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RESINS

Resins are solid or semisolid plant exudates formed in schizogenous or schizolysigenous ducts or cavities. They are complex mixtures of compounds like resin alcohols (resinols), resin acids, resinotannols, (resinphenols), esters and resenes. Some resins(e.g. Benzoin and Balsam of Tolu) are formed when the plant is injured. These resins are called as pathological resins.

The resins commonly used in pharmacy are derived from natural sources, and almost are plant products -Shellac, an insect secretion, being an important exception.

Resins are classified on the basis of their occurrence in combination with another compounds as :

Balsams : Balsams are resinous substances which contain large proportions of benzoic or cinnamic acids either free or in combination or their esters. Tolu Balsam contains 35 to 50% of balsamic acids (chiefly benzoic and cinnamic acids) which are present partly in the free state and partly in combination with complex 'resin alcohols'. Benzoin, Peru Balsam and Storax, are another examples of balsams.

Oleoresins : When resins occur with volatile oils, the mixture is called as oleoresins. Turpentine, Capsicum, Ginger, Male Fern, Canada Balsam and Copaiba are oleoresins.

Gum Resins : When resins are found in combination with gums, then such resins are known as *gum resins*. These resins are purified by dissolving the associated gum in water. Asafoetida, Gambage and Myrrh are gum-resins.

Oleo-gum Resins : Oleo-gum-resins are associated with gum and volatile oil both. The volatile oil is removed by steam distillation while gum is separated by dissolving in water, e.g., Myrrh, Ipomoea.

Glycoresins (Glucoresins) : Some resins are found in combination with glycosides. These resins occur in Ipomoea, Scammony, Jalap and Podophyllum. On hydrolysis they produce sugars and complex resin acids as aglycones.

Formation of Resins

In many instances a resin in plants is formed in special passages or tubes called resin ducts, which are usually anastomose . Thus a single incision may drain the resin from a considerable area of the plant. The cells lining the ducts possess a layer (called the resinogenous layer) of slimy matter bounded by a fine cuticle and resin is secreted in this layer. It is excreted through the cuticle layer into the resin duct.

In some cases, e.g. Copaiba, numerous resin ducts are present. Tapping is necessary to drain the ducts. Such resin is called as normal or physiologically-produced resin. In other instances, e.g. turpentine, only a few resin ducts are normally present, but following injury to the cambium the new or secondary wood subsequently formed which contains very large number of ducts. The resin from these ducts is called wound, traumatic or pathologically-produced resin.

Resin may continue to flow for a considerable period from wounding, or in some cases it may be necessary to inflict wounds at frequent intervals. Further, invasion of the wound by fungi and bacteria sometimes plays an important part in the composition of the resin exuded. For example, the simple wound resin of Styrax and Benzoin differs materially from the resin exuded after fungal invasion of the wound.

Characters : Purified resins are amorphous, brittle, transluscent, hard solids. On heating they are softened and then melted. They are practically insoluble in water but dissolve in organic solvents like alcohol, ether and chloroform. Varnish-like film is formed on evaporation of the solvent. They produce smoky flame on burning.

Chemical Constituents : Chemically, the resins are complex mixtures of the following compounds :

1. **Resin Acids :** Resin acids are the mixture of oxyacids, carboxylic acids and phenolic acids. They are present in the free state or as esters. They are soluble in aqueous alkaline solutions which form soap-like froth on shaking. Abietic acid in Rosin or Colophony, copaivic acid and oxycopaivic acid in Copaiba, guaiaconic acid in Guaiac, pimaric (pimarinic) acid in Frankincense, sandaracolic acid in Sandarac, aleuritic acid in Shellac and commiphoric acid in Myrrh are the examples of resin acids.
2. **Resin Alcohols :** Resin alcohols are complex molecules with high molecular weight. They are present in the free state or as esters of simple aromatic acids, e.g. benzoic acid, salicylic acid and cinnamic acid. They are further sub-divided as :
   (i) *Resinotannols :* They are tannins and form blue colour with ferric chloride, e.g., aloeresinotannol from Aloe, amoresinotannol and galbaresinotannol from Ammoniac, peruresinotannol from Balsam of Peru, siaresinotannol and sumaresinotannol from Benzoin.
   (ii) *Resinols :* Resinols do not contain tannins. Benzoresinol from Benzoin,storesinol from Storax and guaiacresinol from Guaiac resin are the examples of resinols.
3. **Resenes :** Resenes are complex neutral compounds which do not respond to any chemical reaction. They are insoluble in acids and alkalies and do not form any salts or esters, e.g., alban and fluavil from Gutta percha, copalresene from Copal, dammaresene from Dammar, dracoresene from Dragon's blood and olibanoresene from Olibanum.

Resin containing drugs possess purgative (Podophyllum), cathartic (Colocynth, Gamboge, Ipomoea), hydragogue (Jalap), sedative (Cannabis), counter-irritant (Capsicum, Turpentine), anthelmintic (Asphidium), expectorant (White Pine, Copaiba, Storax, Tolu Balsam, Benzoin) and laxative (Asafoetida) properties. Externally resins are used as mild antiseptic in the form of cerates, ointments and plasters. They are employed in the preparation of emulsions.

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. elliottii* (slash pine), *P. pinaster* (syn. *P. maritima*), *P. halepensis*, *P. massoniana*, *P. tabuliformis*, *P. carribacea* var. *hondurensis*, *P. oocarpa*, *P. radiata* and *P. roxburghii* (syn. *P. longifolia*).

Family : Pinaceae.

Habitat : The genus *Pinus* is widely found in many countries including U.S.A., France, Italy, Portugal, Spain, Greece, New Zealand, China, India (Himalayan region), and Pakistan.

Colophony is chiefly produced in U.S.A. contributing about 80% world supply. Other countries producing resin are China, France, Spain, India, Greece, Morocco, Honduras, Poland and Russia.

Collection : The collection of the oleoresin is very laborous procedure. Although Colophony is a normal (physiological) resin of *Pinus* species, its amount is increased by injuring the plant. For its collection a few-feet long groove or blaze is made in the bark with the help of knife or some other instrument. A metal or earthenware cup is attached below the groove by nails. The cup is adjusted accordingly when the size of groove increases. The resin is taken out at different intervals and sent for further processing.

The flow of oleoresin is increased by applying sulphuric acid (50%), plant hormones or cultures of *Fusarium* species to the grooves. By such treatment the living xylem cells produce excess amount of oleoresin which is leaked to the adjacent cells.

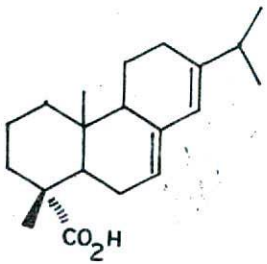
Preparation : The crude oleoresin is mixed with turpentine, heated in a stainless steel vessel and filtered. The filtrate is allowed to stand to separate water and other impurities. The diluted oleoresin is steam distilled in copper or stainless steel stills to remove turpentine. After distillation the molted resin is transferred into barrels, cooled and exported.

Characters : Colophony occurs as translucent, hard, shiny, sharp, pale yellow to amber fragments, brittle fracture at ordinary temperature, burns with smoky flame, slight

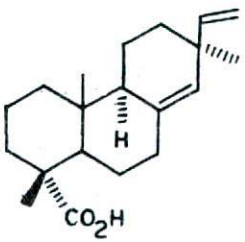
turpentine-like odour and taste, melts readily on heating, density 1.07-1.09. Acid number is not less than 150. It is insoluble in water but freely soluble in alcohol, benzene, ether, glacial acetic acid, oils, carbon disulphide and alkali solutions.

