is due to the presence of sulphur compounds. The main constituent of the oil is isobutyl propanyl disulphide ($C_6H_{16}S_2$). The three sulphur compounds, such as, 1-methylpropyl-1-propenyl disulphide, l-(methylthio)-propyl-1-pro-penyl disulphide, and l-methyl-propyl 3-(methylthio)-2-propenyl disulphide have also been isolated from the resin; the latter two have pesticidal properties. The flavour is largely due to R-2-butyl-l-propenyl disulphide and 2-butyl-3-methylthioallyl disulphide (both as mixtures of diastereoisomers).

The drug also contains a complex mixture of sesquiterpene umbelliferyl ethers mostly with a monocyclic or bicyclic terpenoid moiety. Resin consists of ester of asaresinotannol and ferulic acid, pinene, vanillin and free ferulic acid. On treatment of ferulic acid with hydrochloric acid, it is converted into umbelliferone (a coumarin) which gives blue fluorescence with ammonia.



Asafoetida also contains phellandrene, sec-butylpropenyl disulphide, geranyl acetate, bornyl acetate, α-terpineol, myristic acid, camphene, myrcene, limonene, fenchone, eugenol, linalool, geraniol, isoborneol, borneol, guaiacol, cadinol, farnesol, assafoetidin, foetidin, etc.

Chemical Tests

1. On trituration with water it produces a milky emulsion.
2. The drug (0.5 g) is boiled with hydrochloric acid (5 ml) for some time. It is filtered and ammonia is added to the filtrate. A blue fluorescence is obtained.
3. To the fractured surface add 50% nitric acid. Green colour is produced.
4. To the fractured surface of the drug, add sulphuric acid (1 drop). A red colour is obtained which changes to violet on washing with water.

Uses

Asafoetida is used as carminative, expectorant, antispas-modic, and laxative as well as externally to prevent bandage chewing by dogs; for flavouring curries, sauces, and pickles; as an enema for intestinal flatulence, in hysterical and epileptic affections, in cholera, asthma, whooping cough, and chronic bronchitis.

Adulteration

Asafoetida is adulterated with gum Arabic, other gum-resins, rosin, gypsum, red clay, chalk, barley or wheat flour, and slices of potatoes.

MYRRH

Synonyms

Gum-resin Myrrh; Gum Myrrh; Arabian or Somali Myrrh; Myrrha.

Biological Source

Myrrh is an oleo gum-resin obtained from the stem of *Commiphora molmol* Eng. or other species of Commiphora, belonging to family Burscraceae.

Geographical Source

It grows in Arabian pennisula, Ethiopia, Nubia, and Somal-iland.

Characteristics

Myrrh occurs as irregular masses or tears weighing up to 250 g. The outer surface is powdery and reddish-brown in colour. The drug breaks and is powdered readily. Fractured surface is rich brown and oily. Odour is aromatic and taste is aromatic, bitter, and acrid.

Chemical Constituents

Myrrh contains resin (25–40%), gum (57–61%), and volatile oil (7–17%). Large portion of the resin is ether-soluble containing α-, β-, and γ-commiphoric acids, resenes, the esters of another resin acid and two phenolic compounds. The volatile oil is a mixture of cuminic aldehyde, eugenol, cresol, pinene, limonene, dipentene, and two sesquiterpenes. The disagreeable odour of the oil is due to mainly the disulphide. The gum contains proteins (18%) and carbohydrate (64%) which is a mixture of galactose, arabinose, glucuronic acid, and an oxidase enzyme.

Chemical Tests

1. A yellow brown emulsion is produced on trituration with water.
2. Ethereal solution of Myrrh turns red on treatment with bromine vapours. The solution becomes purple with nitric acid.

Uses

Myrrh is used as carminative and in incense and perfumes. It has local stimulant and antiseptic properties and is utilized in tooth powder and as mouth wash. Topically it is astringent to mucous membranes. It is used in a tincture, paint, gargle and rinse due to its disinfecting, deodourizing, and in inflammatory conditions of the mouth and throat. Alcoholic extracts are used as fixatives in the perfumery industry.

