6. Collection and preparation of crude drug for the market as exemplified by Ergot, Opium, Rauwolfia, Digitalis, Senna.

ERGOT

Synonyms

Ergot; Rye Ergot; Secale cornutum; Spurred rye; Ergot of rye; Ergota.

Biological Source

Ergot is the dried sclerotium of a fungus, *Claviceps purpurea* Tulasne, belonging to family Clavicipitaceae, developing in the ovary of rye plant, *Secale cereale* (Family Poaceae).

Ergot should yield about 0.15% of the total alkaloids calculated as ergotoxine and water-soluble alkaloids equivalent to about 0.01% of ergonovine.

Geographical Source

It is mainly found in Czechoslovakia, Hungary, Switzerland, Germany, France, Yugoslavia, Spain, Russia and India. In India Ergot is cultivated at Kodaikanal (T.N.).

Cultivation and Collection

The life cycle of the fungus, *Claviceps purpurea,* which is a parasite, passes through the following characteristic stages:

1. Sphacelia or honeydew or asexual stage
2. Sclerotium or ascigerous or sexual stage and
3. Ascospore stage.

1. Sphacelia or honeydew or asexual stage

The rye plant becomes infected by the spores of the fungus in the spring session when flowers bloom for about one week. The spores are carried by the wind or by insects to the flowers and collected at the base of the young ovary where moisture is present. There germination of the spores takes place. A filamentous hyphae is formed which enters into the wall of the ovary by enzymatic action. A soft, white mass over the surface of ovary is formed, which is known as Sphacelia. A sweet viscous yellowish liquid, known as honeydew, is secreted during the Sphacelia stage which contains reducing sugars (reduce Fehling solution). From the ends of some hyphae small oval conidiospores (asexual spore/s) are abstricted which remain suspended on honeydew. The sweet taste of honeydew attracts some insects like ants and weevils. Insects suck the sweet liquid and carry the conidiospores to the plants and spread the fungal infection in the rye plants. Cultured conidiospores are used for the inoculum. Strains capable of producing about 0.35% of selected alkaloids, mainly ergotamine, are now utilized.

2. Sclerotium or ascigerous or sexual stage

During the Sphacelia stage the hyphae enter only the outer wall of the ovary. On further development they penetrate into deeper parts, feed on the ovarian tissues and replace it by a compact, dark purple hard tissue known as pseudoparenchyma. It forms the sclerotium or resting state of the fungus. During summer the sclerotium or ergot increases in size and projects on the rye, showing sphacelial remains at its apex. It is collected at this stage by hands or machine and used as a drug. Ergot is then dried to remove moisture. About 6 weeks after inoculation, the mature sclerotia are harvested. They may be picked up by hand or collected by machine. The number and size of the ergots produced on each spike of cereal by *C. purpurea* varies, rye usually bears sclerotia, while wheat bears very few.

3. Ascospore stage

If Ergot is not collected, it falls on the ground. In the next spring session they produce stalked projections known as stromata which have globular heads. In the inner surface of the heads there are many flask-shaped pockets known as perithecia. Each of these perithecia contains many sacs (asci) which possesses eight of the thread-like ascospores. These ascospores are carried out by insects or wind to the flowers of the rye as described in the first stage. In this way life cycle of Ergot is completed.

The ascospores may be germinated on a nutritive medium to get conidiospore bearing cultures. The suspension of these conidiospores is usually used as a spray to infect rye plants for commercial production of Ergot.

Ergot is collected from fields of rye when the sclerotia are fully developed and projecting from the spike, or they are removed from the grain by shifting. The size of the crop varies according to weather conditions. The vegetative phase of the fungus can, like that of other moulds, be cultivated artificially. Under such conditions the typical sclerotia do not develop.

Characteristics

The size of sclerotium (Ergot) is about 1–4 cm long, 2–7 mm broad. Shape is fusiform, slightly curved, sub-cylindrical, tapering at both ends. The outer surface is dark or violet-black in colour, has longitudinal furrows and sometimes small transverse cracks. The fractured surface shows thin, dark outer layer, a whitish or pinkish-white central zone of pseudoparenchyma in which darker lines radiate from the centre. Odour is characteristic and taste is unpleasant.