Chemical 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 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.



Abietic acid



Pimaric acid

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 (sylvic acid, $C_{20}H_{30}O_2$);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. On heating at 300°C abietic acid is transformed into *neo*-abietc acid. The other constituents of Colophony are sipinic acid and a hydorcarbon.

Uses : Colophony is used as stiffening agent in ointments,

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; for water proofing cardboard, walls, etc.

BALSAM TOLU

Synonyms : Tolu Balsam; Thomas Balsam; Opobalsam; Resin Tolu; Balsam of Tolu; Balsamum tolutanum.

Biological Source : Balsam Tolu is obtained by incision of stem of *Myroxylon balsamum.* (L.) Harms.

Family : Leguminosae.

Habitat : Colombia (near lower Magdalena river), West Indies, Cuba, Venezuela and Peru.

Collection : Balsam Tolu is a pathological resin and is formed in trunk tissues as a result of injuries. It is collected all the year except the period of heavy rains by making V-shaped incisions in the bark and sap wood. Calabash cups are placed to receive the flow of balsam. Many other incisions are made on higher portion on the trees. Collected balsam is transferred into larger tin containers and exported.

Characters : Tolu Balsam occurs as soft, yellowish-brown or brown, semi-solid or plastic solid, transparent in thin layers, brittle when old, dried or kept in cold, aromatic odour, and taste is aromatic, vanilla-like and slightly pungent. It is insoluble in water and petroleum ether; soluble in alcohol, benzene, chloroform, ether, glacial acetic acid and partially soluble in carbon disulphide and NaOH solution.

Chemical Tests

1. Alcoholic solution of Balsam Tolu (1g) gives green colour with ferric chloride due to toluresinotannols.
2. Alcoholic solution of Balsam Tolu is acidic to litmus paper.
3. To filtered solution of Balsam Tolu (1 g) in water (5 ml) aqueous potassium permanganate solution is added and heated for 5-10 minutes. Odour of benzaldehyde is produced due to oxidation of cinnamic acid.

Chemical Constituents : Tolu Balsam contains resin (~80%) which is a mixture of resin alcohols combined with cinnamic and benzoic acids. The aromatic acids are also present

in free state in proportions 8-15 per cent. The other constituents reported in the drug are benzyl benzoate, benzyl cinnamate, vanillin, styrene, eugenol, ferulic acid, 1,2-diphenylethane (bibenzyl), mono-and sesquiterpene hydrocarbons and alcohols.

Uses : Balsam of Tolu is used as an expectorant, stimulant and antiseptic. It is an ingredient of cough mixtures and Compound Benzoin tincture. It is also used as a pleasant flavouring agent in medicinal syrups, confectionery, chewing gums and perfumery.

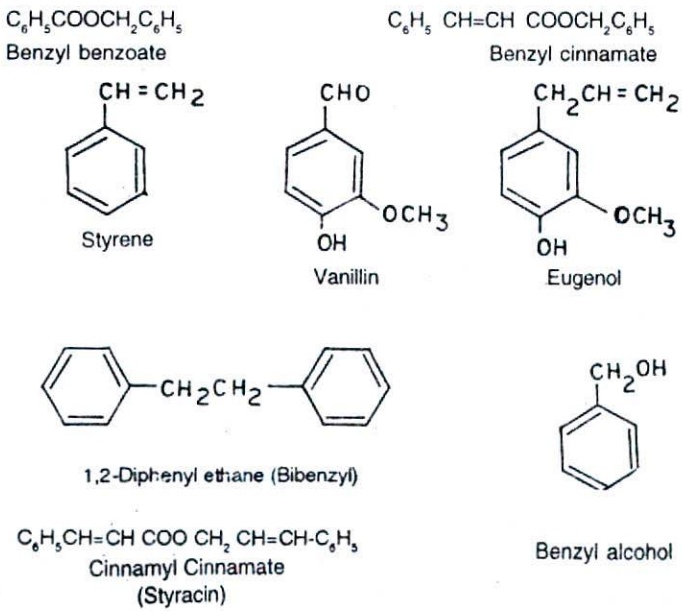
Adulteration : Commercial preparations are usually adulterated with rosin but the general sophistication is the natural balsam from which the aromatic substances have been isolated.

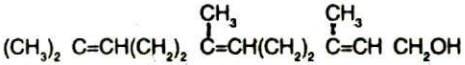
PERU BALSAM

Synonyms : Peruvian Balsam; Indian Balsam; China oil; Black Balsam; Honduras Balsam; Surnam Balsam; Balsam of Peru; Balsamum peruvianum.

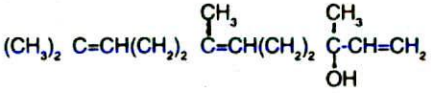
Biological Source : Peru Balsam is obtained by incision of the stem of *Myroxylon balsamum* var. *pereirae* (Royle) Klotsch.

Family : Leguminosae.





Farnesol



Nerolidol (Peruviol)

Habitat : The plant is most widely found in Colombia, Venezuela, Central America (San Salvador), in forests near Pacific coast and cultivated in West Indies, Cuba, Florida and Sri Lanka.

Collection : *M. pereirae* is a large tree, about 25 meters in height. Peru balsam is a pathological resin and is formed when the plant is injured. The 10 years old tree is beaten on four sides in November or December. The cracked bark is scorched with torch to separate it from the trunk. Within a week the bark is dropped from trunk and the balsam begins to flow from the exposed wood. The injured part is covered with cloths or rags in which the resin is absorbed. When the cloths are saturated with exudate, they are removed from time to time and boiled with water. On cooling the water extracted balsam is settled out which is removed, strained, packed in tin cans and exported.

Characters : Fresh Peru Balsam is a soft, yellow, viscous liquid or semi-solid. On keeping it becomes dark brown, or nearly black, brittle solid. It softens on heating in which crystals of cinnamic acid may be visible under microscope. It does not stick, has an empyreumatic, aromatic, vanilla-like odour and a bitter, acrid, persistent taste. It is insoluble in water and olive oil but soluble in alcohol, chloroform, and glacial acetic acid, usually with a slight opalescense.

Chemical Constituents : The drug contains balsamic esters (56-66%) like benzyl cinnamate (cinnamein), C_6H_5 CH=CH $COOCH_2$ C_6H_5 (50-60%), benzyl benzoate and cinnamyl cinnamate (styracin), resin (28%) consisting of peruresinotannol combined with cinnamic and benzoic acids, alcohols [nerolidol (peruviol) farnesol and benzyl alcohol] and small amounts of vanillin, and free cinnamic acid.

Uses : Peru Balsam is used as miticide, to aid in healing of indolent wounds, as scabicide and parasiticide, in skin

ulcer therapy, as local protectant and rubefacient. It is an antiseptic and vulnerary and as a stimulating expectorant. It is also employed in perfumery and some chocolate flavourings, also in making of odours.

SUMATRA BENZOIN

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

Biological Source : Sumatra Benzoin is obtained from the incised stem of *Styrax benzoin* Dryander and *Styrax paralleloneurus* Perkins. It contains about 25% of total balsamic acids, calculated as cinnamic acid.

Family : Styraceae.

Habitat : Sumatra, Malacca, Malaya, Java and Borneo.