Marketed Products

It has been marketed as Guggulipid by CDRI, Lucknow, India. In ayurveda, it is sold as Yograj guggulu (Baidyanath) for antiinflammatory and antihyperlipidemic activity, and it is also a constituent of Madhumehari (Baidyanath).

GENTIAN

Synonyms

Gentian Root, Yellow Gentian Root

Biological Source

Gentian consists of dried unfermented rhizomes and roots of *Gentiana lutea* Linn., belonging to family Gentianaceae.

Geographical Source

Mountanious regions of Central and south Europe, of France and Switzerland, of Spain and Portugal, the Pyr-enees, Sardinia and Corsica, the Apennines, the Mountains of Auvergne, the Jura, the lower slopes of the Vosges, the Black Forest and throughout the chain of the Alps as far as Bosnia and the Balkan States.

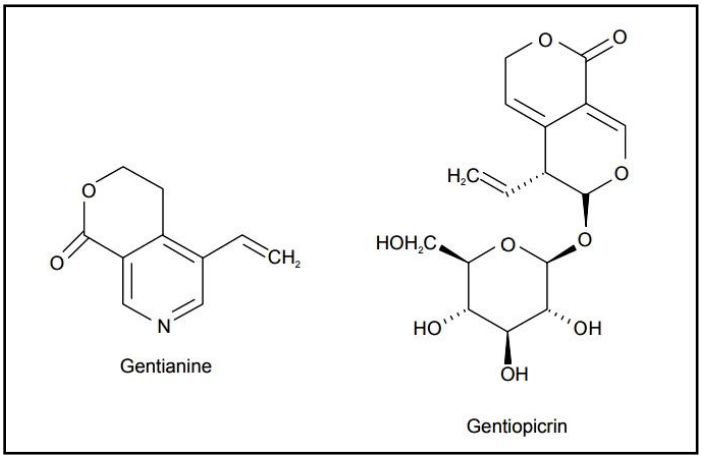
Characteristics

When fresh, they are yellowish-white externally, but gradually become darker by slow drying. Slow drying is employed to prevent deterioration in colour and to improve the aroma. Occasionally the roots are longitudinally sliced and quickly dried; the drug being then pale in colour and unusually bitter in taste, but this variety is not official.

The dried root as it occurs in commerce is brown and cylindrical, 1 foot or more in length, or broken up into shorter pieces, usually 1/2 inch to 1 inch in diameter, rather soft and spongy, with a thick reddish bark, tough and flexible, and of an orange-brown colour internally. The upper portion is marked with numerous rings, the lower longitudinally wrinkled. The root has a strong, disagreeable odour, and the taste is slightly sweet at first, but afterwards very bitter.

Chemical Constituents

Gentian contains bitter glycosides. The dried gentian root contains Gentinin and Gentiamarin, bitter glucosides, together with Gentianic acid (gentisin), the latter being physiologically inactive. Gentiopicrin, another bitter glucoside, a pale yellow crystalline substance, occurs in the fresh root, and may be isolated from it by treatment with boiling alcohol. Gentinin, crystalline glycoside is not a pure chemical substance, but a mixture of gentiopicrin and a colouring substance gentisin (gentianine) or gentlanic acid. Gentian contains a bitter trisaccharide, gentianose which on hydrolysis yields two molecules of glucose and one molecule of fructose. The saccharine constituents of gentian are dextrose, laevulose, sucrose and gentianose, a crystallizable, fermentable sugar. It is free from starch and yields from 3 to 4% ash.



Uses

Gentian root has a long history of use as an herbal bitter in the treatment of digestive disorders. It contains some of the most bitter compounds known and is used as a scientific basis for measuring bitterness. It is useful in states of exhaustion from chronic disease and in all cases of debility, weakness of the digestive system and lack of appetite. It is one of the best strengthened of the human system, stimulating the liver, gall bladder and digestive system, and is an excellent tonic to combine with a purgative in order to prevent its debilitating effects.

It is also used as anthelmintic, antiinflammatory, antiseptic, bitter tonic, cholagogue, emmenagogue, and febrifuge, refrigerant and stomachic. It is taken internally in the treatment of

liver complaints, indigestion, gastric infections and anorexia. It should not be prescribed for patients with gastric or duodenal ulcers.

COLOPHONY

Synonyms

Rosin, yellow resin; Abietic anhydride; colophony resin; amber resin; resin; coloponium.