Fig. 15.9 *Claviceps purpurea*

Microscopy

Ergot shows an outer zone of purplish-brown, obliterated rectangular cells. The pseudoparenchyma consists of oval or rounded cells containing fixed oil and protein, and with highly refractive walls which give a reaction for chitin. Cellulose and lignin are absent.

Microscopy

Ergot shows an outer zone of purplish-brown, obliterated rectangular cells. The pseudoparenchyma consists of oval or rounded cells containing fixed oil and protein, and with highly refractive walls which give a reaction for chitin. Cellulose and lignin are absent.

Chemical Constituents

A large number of alkaloids have been isolated from the Ergot. The most important alkaloids are ergonovine and ergotamine. On the basis of solubility in water the alkaloids are divided into two groups: water-soluble ergometrine (or ergonovine) group or water-insoluble (ergotamine and ergotoxine) groups as given hereunder:

	Group	Alkaloids
Water-soluble group		
I.	Ergometrine group	Ergometrine, Ergometrinine
Water-insoluble group		
II.	Ergotamine group	Ergotamine, Ergotaminine, Ergosine, Ergosinine
III.	Ergotoxine group	Ergocristine, Ergocristinine, Ergocryptine, Ergocryptinine, Ergocornine, Ertgocorninine

Only the first group, ergometrine group, belongs to water-soluble compounds. Alkaloids of Group II and III are polypeptides in which lysergic acid or isolysergic acid is linked to amino acids. Alkaloids obtained from lysergic acid are physiologically active compounds. In the first group, for example, ergometrine alkaloids, lysergic acid or its isomer is linked to an amino alcohol.

The ergot alkaloids (ergolines) can also be divided into two classes (1) the clavine-type alkaloids, which are derivatives of 6,8-dimethyl-ergoline and (2) the lysergic acid derivatives, which are peptide alkaloids and contains the pharmacologically active alkaloids that characterize the ergot sclerotium (ergot). Each active alkaloid occurs with an inactive isomer involving isolysergic acid.

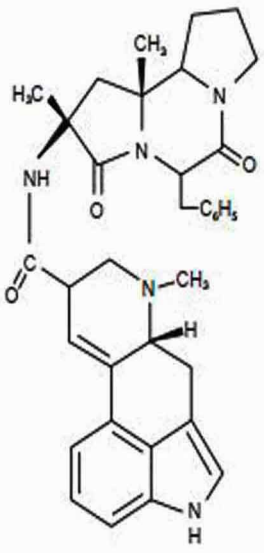
Chemical Tests

1. Ergot under UV light shows a red-coloured fluorescence.
2. Ergot powder is extracted with a mixture of $CHCl_3$ and sodium carbonate. The $CHCl_3$ layer is separated and a mixture of p-dimethylaminobenzaldehyde (0.1 g), H_2SO_4 (35%, v/v, 100 ml) and 5% ferric chloride (1.5 ml) is added. A deep blue colour is produced.

Uses

Ergot is oxytocic, vasoconstrictor and abortifacient and used to assist delivery and to reduce post-partum haemorrhage. Lysergic acid diethylamide (LSD-25), obtained by partial synthesis from lysergic acid, is a potent specific psychotomimetic. Ergometrine is oxytocic and used in delivery. It stimulates the tone of uterine muscles and prevents post-partum haemorrhage.

Only ergometrine produces an oxytocic effect, ergotoxine and ergotamine having quite a different action. Ergometrine is soluble in water or in dilute alcohol. It is known as ergonovine. Ergotamine and the semisynthetic dihydroergotamine salts are used as specific analgesics for the treatment of migraine. Lysergic acid diethylamide (LSD-25), prepared by partial synthesis from lysergic acid, is a potent specific psychotomimetic.



Ergotamine

Oxytocic: A drug that induces labour (delivery of the baby) by stimulating contractions of the muscles of the uterus

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.