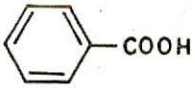
Collection : The plants are medium size trees. Sumatra Benzoin is a pathological resin which is formed by making incision and by attack of fungi. In Sumatra the seeds are sown in rice fields. The rice plants provide protection to benzoin plants during first year. After harvesting of the rice crop the trees are allowed to grow. When they are 7 years old, three triangular wounds are made in a vertical row about 40 cm apart from each other at the base exposing the xylem. A yellow, soft, sticky resin exudes after a week which is known as Almond Tears. The first secretion is sticky and rejected. Further new wounds are made above the earlier wounds at a distance of 4 cm at 3-monthly intervals. Second exudation is milky white and is used for medicinal purpose. The stem is incised four times during one year. All types of exudations are sent to industry for further processing. A single tree yields about 10 kg of resin per year and is completely exhausted by the 19th year of its life.

Characters : Sumatra Benzoin consists of hard opaque, whitish or reddish blocks or tears, brittle, softening on warming and gritty on chewing. The matrix is translucent, reddish-brown or greyish-brown. Odour is balsamic and taste is slightly acrid, aromatic and resinous.

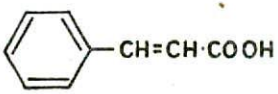
Chemical Constituents : Sumatra Benzoin consists of free balsamic acid (cinnamic and benzoic acids) (25%) and their esters. The amount of cinnamic acid is usually double that of benzoic acid. It also contains triterpenic acids like siaresinolic acid (19-hydroxyoleanolic acid) and sumaresinolic

acid (6-hydroxyoleanolic acid); traces of vanillin, phenylpropyl cinnamate, cinnamyl cinnamate and phenylethylene.

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.



Benzoic acid



Cinnamic acid

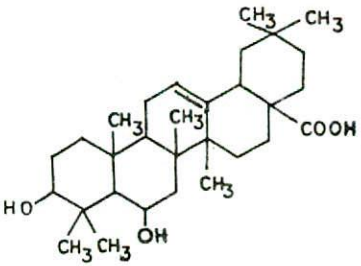
SIAM BENZOIN

Biological Source : Siam Benzoin is a balsamic resin derived from stem of *Styrax tonkinensis* Craib.

Family : Styraceae.

Habitat : North Laos, North Vietnam, Annam, and Thailand.

Collection : Siam Benzoin is also a pathological resin produced by incising the bark and by fungus attack. The stem of 6-8 years old plant is incised when balsam exudates. The resin is obtained in the form of liquid which is solidified.



Sumaresinolic acid

Characters: Siam Benzoin occurs as tears or in blocks of variable sizes and reddish brown externally, but milky-white or opaque internally. Matrix is glassy, reddish-brown, resinous, brittle but softening on chewing and become plastic-like on chewing. It has vanilla-like odour and a balsamic taste.

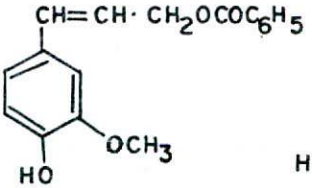
Chemical Constituents : The principal constituent of Siam

Benzoin is coniferyl benzoate (60-70%) (3-methoxy-4-hydroxycinnamyl alcohol). Other constituents are free benzoic acid (10%), triterpene siaresinolic acid (6%) and vanillin.

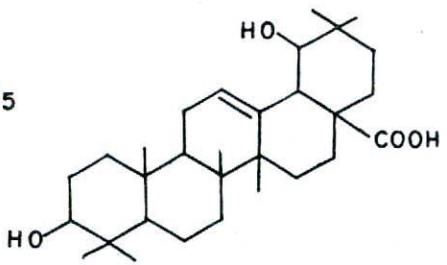
Chemical Tests

1. Heat Sumatra Benzoin (5 g) with 10% aqueous potassium permanganate solution. A bitter almond-like odour is produced due to oxidation of cinnamic acid present in Sumatra Benzoin. This test is negative in case of Siam Benzoin.
2. To a petroleum ether solution of Benzoin (0.2 g), 2-3 drops of sulphuric acid are added in a China dish. Sumatra Benzoin produces reddish-brown colour while Siam Benzoin shows purple-red colour on rotating the dish.
3. To alcoholic solution of Benzoin ferric chloride solution is added. A green colour is produced in Siam Benzoin due to the presence of phenolic compound coniferyl benzoate. This test is negative in case of Sumatra Benzoin which does not contain sufficient amount of phenolic constituents.

Uses : Siam Benzoin acts as antiseptic and expectorant; it is used to prepare benzoinated lard, cosmetics, fixatives and in perfumery. It is superior to the Sumatra Benzoin with respect to antioxidative effect in Lard and other fats.



Coniferyl benzoate



Siaresinolic acid

STORAX

Synonyms : Styrax; Sweet oriental gum; Prepared Storax; Liquid Storax; Styrax preparatus.

Biological Source : Storax is a balsam obtained from the trunk of *Liquidambar orientalis* Miller, commercially known

as Levant Storax, or of *Liquidambar styraciflua* Linn, known as American Storax. The balsam is subsequently purified.

Family : Hamamelidaceae.

Habitat : Levant Storax is a native to Asia Minor. American Storax is produced chiefly in Honduras; found along the Atlantic coast from Connecticut to Central America.

Collection : Levant Storax and American Storax are medium-sized trees attaining the height of 15 m and 40 m, respectively. Levant Storax is a pathological resin. In the early summer the bark of 3-4 years old tree is injured by bruishing. Cambium is activated to produce new wood with balsam secreting ducts. The bark is gradually saturated with balsam which is peeled off. The pieces of bark are pressed to get the product. The bark is boiled in hot water and re-pressed. The crude balsam is poured into casks or cans and exported.

American Storax exudes into natural spaces present in between the bark and the wood. The presence of balsam in spaces may be detected by excresences on the outside of the bark. From these pockets the balsam is tapped with gutters into containers which is exported in tin cans.

Storax is purified by dissolving the crude balsam in alcohol, filtering and evaporating the solvent under low temperature not to lose volatile compounds. The alcohol-insoluble part consists of vegetable debris and a resin.

Chatacters : Levent Storax is a viscous, semiliquid greyish, sticky, opaque mass which deposits as a dark-brown, heavier, oleoresinous product on standing. American Storax is a semisolid, sometimes solid mass softened by warming, becoming hard, opaque, and darker coloured. Storax is transparent in thin layers, has characteristic taste and odour, and is denser than water. It is insoluble in water; almost completely soluble in warm alcohol, ether, acetone, and carbon disulphide. Odour is agreeable and taste is balsamic.

Chemical Constituents : Storax is rich in two resin alcohol (50%), α-storesin and β-storesin and balsamic acids (30-47%). The alcohols occur partly free and partly as esters of cinnamic acid (10-20%). Storax also contains cinnamyl cinnamate or styracin (5-10%), phenylpropyl cinnamate (10%); ethyl cinnamate, benzyl cinnamate, free cinnamic acid (5-15%), styrene, traces of vanillin and volatile oil (0.5-1%).

Steam-distillation of Storax yields a pale yellow or dark brown oil (0.5-1.0%), known as oil of Storax. It has a pleasant but peculiar odour.

Uses : Storax is used as a stimulant, expectorant, parasiticide, topical protectant and an antiseptic. Pharmaceutical preparations like Compound Benzoin Tincture, Friars' Balsam and Benzoin Inhalation are also prepared from the Storax.

COPAIBA

Synonyms : Balsam Copoiba; Balsam of Copaiba; Balsam Capivi; Jesuit's Balsam, Copaiva.

Biological Source : Copaiba is an oleoresin obtained from trunks of South American species of *Copaifera (Copaiba)* like *Copaifera lansdorfii* Dest.