Biological Source

Colophony is a solid residue left after distilling off the volatile oil from the oleoresin obtained from *Pinus palustris* (long leaf pine) and other species of *Pinus* such as *P. pinaster*, *P. halepensis*, *P. massoniana*, *P. tabuliformis*, *P. carribacea* var., belonging to family Pinaceae.

Geographical Source

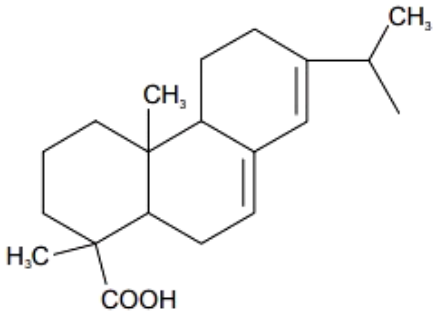
The genus *Pinus* is widely found in United States, France, Italy, Portugal, Spain, Greece, New Zealand, China, India (Himalayan region), and Pakistan. Colophony is chiefly produced in the United States contributing about 80% of world supply. Other countries producing the resin are China, France, Spain, India, Greece, Morocco, Honduras, Poland, and Russia.

Characters

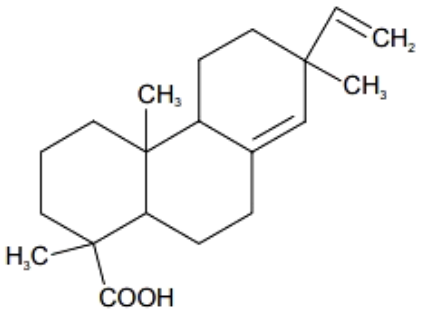
Colophony occurs as translucent, hard, shiny, sharp, pale yellow to amber fragments, fracture brittle at ordinary temperature, burns with smoky flame, slight turpentine-like odour and taste, melts readily on heating, density 1.07–1.09. Acid number is not less than 150. It is insoluble in water but freely soluble in alcohol, benzene, ether, glacial acetic acid, oils, carbon disulphide, and alkali solutions.

Chemical Constituents

Colophony contains resin acids (about 90%), resenes, and fatty acid esters. Of the resin acids about 90% are isomeric α-, β-, and γ-abietic acids; the other 10% is a mixture of dihydroabietic acid and dehydroabietic acid. Before distillation, the resin contains excess amounts of (+) and (-) pimaric acids. During distillation the (-) pimaric acid is converted into abietic acid while (+) pimaric acid is stable. The other constituents of Colophony are sipinic acid and a hydrocarbon.



Abietic acid



Pimaric acid

Chemical Tests

1. To a solution of powdered resin (0.1 g) in acetic acid (10 ml) one drop of conc. Sulphuric acid is added in a dry test tube. A purple colour, readily changing to violet, is formed.
2. To a petroleum ether solution of powdered Colophony twice its volume of dilute solution of copper acetate is shaken. The colour of the petroleum ether layer changes to emerald-green due to formation of copper salt of abietic acid.
3. To alcoholic solution of Colophony sufficient water is added. It becomes milky white due to precipitation of chemical compounds.
4. Alcoholic solution of Colophony turns blue litmus to red due to the presence of diterpenic acids.

Uses

Colophony is used as stiffening agent in ointments, adhesives, plasters and cerates and as a diuretic in veterinary medicine. Commercially it is used to manufacture varnishes, printing inks, cements, soap, sealing wax, wood polishes, floor coverings, paper, plastics, fireworks, tree wax, rosin oil, and for water proofing cardboard. The abietic acids show antimicrobial, antiulcer and cardiovascular activity; some have filmogenic, surfactant, and antifeedant properties.

Artemisia

Synonym Name: Japanese Wormwood, Japan Sagebrush; Hindi: Pamasi, Ptee Nepali: चिन्ती Chyenti

Latin Name: *Artemisia japonica* Thunb.