History

The cultivation of opium dates back to 3400 B.C. in Mesopotamia and by 1300 B.C. Egyptians began the cultivation of opium thebaicum. Hippocrates 'the father of medicine', (460–357 B.C.) prescribed drinking the juice of the white poppy mixed with the seed of nettle and also acknowledged its use as narcotic and styptic in internal diseases. It was Alexander the Great, who introduced opium to India and Persia. During the 17th century tobacco smoking was introduced in China, which resulted in its extensive. In 1800 control on opium supply and prices was brought and in 1805 Friedrich W. Seiturner (German pharmacist) isolated and identified the chief chemical constituent of opium. The compound isolated was named morphium (morphine) after Morpheus, the god of dreams. Eventually many other constituents like codeine (1832) and papaverine (1848) were also isolated and identified. Due to the uncontrolled use of opium in china (late 18th century) the imperial court had to ban its use. The United States in 19th century made easy availability of the opium preparations and the 'patent medicines'. Later on during the war, the Union Army were provided with enough amount of opium pills, laudanum, morphine sulphate, etc., which made opium addiction known as the 'army disease or the 'soldier's disease'.

By 1870s, substitute for morphine by acetylating morphine were prepared and in 1898 a German company manufactured 3, 6-diacetylmorphine (Heroin) in bulk quantity. In December 1914, Harrison Narcotics Act which called for control of each phase of the preparation and distribution of medicinal opium, morphine, heroin, cocaine, and any new derivative with similar properties, was enforced by the United States Congress. The Federal Controlled Substances Act of 1970 is the redefined act of the Harrison Act. In 1999, opium was declared as the Bumper crop of Afghanistan by producing 75% of world's heroin. In December 2002 the U.K. government under the health plan, will make heroin available free on National Health Service to all those with a clinical need for it.

Cultivation and Collection

Opium is cultivated under license from the government. Its seeds are sown in October or March in alluvial soil. After germination of seeds snow falls. In spring the thin plant attains the height of 15 cm. Fertilizers are used for better crop. The poppy of first crop blossoms in April or May and the capsule mature in June or July. When the capsules are about 4 cm in diameter, the colour changes from green to yellow; they are incised with a knife about 1 mm deep around the circumference between midday and evening. The knife, known as a 'nushtur' bears narrow iron spikes which are drawn down the capsule to produce several longitudinal cuts. The incision must not penetrate into the interior of the capsule otherwise latex will be lost. The latex tube opens into one another. The latex, which is white in the beginning, immediately coagulates and turns brown. Next morning it is removed by scrapping with a knife and transferred to a poppy leaf. Each capsule is cut several times at intervals of two or three days. After collection the latex is placed in a tilted vessel so that the dark fluid which is not required may drain off. By exposure to air the opium acquires a suitable consistency for packing. The dried latex is kneaded into balls, wrapped in poppy leaves and dried in shade. The principal commercial varieties of Opium are Turkish Opium, Indian Opium, Chinese Opium, Yugoslavian Opium and Persian Opium.

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. Opium is intended only as a starting material for the manufacture of galenical preparations and is not dispensed as such.

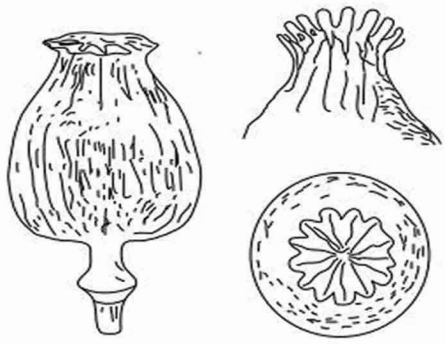


Fig. 15.25 *Papaver somniferum* capsules

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, thebaine (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 benzylisoquinoline 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.
4. *Cryptopine Type:* Protopine, cryptopine.
5. *Unknown Constituents*: Aporeine, diodeadine, meconidine, papaveramine and lanthopine.