Family : Leguminosae.

Habitat : Brazil, Venezuela, Colombia, especially the Amazon valley and banks of Orinoco.

Collection : Copaiba is a physiological resin. The tree is 18 meters in height which is tapped and the oleoresin conducted directly to containers. About 20-24 litres of the product is collected from one tree.

Characters : Copaiba is a transparent, viscid, pale yellow to brown-yellow liquid, peculiar odour; bitter acrid, nauseating taste. It is insoluble in water but soluble in benzene, chloroform, ether, oils, carbon disulphide, absolute alcohol, and petroleum ether.

Chemical Constituents : Copaiba contains volatile oil, resin, illuric acid ($C_{20}H_{28}O_3$), metacopaivic acid (in Maracaibo Copaiba), copaivic acid and oxycopaivic acid (in Para Copaiba). These acids are the diterpenes relating to abietic or pimaric acid.

Uses : Copaiba has diuretic, antiseptic, expectorant and disinfectant properties and is used in leucorrhoea, gonarrhoea, in varnishes and for manufacturing photographic paper.

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 the decapitated rhizome and

roots of *Ferula asafoetida* L., *F. foetida*, Royel, *F. rubricaulis* Boiss. and some other species of *Ferula*.

Family : Umbelliferae.

Habitat : Iran, Turkestan, Afghanistan. (Karam and Chagai districts).

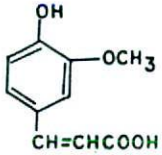
Collection : The plant is a perennial branching, 3 m high herb possessing large schizogeneous ducts and lysigenous cavities containing milky liquid. Upon exudation and drying of the liquid, Asafoetida is obtained. For the collection of the drug the upper part of the root is laid bare and the stem cut off close to the crown in March-April. The exposed surface is covered by a dome-shaped structure made of twigs and earth. After separating each slice, exudation of oleo-gum-resin, present as whitish gummy resinous emulsion in the schizogenous ducts of the cortex of the stem, takes place. It hardens on the cut surface which is collected, packed in tin-line cases and exported. Removal of the exudation and exposure of fresh surface proceeds until the root is exhausted. The yield is usually soft enough to agglomerate into masses when packed.

Characters : 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, greyish-white or dull yellow or reddish brown in colour.

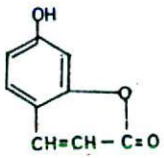
Asafoetida mass is mixed with fruits, fragments of root, sand and other impurities. Asafoetida has a strong garlic-like (alliaceous) odour and a bitter, acrid and alliaceous taste. When triturated with water, it makes a milky emulsion. It should not have more than 50% of matter insoluble in alcohol (90%)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

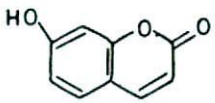
Chemical Constituents : Asafoetida contains volatile oil (4-20%), resin (40-65%) and gum (~25%). The garlic-like odour of the oil is due to the presence of sulphur compounds of the formulae $C_7H_{14}S_2$, $C_{16}H_{20}S_2$, $C_8H_{16}S_2$, $C_{10}H_{18}S_2$, $C_7H_{14}S_3$ and $C_8H_{16}S_3$. The main constituent of the oil is isobutyl propanyl disulphide ($C_8H_{16}S_2$). The three sulphur compounds, viz. 1-methylpropyl 1-propenyl disulphide, 1-(methylthio)-propyl 1-propenyl disulphide and 1-methylpropyl 3-(methylthio)-2-propenyl disulphide have also been isolated from the resin; the latter two have pesticidal properties. 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.



Ferulic acid





Umbelliferone

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 sometime. 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, antispasmodic 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, slices of potatoes, etc.

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 *C. abyssinica* or other species of *Commiphora.*

Family : Burseraceae.

Habitat : Arabian pennisula, Ethiopia, Nubia and Somaliland.

Collection : Myrrh plants are small trees up to 10 meters

in height. They have the phloem paranchyma and closely associated ducts containing a yellowish granular liquid. The tissues between these ducts often collapse, thereby producing large cavities similarly filled, i.e., schizogenous ducts become lysigenous cavities. The gum-resin exudes spontaneously or by incising the bark. The yellowish-white, viscous fluid is solidified readily to produce reddish-brown masses which are collected by the natives.

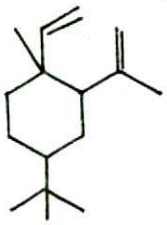
Characters : Myrrh occurs as irregular masses or tears weighing up to 250 g. The outer surface is powdery and reddish-brown in colour. The drug breaks and is powdered readily. Fractured surface is rich brown and oily. Odour is aromatic and taste is aromatic, bitter and acrid.

Chemical Constituents : Myrrh contains resin (25-40%), gum (57-61%), and volatile oil (7-17%). Large portion of the resin is ether-soluble which contains α-, β-and γ-commiphoric acids, resenes, the esters of another resin acid and two phenolic compounds. The ether insoluble portion is a mixture of α-and β-heerabomyrrholic acids. The volatile oil is a mixture of cuminic aldehyde, eugenol, meta-cresol, pinene, limonene, dipentene and two sesquiterpenes The disagreeable odour of the oil is due to mainly the disulphide, $C_{11}H_2OS_2$. The gum contains proteins (18%) and carbohydrate (64%) which is a mixture of galactose, arabinose, glucuronic acid and an oxidase enzyme. From the essential oil of *Commiphora abyssinica* the sesquiterpenes like elemol, furanodiene, furanodienone, isofuranogermacrene, curzerenone and linderstrene have been isolated.

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.



Elemol

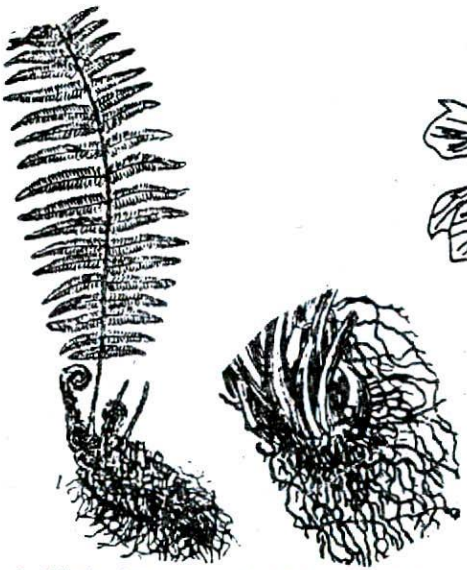
It is used as a tincture, paint, gargle and rinse due to its disinfecting, deodourizing, and granulation-promoting actions in inflammatory conditions of the mouth and throat. Alcoholic extracts are used as fixatives in the perfumery industry.

MALE FERN

Synonyms : Aspidium, Male shield-fern, Filix mas (B.P.); Male fern rhizome; Rhizoma filicis maris.

Biological Source : Male Fern consists of the rhizome, frond bases and apical bud of *Dryopteris filix-mas* (L.) Schot, known as European Aspidium or Male Fern, or of *Dryopteris marginalis*, known as American Aspidium or Marginal Fern collected late in autumn, divested of the roots and dead portions, and carefully dried, retaining its internal green colour.

Family : Polypodiaceae.



A. Whole drug B. Entire ramentum

Fig. 11.1 Male Fern



Fig. 11.2. *Podophyllum peltatum* entire plant

Habitat : *Dryopteris filix-mas* is native of Europe, Northern Africa, Northern Asia, North America, Rocky Mountains and Andes of South America. *Dryopteris marginalis* occurs in eastern and central U.S.A. and India.