Family & Genus: Asteraceae, Artemisia

Description: Japanese Wormwood is perennial herb, 50-90 cm tall, with solitary or several, branched, almost hairless stems from woody, 1.5-2.5 cm thick, upright rootstock. Basal and lower stem leaves are distinctly wedge-shaped, oblong-obovate to flabellate, 5-8 cm long, coarsely toothed at the tip. Middle and upper stem leaves are mostly basally eared, palmately divided or cut or irregularly cut into linear to narrow laneshaped, 4-15 x about 1 mm, pointed segments. Flower-heads are heterogamous, numerous, short to long stalked, broadly ovate to spherical, 2.5-3 x 1.75-2 mm, nodding in a narrow or wide, 15-20 x 3-15 cm panicle, with almost horizontal or obliquely patent, 3-20 cm long branches. Receptacle is hemispherical, glabrous. Florets are 12-15, yellow. Seed pod is oblanceolate, about 1 mm long, dark brown. Flowering: July-September.

Distribution: Growing in forest edges, forests, open fields, mountain slopes, hills, roadsides and in thickets. Widely distributed in the southern and northern parts of China. The medicinal materials are mainly produced in Jiangsu, Sichuan and etc.

Part Used: Medical part: roots and entire plant. Chinese name: roots: Muhaogen. Entire plant: Duhao.

Harvest & Processing: Roots: excavated, removed soil, well washed and sun-dried. Entire plant: collected in summer and autumn, sun-dried or used fresh.

Chemistry: Above ground parts contain volatiles, such as spathulenol (12 %), germacrene D (7.5 %), β-elemene (2.8 %), caryophyllene (2.4%), etc, flavonoid and phenolic acids.

Pharmacology: Anti-pathogenic microorganism, antiausterity activities against the PANC-1 human pancreatic cancer cell line.

Usage: Root: puerperal cold, rheumatic arthralgia, impairment caused by overstrain and hypodynamia, puffiness, malaria. Whole herb: summer common cold, hectic fever of tuberculosis, empsyxis, infantile malnutrition with fever, non-traumatic hemorrhage, hemafecia,

metrorrhagia and metrostaxis, leukorrhea, Icteric hepatitis, erysipelas, venomous snake bites. Root: oral administration: decocting, 15-30g. Entire plant: oral administration: decocting, 10-15g, double dose for used fresh. External: appropriate amount, prepared decoction for washing; or used fresh, smashed for application.

Taxus

Synonym Paclitaxel; Taxol A

Biological Source It is obtained from the bark of the Pacific Yew tree, *Taxus brevifolia* Nutt belonging to the family Taxaceae.

Geographical Source The plant is a native to the northwest United States. It is a small, not so growing evergreen tree.

Preparation Keeping in view the paucity of the drug it look quite some time to isolate taxol and establish its chemical structure. The very complexity of its chemistry has more or less turned its total synthesis into a not so viable and feasible economic exercise. However, an attempt is being made to enhance its availability through the semisynthetic route whereby the taxol precursors are usually obtained by extraction from the needles of largely available species of Taxus.

Example The chemical component, 10-descetylbaccatin III, isolated from the needles of *Taxus baccata* Linn., may be conveniently converted to taxol via simple synthetic route.

Note: The needles, in comparison to the bark, may be harvested without causing any injury to the plant whatsoever, and thus provides a rather more easily renewable plant source for the drug.

Chemical Structure The chemical structure is provided below:

Taxol

Characteristic Features Taxol has the following characteristic features, namely:

(a) It has a taxane ring system,

(b) It has a four membered octane ring

(c) An ester side chain at C-13 of the taxane ring is a prime requirement for taxol's cytotoxic activity, and

(d) The presence of an accessible hydroxyl moiety at C-2 of the ester side chain renders an appreciable enhancement of the cytotoxic activity.

Uses

1. Taxol is primarily employed in the treatment and management of metastatic carcinoma of the ovarian glands after the failure of follow-up chemotherapy.
2. It is also used in the treatment of breast cancer usually after the observed failure of combination chemotherapy for metastatic disease.
3. Because of its hydrophobic nature the injectable concentrate of taxol formulation meant for intravenous infusion is normally solubilized duly in polyoxyethylated caster oil. However, before injection it should be appropriately diluted in normal saline or dextrose solution or combination thereof.

References

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2. Kokate, C. K.; Gokhale, S. B.; Purohit, A. P. A textbook of Pharmacognosy, 29th ed.; Nirali Prakashan: Pune, 2009.