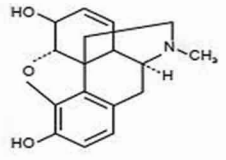
The drug also contains sugars, sulphates, albuminous compounds, colouring matter and moisture. In addition to these anisaldehyde, vanillin, vanillic acid, β-hydroxystyrene, fumaric acid, lactic acid, benzyl alcohol, 2-hydroxycinchonic acid, phthalic acid, hemipinic acid, meconin and an odorous compound have also been reported.

Chemical Tests

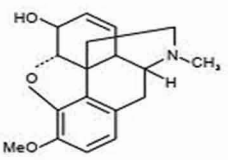
1. Aqueous extract of Opium with $FeCl_3$ solution gives deep reddish purple colour which persists on addition of HCl. It indicates the presence of meconic acid.
2. Morphine gives dark violet colour with conc. H_2SO_4 and formaldehyde.

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.



Morphine



Codeine

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

It is an erect, evergreen, small shrub native to the Orient and occurs from India to Sumatra. It is also found in Burma, Thailand, Philippines, Vietnam, Indonesia, Malaysia, Pakistan and Java. In India it occurs in the sub-Himalayan tracts from Sirhind eastwards to Assam, especially in Dehradun, Siwalik range, Rohelkhand, Gorakhpur ascending to 1,300 m, east and west ghats of Tamil Nadu, in Bihar (Patna and Bhagalpur), Konkan, Karnataka and Bengal.

Cultivation and Collection

Rauwolfia grows in tropical forests at an altitude of 1,200–1,300 m at temperature 10–40°C. There should be enough rain or irrigation for its cultivation. The soil should be acidic (pH 4–6), clayey and manure is applied for better crop. Propagation is done by planting seeds, root cuttings or stem cuttings. Better drug is obtained when the propagation is carried out with fresh seeds. The plants should be protected from nematodes, fungus and Mosaic virus.

The drug is collected mainly from wild plants. Roots and rhizomes are dug out in October–November when the plant roots are two to four years old. The aerial parts and roots are separated. The roots are washed and dried in air. The roots containing moisture up to 12% should be protected from light. Seasonal variation, genetic differences, geographic location, improper handling and drying, and other factors account for percentage differences in alkaloid amount. Rauwolfia should be packaged and stored in well-closed containers in a cool, dry place that is secure against insect attack.

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. Young pieces contain slight wrinkles while old pieces have longitudinal ridges. Circular scars of rootlets are present. Bark exfoliation is present in old samples leaving behind patches of exposed wood. The fracture is short. A narrow, yellowish-brown bark and a dense pale yellow wood are present on the smooth transverse surface at both the ends. Pieces of rhizome closely resemble the root but may be identified by a small central pith. They are attached to them with small pieces of aerial stem. Slight odour is felt in recently dried drug which decreases with age; taste is bitter.

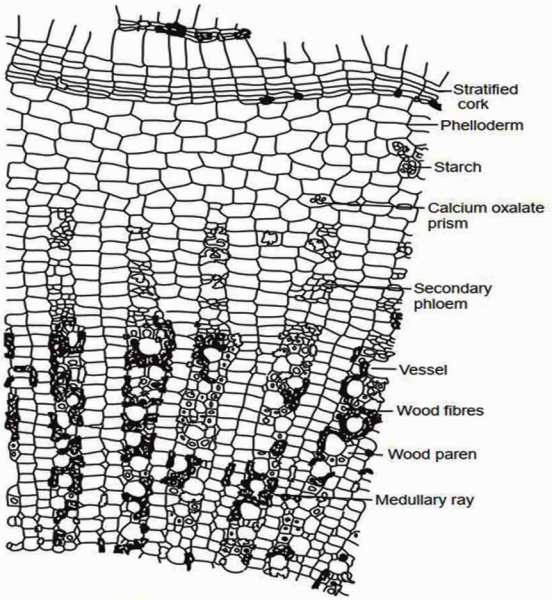


Fig. 15.11 Transverse section of Rauwolfia root

Fig. 15.10 Root and twig of *Rauwolfia serpentina*

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.