Collection : Male Fern is a perennial wood fern. The underground parts of the plant are collected in late autumn; roots, and dead portions are removed, dried and preserved carefully.

Characters : The drug occurs in pieces, 7-25 cm in length, 2 cm in diameter. It is surrounded by frond bases which are brown externally and densely covered with ramenta. Internally the frond bases are green. Larger pieces are generally cut into small slices. The rhizome is brown externally and yellow-green internally. On long storage the internal part of rhizome turns brown and the activity decreases. Odour is slight and taste is sweet in the beginning and bitter and nauseous later on.

Chemical Constituents : The drug contains oleoresin (6.5-15%) which is a mixute of active constituents derived from phloroglucinol. The compounds possess mono-, bi-, tri-, and tetracyclic ring structures. The monocyclic derivatives are aspidinol, filicinic acid and filicinyl butanone which condense to yield bicyclic components like albaspidin and flavaspidic acid or tricyclic derivative like filixic acid. In addition to these aromatic compounds, volatile oil asbaspidin, filicin, filmaron, and filix red have been isolated from the Male Fern.

The chief active principle of the Male Fern is the complex dibasic acid, filmarone, an amorphous brownish yellow acid.

The crude drug deteriorates rapidly in storage. The oleo-resin, which is comparatively more stable, is extracted from the drug. The oleo-resin is obtained by exhausting the fresh coarsely powdered drug with ether in a perculator and evaporating the extract into a thick syrup. The official oleo-resin should contain 24-26% filicin by weight.

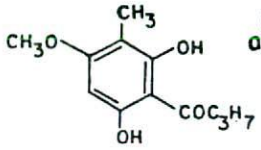
Uses : Male Fern is used as taenicide due to its anthelmintic properties. The side effects of the drug are stomach pains, colic, diarrhoea, blood in stool, albuminuria, nervous excitement, mental disturbances and defects in vision and blindness.

Filicin is an active vermifuge, especially effective for the expulsion of tapeworm. It is administered in capsules or in pills. Taenia are expelled in a few hour after administration. In combination with calomel, both vermifugal and purgative actions are ensured.

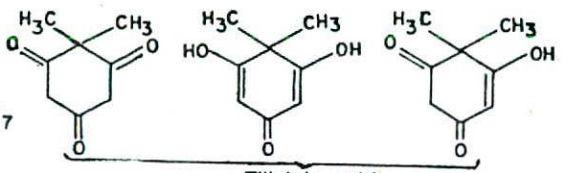
PODOPHYLLUM

Synonyms : May apple; Mandrake root; Indian apple; Vegetable calomel; Podophyllum rhizome, American Mandrake; Rhizoma podophylli.

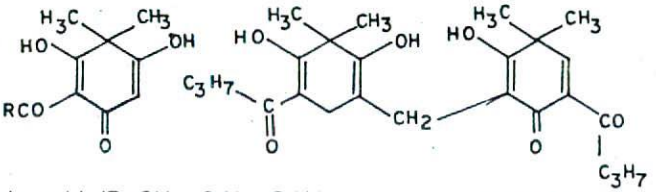
Biological Source : Podophyllum consists of the dried rhizome and roots of *Podophyllum peltatum* Linn.



Aspidinol

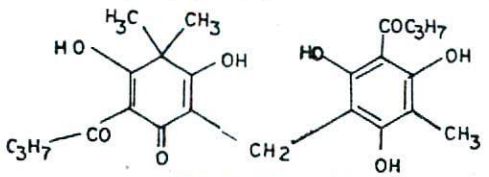


Filicinic acid

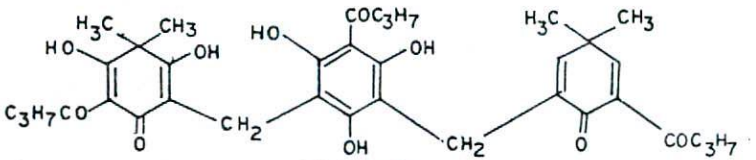


Acylfilicinic acid (R=CH_3; C_2H_5; C_3H_7)

Albaspidin



Flavaspidic acid



Filixic acid

Family : Berberidaceae.

Habitat : Podophyllum is found in eastern parts of Canada and the U.S.A.

Collection : The plant is a perennial herb growing in marshy, shady situations. It bears a single rhizome which is a meter in length. This is dug up, cut into 10 cm long pieces and dried. The bulk of the crop is gathered in late summer and autumn, cut into pieces 10-20 cm long, dried, and the rootlets usually removed. The rhizomes are reported to contain a higher percentage of active constituents in late

spring and early summer, but drug collected at these times contains very little starch and abundance of water, and consequently there is considerable shrinkage upon drying.

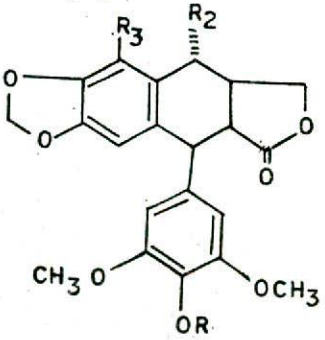
Characters : Podophyllum occurs in subcylindrical reddish-brown pieces, length 5-20 cm, breadth 5-6 mm. The nodes are elongated. Outer surface is wrinkled in case of summer rhizome or smooth in autumn rhizome. Stem scars are present on the upper surface while on the lower side of each node 5-12 root scars or root portions exist. The fracture is short and starchy.

Chemical Constituents : Podophyllum contains resin (3.5-6%) whose active principles are lignans (C_{18} compounds). The important lignans are podophyllotoxin (~20%), β-peltatin (~10%) and α-peltatin (~5%) occurring in free state and as glucoside. In addition to these lignans, the other closely related compounds like dimethyl podophyllotoxin and the glucoside, desoxypodo-phyllotoxin and podophyllotoxone are present in the drug. All these compounds possess cytotoxic or antitumour activity. Treatment of lignans with alkali produces epimerization with formation of the stable cis-isomers which are physiologically inactive.



Fig. 11.3. Podophyllum roots and rhizome

Picropodophyllin and quercetin are also present in Podophyllum.



Podophyllotoxin, R_1=CH_3, R_2=OH, R_3=H
α-Peltatin, R_1=R_2=H, R_3=OH
β-Peltatin, R_1=CH_3, R_2=H, R_3=OH
Demethylpodophyllotoxin, R_1=R_3=H, R_2=OH
Podophyllotoxone R_1=CH_3, R_2=OH, R_3=H
Desoxypodophyllotoxin, R_1=CH_3, R_2=R_3=H

Uses : Podophyllum possesses purgative and anti-cancer properties. It has a cytotoxic action and is used as a paint in the treatment of soft venereal and other warts.

INDIAN PODOPHULLUM

Synonyms : Papra (Hindi); Rhizoma Podophylli indici; Indian Podophyllum rhizome.

Biological Source : Indian Podophyllum consists of the dried rhizome and roots of *Podophyllum hexandrum* Royle (syn. *P. emodi* Wall. ex Hook). It contains 40-50% of podophyllotoxin.

Family : Berberidaceae.

Habitat : Podophyllum is found in the interior ranges of Himalayas at 3000-4600 m from Sikkim to Hazara descending to 2,000 m in Kashmir. It is cultivated in Punjab, Uttar Pradesh and N.W. Frontier Provinces.

The plant fluorishes well as an undergrowth in the fir forests, rich in humus and decayed organic matter. It is generally associated with species of *Rhododendron*, *Salix*, *Juniperus* and *Viburnum*, but it also met with in open alpine meadows. The plant loves moist and shady localities situated between 2,500 and 4,000 m.