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. Rescinnamine is the methyl reserpate ester of 3,4,5-trimethoxy cinnamic acid. The usual antihypertensive dose of rescinnamine is 500 µg, two times a day. Higher doses may cause serious mental depression. Deserpidine is 11-des-methoxyreserpine. It is a wide-range tranquilizer and antihypertensive and is free from the side effects.

Marketed Products

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

DIGITALIS LEAVES

Synonyms

Digitalis, purple foxglove, finger flower, lady's glove, Foxglove Leaves, Folia Digitalis.

Biological Sources

Digitalis consists of dried leaves of *Digitalis purpurea* Linn., belonging to family Scrophulariaceae.

Geographical Sources

It is mainly found in England, Germany, France, North America, India, Iraq, Japan, Kurdistan, Mexico, Nepal, Spain, Turkey.

Cultivation and Collection

Digitalis is a biennial herb growing wild but good quality of the drug is obtained especially from cultivated plant. The plant will flourish best in well drained loose soil, preferably of siliceous origin, with some slight shade. The plants growing in sunny situations possess the active qualities of the herb in a much greater degree than those shaded by trees, and it has been proved that those grown on a hot, sunny bank, protected by a wood, give the best results.

It grows best when allowed to seed itself, if it is desired to raise it by sown seed, 2 lb of seed to the acre are required. For cultivation special strains of the seeds are selected which would produce disease-resistant plants with maximum activity. Attention is specially paid to the structure of the soil in seed beds. As the seeds are so small and light, they should be mixed with fine sand in order to ensure even distribution. Before sowing soil is sterilized. They should be thinly covered with soil. The seeds are uncertain in germination, but the seedlings may be readily and safely transplanted in damp weather, and should be pricked out to 6–9 inches apart. Sown in spring, the plant will not blossom till the following year. Seeds must be gathered as soon as ripe. In dry season sufficient water is supplied to the plant. In the first year, a long stalk with rosette of leaves is produced. The flowers of the true medicinal type must be pure, dull pink or magenta, not pale-coloured, white or spotted externally.

Collection of these leaves is carried out from September to November by hand and thus other organic matter and discoloured leaves are avoided. After collection the leaves should be dried as soon as possible at 60°C. By quick drying characteristic green colour of the leaves is maintained. Drying is carried out till moisture is not more than 5%. Leaves are packed under pressure in airtight containers.

Morphology

Colour	Dark greyish green in colour
Odour	Odourless
Taste	Bitter
Shape	Ovatelanceolate to broadly ovate. Leaves have a subacute apex, decurrent base and crenate or dentate margin. The upper surface of leaf is hairy, slightly pubescent, dark green and little wrinkled. The lower surface of leaf is hairy, greyish-green and very pubescent.
Size	10–30 cm long and 4–10 cm wide

Microscopy

Digitalis has dorsiventral leaf structure. It has plenty of simple covering and glandular trichomes on both the surfaces. 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 bicellular or rarely unicellular head. It has anomocytic or ranunculaceous type of stomata. Trichomes and stomata are more in lower surface. The pericycle is parenchymatous above and collenchymatous below. Calcium oxalate crystals are absent.