The rhizome and roots of the plant are obtained entirely from wild plants. The underground rhizomes remain dormant during winter and produce aerial shoots in April or May after melting of ice. The shoots bear flowers and fruits during summer and die down in November. Rhizomes which bear 3-5 aerial shoots are considered suitable for collection. The rhizomes and roots are dug up in spring or autumn, cleaned, dried in the sun, packed and stored in gunny bags; sometimes they are cut into cylindrical pieces and carefully dried. Rhizomes collected in spring contain a higher resin content than those obtained in autumn. Freshly collected rhizomes possess more amount of active compounds which are lost on prolonged storing.

Characters : The plant is an erect, glabrous, succulent, perennial herb bearing 2-8 cm and 1-2 cm thick, subcylindrical, tortuous and irregular rhizomes. Internodes of the rhizomes are very short appearing knotty. Upper surface bears 3-4 cup-shaped or oval or circular depressed stem scars with an occasional bud or bud-scar on the lateral surface, lower surface contains numerous roots which are

about 10 cm in length and 3 mm thick. The roots may be longitudinally wrinkled, nearly straight, curved or tortuous. Colour is earthy brown. Roots are broken off easily. Fracture is short and starchy. Odour is slight but distinct; taste bitter and acrid.

Chemical Constituents : Indian podophyllum contains excess amount of resin (6-12%) and the concentration of podophyllotoxin is up to 40 per cent. No peltatins are reported but the other constituents are almost the same as reported in the American Podophyllum. The drug also possesses quercetin, berberine, starch and calcium oxalate.

It also contains kaempferol, astragalin (kaempferol-3-glucoside), an essential oil (3.7%) responsible for the odour, wax (8.6%) and mineral salts.

The lignan compounds of podophyllin from *P. hexandrum* are podophyllotoxin, podophyllotoxin glucoside, picropodophyllin, 1-O-glucopyranosyl-picropodophyllin, 4'-dimethyl podophyllotoxin, 4'-demethylpodophyllotoxin glucoside, dehydropodophyllotoxin, podophyllol, podophyllic acid and 4'-demethyl deoxypodopohyllotoxin glucoside.

Uses : Podophyllum resin (podophyllin) is used to treat soft venereal and other warts. The drug has been reported to possess anticancer, cholagogue, purgative, alterative, emetic and bitter tonic properties.

CANNABIS

Synonyms : Indian hemp; Indian Cannabis; Marihuana; Marijuana; Bhang; Ganja; Charas; Kif; Hasach; Pot; Cannabis indica.

Biological Source : Cannabis is the dried flowering top of pistillate plants of *Cannabis sativa* Linn. (Syn. *C. indica* Linn.). It contains not more than 10% of its fruits, large foliage leaves, and stems over 3 mm in diameter.

Family : Moraceae. Some authors have mentioned family as Cannabinaceae and Urticaceae.

Habitat : Cannabis occurs in India, Bangladesh, Pakistan, Iran, Central America, U.S.A., East Africa, South Africa and Asia Minor.

Cannabis Products : The following products are prepared from Cannabis.

1. **Ganja** : It contains up to 10% of its fruits, large foliage leaves and stems over 3 cm. It is known as *Flat-* or *Bombay ganja* when 30 cm long pieces of the herb are made into bundles and pressed. *Round* -or *Bengal ganja* is prepared by rolling the wilted tops between the hands.
2. **Bhang-or Hashish** : It consists of the larger leaves and twigs of both male and female plants. It is smoked with or without tobacco. It is unfit for medicinal use owing to deficiency of resin.
3. **Charas** : It is the crude resin obtained by rubbing the tops between the hands and beating them on a piece of cloth. This is an inferior product. It may be collected by beating the flowering tops in coarse cotton cloths spread on the ground. A greenish-brown soft mass adheres, and may be purified by pressing it through the cloths. The resin is scraped off. It is mixed with many smoking mixtures.

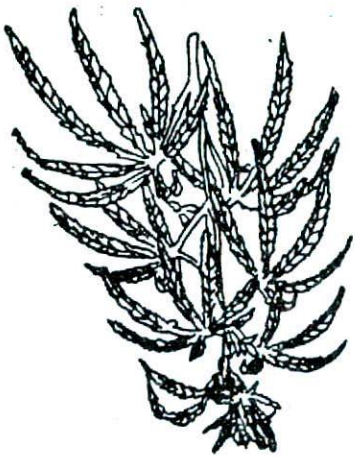


Fig. 11.4. *Cannabis sativa* branch

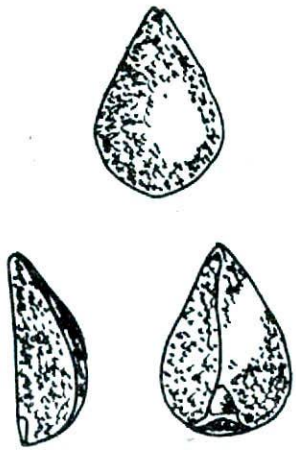
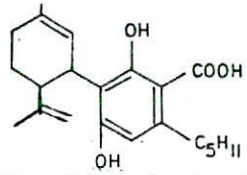


Fig. 11.5 Kaladana seeds

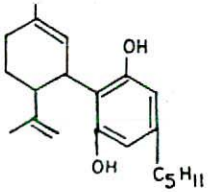
Morphology : Cannabis occurs in flattened, rough, dull dusky green masses. The dried resin is hard, brittle and does not stick. The flat-ganja is flattened mass of a dull green colour. The odour is very marked in the fresh drug and becomes faint alterwards; taste is slightly bitter.

Chemical Constituents : Cannabis yields resin (15-20%) which is brown, amorphous, semi-solid, soluble in alcohol, ether and carbon disulphide. It contains more than 60 compounds (cannabinoids). Some principal active compounds

are cannabinol, tetrahydrocannabinol, cannabidiol, cannabidiol -carboxylic acid, cannabigerol and cannabichromene. The tetrahydrocannabinols (Δ^8-and Δ^9-THC) possess euphoric activity. In addition to cannabinoids the plant also contains volatile oil which is a mixture of 30 compounds; the bases choline, trigonelline, spermidine and cannabisativine (alkaloid); flavonoid O-glucosides of both vitexin and orientin, and calcium carbonate.



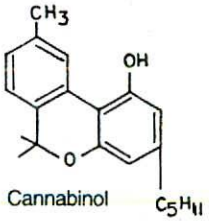
Cannabidiol-carboxylic acid



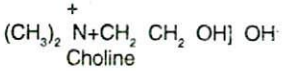
Cannabidiol



Δ^1-Tetrahydro-cannabinol



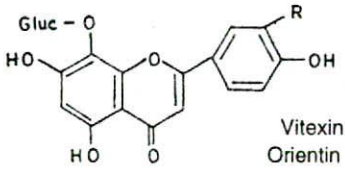
Cannabinol



Choline



Trigonelline



Vitexin (R=H)
Orientin (R=OH)

Uses : Cannabis is used as tonic, intoxicant, stomachic, antispasmodic, analgesic,narcotic, anticonvulsant, anti-anxiety and antitussive agent. When ingested or inhaled as smoke, it may cause euphoria, delirium, hallucinations, weakness, hyporeflexia, and drowsiness. It is a drug of abuse.

KALADANA

Synonyms : Mirchi (Hindi), Krishnabija (Sanskrit).

Biological Source : Kaladana consists of the dried ripe seeds of *Ipomoea hederacea* (L.) (syn *I. nil* Roth.).