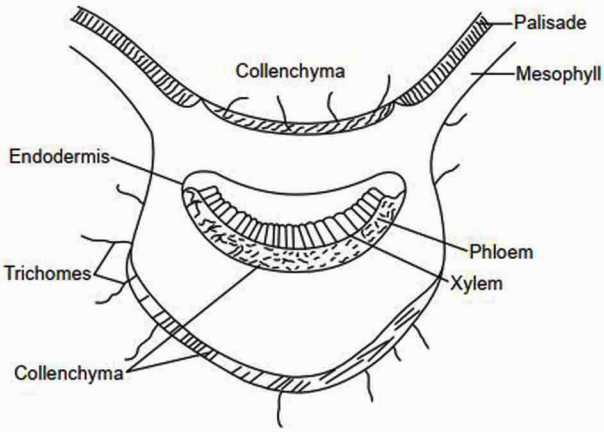


Fig. 16.9 T.S. (schematic) of Digitalis leaf

Chemical Constituents

Digitalis leaves contains 0.2–0.45% of both primary and secondary glycosides. Purpurea glycosides A and B and glucogitoloxin are primary glycosides. Because of greater stability of secondary glycosides, and lesser absorption of primary glycosides a higher content of primary glycosides are not considered ideal and secondary glycosides are used. Purpurea glycosides A and B are present in fresh leaves and by their hydrolysis digitoxin and glucose or gitoxin and glucose are obtained respectively. Hydrolysis of purpurea glycosides can take place by digipuridase (enzyme) present in the leaves. Digitoxin yields on hydrolysis digitoxigenin and three digitoxose. By hydrolysis of verodoxin, gitaloxigenin and digitalose are obtained. Digitalis leaves also contains glycosides like odoroside-H, gitaloxin, verodoxin and glucoverodoxin.

Verodoxin was found to potentiate the activity of digitoxin by synergism. Digitoxose and digitalose are desoxy sugars found only in cardiac glycosides and answers Keller–Killiani test. The important saponins include digitonin, tigonin and gitonin, and luteolin, a flavone responsible for the colour of the drug are also present in the leaves.

Fig. 16.8 *Digitalis purpurea*

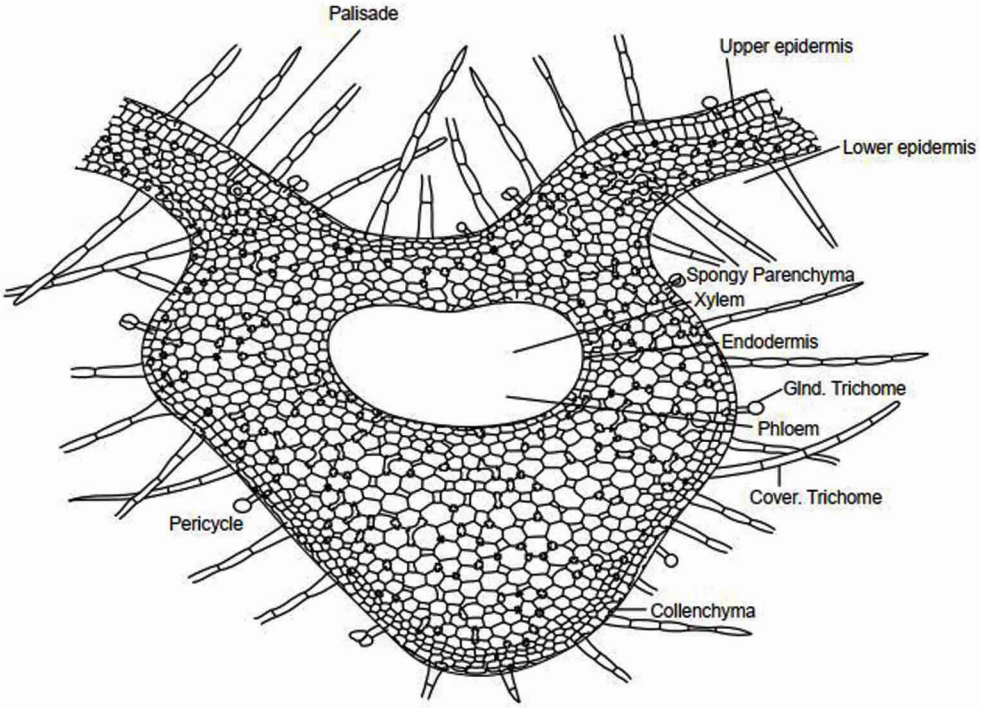
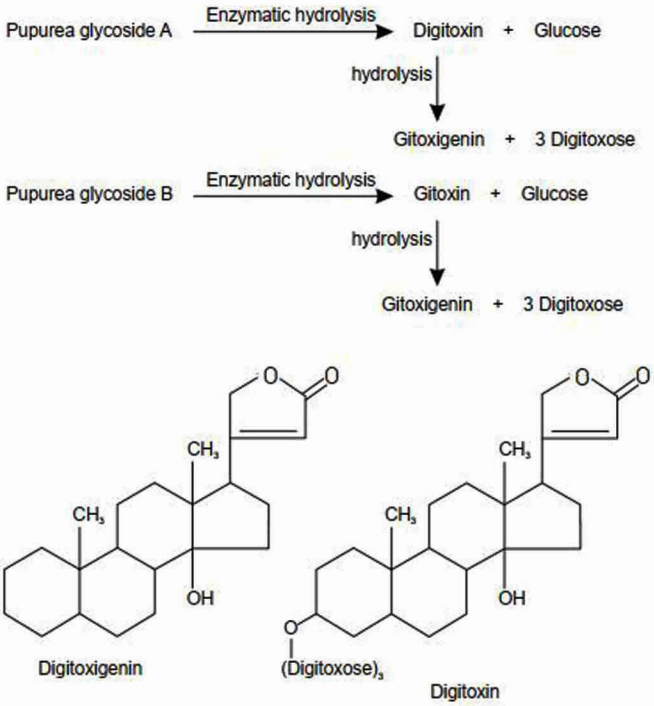