Family : Convolvulaceae.

Habitat : Throughout India both cultivated and apparently wild, up to 2,000 m in the Himalayas.

Morphology : The seeds are 5-6 mm long, 3.7 mm wide, triangular, brownish black in colour. Each seed has two flat faces joining at an angle of 60 to 80°. At the base of joint there is a cordate hilum. Testa is dull black, hard, smooth and glabrous. Taste is first sweetish then acrid.

Chemical Constituents : Drug contains resin (about 15%), mucilage, fixed oil and saponin. Hydrolysis of the resin affords hydroxypalmitic acid and sugar.

Uses : Kaladana is used as purgative and substituted for Jalap.

JALAP

Synonyms : Jalap root; Radix jalapae; Mexican or Vera cruz Jalap.

Biological Source : Jalap is the dried tubercles or tuberous roots of *Ipomoea purga* Hayne (syn. *Exogonium purga* Benth).

Family : Convolvulaceae.

Habitat : Jalap is a large, twining plant indigenous to Mexico. It is also found in India, West Indies, Jamaica and South America. The tubercles are collected mainly in autumn. The larger specimens are cut into pieces to facilitate drying.

Characters : Jalap is fusiform, napiform or irregularly ovoid or pyriform in shape and length is 3-15 cm. The drug is very hard, compact, resinous, and heavy. The surface is covered with a dark brown, wrinkled cork. Lighter-coloured transverse lenticels and rootlet scars are present on the surface. Internally the drug contains weak to pale brown, with dark secondary, concentric complete cambium zones fairly close to the outside and within it numerous irregular dark lines. The drug has slight smoke-like odour, taste is starchy and sweet in the beginning and acrid afterwards.

Chemcial Constituents : Jalap contains resins (8-12%), volatile oil, starch, gum and sugar. The main constituent of Jalap resin is convolvulin which contains 8 hydroxy groups esterified with valeric, tiglic and exogonic acids. It also contains ipurganol, jalapin, β-methyl esculetin, palmitic and stearic acids, and mannitol. Convolvulin on hydrolysis gives glucose, rhamnose and convolvulinic acid.

Uses : It is a hydragogue cathartic and drastic purgative.

Convolvulinic acid



Valeric acid

$CH_3CH=C(CH_3)\ COOH$	$C_{10}H_{14}O_3$	$CH_3(CH_2)_4\underset{\underset{OH}{|}}{CH}\text{-}(CH_2)_9\text{-}COOH$
Methylcrotonic acid	Exogonic acid	Jalapinolic acid (11-Hydroxyhexadecanoic acid)

INDIAN JALAP

Synonyms : Turpeth root; Nishodh (Hindi); Black Nishodh.

Biological Source : Indian jalap consists of dried roots of *Ipomoea turpethum* R. Br.; syn. *Operculina turpethum (L.)* Silva Manso.

Family : Convolvulaceae.

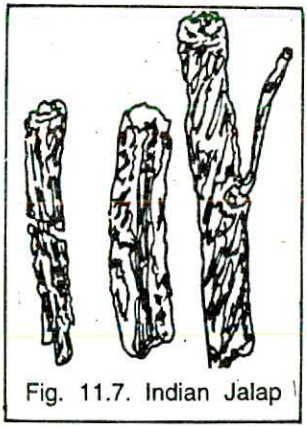


Fig. 11.7. Indian Jalap

Fig. 11.6. Jalap

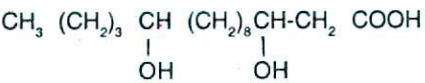
Habitat : Throughout India up to 1000 m.

Characters : Indian jalap occurs in cylindrical or spirally twisted form, length 2-15 cm, diameter 3-5 mm. Outer surface is greyish-brown containing longitudinal wrinkles. Fracture is irregular. Roots are darker and longitudinally furrows are present. Odour is slight and distinct; taste is unpleasant.

Chemical Constituents : Indian jalap contains resin (7-8%) and volatile oil. Alcoholic soluble portion of the resin is a mixture of gluco-gluco-rhamnosides of turpethinic acids like 11-hydroxypalmitic acid (jalapinolic acid), 3,12-dihydroxypentadecanoic acid (operculonic acid); 4, 12-dihydroxypentadecanoic acid; and 4, 12-dihydroxypalmitic acid.

Uses : Indian jalap is used as purgative.

Allied Drug : In Indian system of medicine white Nishoth is also used as purgative. It consists of roots of *Marsdenia tenacissima*. (Family : Asclepiadaceae). The plant is a large twinning shrub occurring throughout India. Roots are cylindrical, cut into pieces. Outer surface contains longitudinal furrows, ridges, and irregular cracks. Colour is yellow to buff, fracture is short and starchy in the bark and splintery in the wood. Odour is musty and taste is bland first, then acrid. The drug has not been investigated for chemical constituents and medicinal uses.



Operculinolic acid (3:12-Dihydroxyhexadecanoic acid)

IPOMOEA

Synonyms : Mexican Scammony (root); Orizaba Jalap root; Orizaba Jalap; Mexican Scammony root; Ipomoea radix.

Biological Source : Ipomoea consists of the dried root of *Ipomoea orizabensis* (Pellet) Led. yielding not less than 15% of resin.

Family : Convolvulaceae.

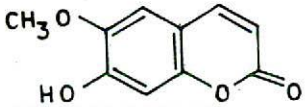
Habitat : Orizaba, Mexico.

Characters : The plant is a perennial vine, the underground portion is a fusiform 60 cm long root. Drug usually occurs as transversely cut slices of 3-12 cm in diameter and 1-5 cm thick. Outer surface is brown to grey, longitudinally wrinkled, fracture is short, irregular and resinous; texture is hard and tough, breaking with difficulty. Odour is slight; taste is acrid and resinous.

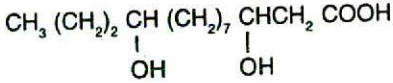
Chemical Constituents : Ipomoea contains resin (10-20%), scopoletin (coumarin), volatile fatty acids, sugars, sitosterol, and calcium oxalate. The 65 per cent of the resinous mass is ether soluble. The prominent constituents of Ipomoea resin

(Jalapin) are the methyl pentosides and other glycosides of jalapinolic acid and its methyl ester, phytosterol glycosides, (ipuranol), ipurolic acid and convolvullinic acid. Other compounds reported in ipomoea are 3, 4-dihydroxycinnamic acid, cetyl alcohol and gum.

Uses : Ipomoea is used as cathartic with hydragogue activity and for preparation of resin.



Scopoletin



Ipurolic acid

COLOCYNTH

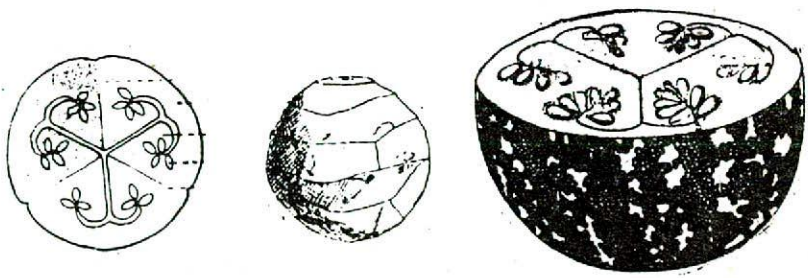
Synonyms : Bitter apple; Bitter cucumber; Bitter gourd; Colocynth pulp; Indrayan (Hindi); Colocynthis; Fructus Colocynthidis.

Biological Source : Colocynth is the dried pulp of the unripe but fully grown fruit of *Citrus colocynthis* Schrad.