Fig. 16.10 Transverse section of Digitalis leaf



Chemical Tests

Digitalis glycosides having five membered lactone ring answers positive for the following tests which are due to the intact lactone.

1. *Baljet Test:* To a thick section of the leaf sodium picrate reagent is added. Yellow to orange colour indicates the presence of glycoside.
2. *Legal Test:* Glycoside is dissolved in pyridine and sodium nitroprusside solution is added to it and made alkaline. Pink to red colour is produced.
3. *Keller–Killiani Test:* The isolated glycoside is dissolved in glacial acetic acid and a drop of ferric chloride solution is added followed by the addition of sulphuric acid which forms the lower layer. A reddish-brown colour is seen in between two liquids and the upper layer becomes bluish green.

If the powdered leaves are used, 1 gm of the powdered leaves is extracted with 10 ml of 70% alcohol for couple of minutes, filtered and to 5 ml of filtrate 10 ml of water and 0.5 ml of strong solution of lead acetate is added and filtered and the filtrate is shaken with 5 ml of chloroform. Chloroform layer is separated in a porcelain dish and the test is carried out as mentioned above.

Uses

The foxglove is a widely used herbal medicine with a recognized stimulatory effect upon the heart. It is also used in allopathic medicine in the treatment of heart complaints. It has a profound tonic effect upon a diseased heart, enabling the heart to beat more slowly, powerfully and regularly without requiring more oxygen. At the same time it stimulates the flow of urine which lowers the volume of the blood and

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 Tinnevelly 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.

Cultivation and Collection

Senna plant is a small shrub of 1–1.5 m height with paripinnate compound leaves. Tinnevelly senna is mostly cultivated in well-ploughed, levelled, rich clayed semiirrigated land sometimes after paddy crop in South India. Propagation is done by seeds which are rubbed with coarse sand and sown thinly by broadcasting or in rows 30 cm apart, first during February–March and second after rain in July. Seeds germinate on the third day. The crop becomes ready for harvesting after about 2 months but first plucking of leaflets is done after 3 months of sowing when the leaves appears mature, thick and bluish in colour. Second plucking is followed after a month and subsequent pluckings after 4–6 weeks. The plant can survive for two to three years, but it is grown as an annual. After third plucking the plants are uprooted. Plant shows great tolerance for salinity. It sometimes shows die-back symptoms in which the branches or shoots die from the tip inward, which is caused by parasites or environmental conditions. Leaflets of Tinnevelly senna are collected by careful plucking from luxuriantly grown plants and compressed into bales.

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 16.1.

Table 16.1 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

Fig. 16.1 Leaflets and legumes of *Cassia angustifolia*

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.

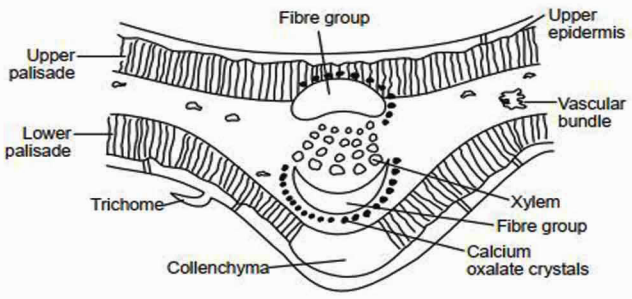
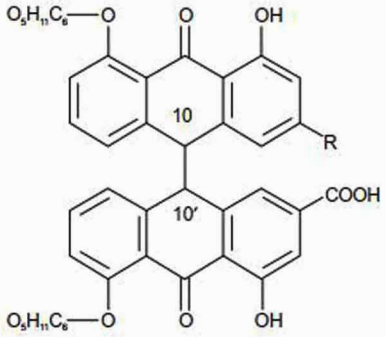


Fig. 16.2 Transverse section of senna leaf (schematic)

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 chrysophanol, 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

1. *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.

Cassia angustifolia (Bombay or Mecca or Arabian senna) a mild variety of Indian senna have the morphology similar to that of Tinnevelly senna but the leaflets are narrow, more elongated and brownish green in colour. *C. marilandica* or American Senna, Wild Senna, *Poinciana pulcherima,* formerly *Maryland Senna,* is a common perennial from New England to Northern Carolina. Its leaves are compressed into oblong cakes like other herbal preparations of the Shakers. It acts like Senna, but is weaker, and should be combined with aromatics. These leaves are also found mixed with or substituted for Alexandrian Senna. *Coriaria myrtifolia* is a Mediterranean shrub and highly poisonous, so that it should be recognized when present. The leaves are green, very thin and soft, three veined, ovate-lanceolate, and equal at the base. It is also used to adulterate sweet marjoram. *Cassia montana* yields a false Senna from Madras, partly resembling the Tinnevelly Senna, though the colour of the upper surface of the leaves is browner.

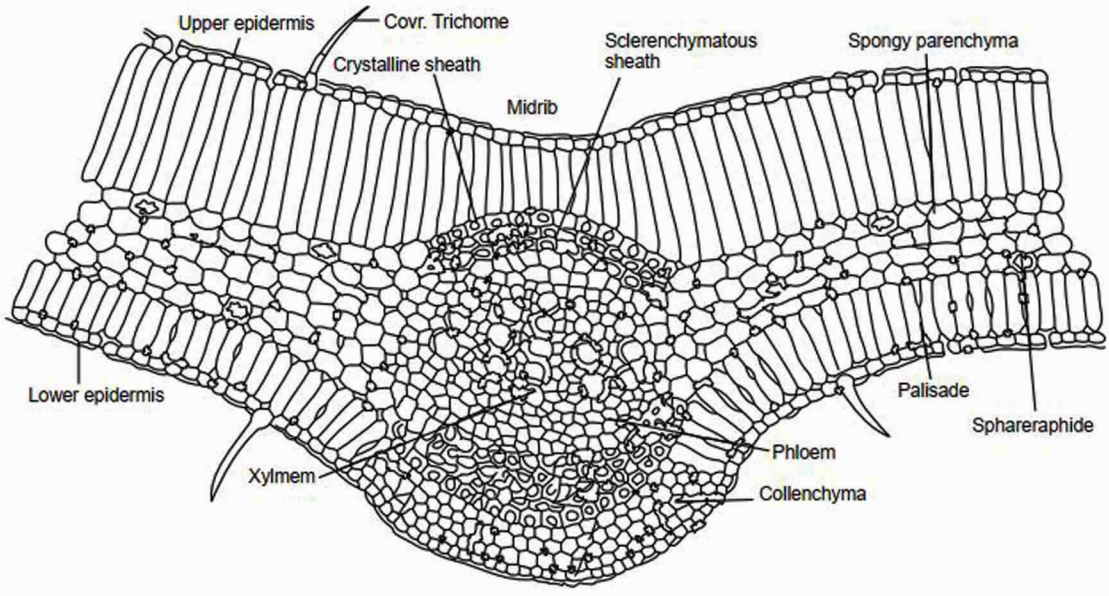


Fig. 16.3 Transverse section of senna leaflet