Family : Cucurbitaceae.

Habitat : The plant occurs in Syria, Cyprus, Sudan, North Africa, Turkey, Spain and widely throughout India.

Collection : The plant is a perennial herbaceous vine. The collected fruits are peeled to separate the epicarp and immediately dried in the sun.



A. Whole fruit B. T.S. of fruit showing placenta and seeds

Peeled fruit

Fig. 11.8. Colocynth

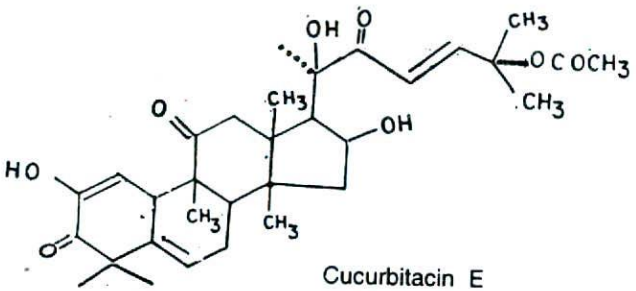
Morphology : The fruit is almost a globular berry, 4-10 cm in diameter. The peeled fruits are 4-8 cm in diameter, subspherical, nearly white, light in density and show sometimes small patches and impressions due to cuts occurred by knife. Transverse section of the fruit shows three

segments, divided by the radiating placentas, with seeds attached to the internal margins. Pulp is light, pithy and spongy, easily broken white or light yellow in colour.

Flat, ovoid seeds, 200-300 in each fruit, are present which are compressed, brown or orange in colour, one end somewhat pointed with rounded margin, 7 mm long and 4.5 mm wide. Fruit is odourless and taste is very bitter.

Chemical Constituents : Colocynth contains ether-chloroform soluble resin, a phytosterol glycoside, citrullol, pectin, colocynthin, colocynthetin, albuminoids and other glycosides. The glycosides on hydrolysis form cucurbitacin E (α-elaterin), and cucurbitacin L (dihydroelatericin B). Choline and two alkaloids have also been isolated from the drug.

Uses : Colocynth is very powerful cathartic. Cucurbitacin E is reported to possess anticancer activity.



Cucurbitacin E
(α-Elaterin)

GINGER

Synonyms : Zingiber, Saunth (Hindi); Rhizoma zingiberis.

Biological Source : Ginger is the dried rhizome of *Zingiber officinale* Rosc, scraped to remove the darker outer skin and dried in the sun.

Family : Zingiberaceae.

Habitat : Southern Asia, West Indies. China, Africa, India, cultivated in all tropical countries.

A number of commercial varieties of Ginger are available. *Nigerian Ginger* is darker in colour, small size and more pungent taste. *Cochin Ginger* is usually larger, well scraped, contains more starch and breaks with a shorter fracture.

African Ginger is darker in colour, more pungent in taste and less flavour than *Jamaica Ginger*.

African Ginger is mostly unpeeled, much of the ventral and dorsal surfaces bear patches of wrinkled cork of an earthy-brown colour. It is darker than Cochin Ginger in bulk, and appears discoloured due to lack of care during preparation. The fracture is short, odour strongly aromatic and taste pungent.

The rhizomes of *Jamaican Ginger*, the best quality ginger, are unbleached and devoid of outer suberized layers. The rhizome is pale yellowish brown to yellowish orange. The fracture is short and uneven, fibrous and resinous. It is pleasantly pungent and aromatic. An inferior grade of Jamaican Ginger, known as *Rotoon Ginger*, is also marketed.

Indian Ginger is considered only second to *Jamaican* in quality. There are two main types of Indian Ginger : (i) *Cochin Ginger*, which comes from central Kerala, is the peeled type, light brown to yellowish grey externally; and (ii) *Calicut Ginger*, from Malabar, is orange or reddish brown, resembling *African Ginger*, but the periderm is usually removed. It is inferior to *Cochin Ginger* in quality. Another type, *Calcutta Ginger*, is greyish brown to greyish blue externally. Indian Ginger is more strachy and is almost as pungent as *Jamaican Ginger*, but is less agreeable in odour. *Indian Ginger* has a faint lemon-like odour due to the presence of citral.

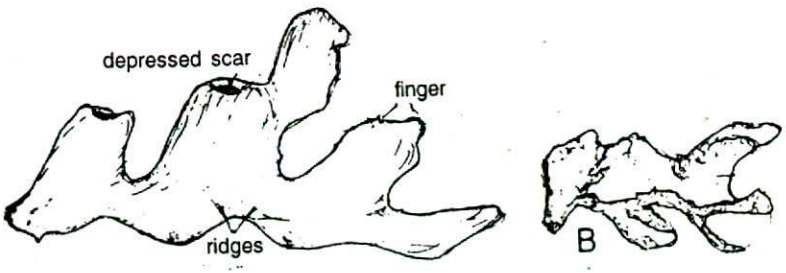
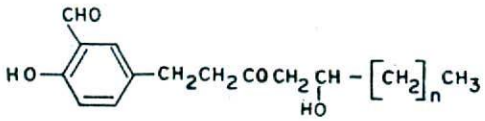
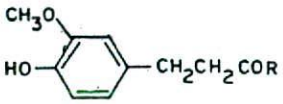


Fig. 11.9. Ginger rhizome

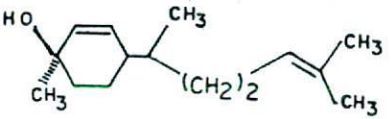
Chinese Ginger is white and is free from fibre. It is inferior in aroma to the *Jamaican Ginger* and consists of rhizomes which are not fully ripe. The fibres are absent.



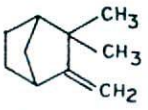
Gingerol (n=3, 4 or 5)



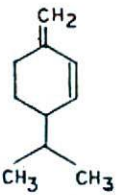
Zingerone, R=CH_3
Shogaol, R=CH=CH-$[CH_2]_4$-CH_3



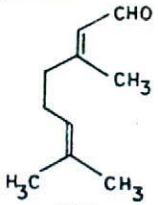
Zingiberenol



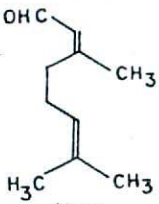
Camphene



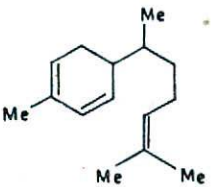
β-Phellandrene



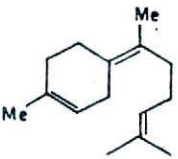
Citral



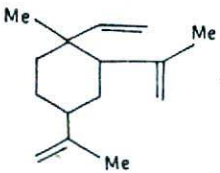
Neral



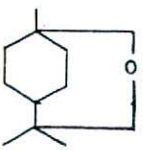
Zingiberene



Bisabolene



β-Elemene



1,8-Cineole



p-Cymene

The other Ginger are : The *Japanese Ginger (Z. mioga)* and *Martinique Ginger (Z. zerumbet).*

Cultivation : Ginger plant is a perennial herb about 1 m high with branching rhizome. The plant is propagated by rhizome cuttings each bearing a bud. The pieces of rhizome are planted in holes during March or April in a well-drained clayey loam. In December or January rhizomes are collected. For getting scrapped drug rhizomes are boiled with water, peeled, washed and dried in sun by turning them up and down from time to time.

Ginger requires a warm and humid atmosphere. A well distributed rainfall is required for its cultivation. If areas receiving less rainfall, the crop needs regular irrigation.

Morphology : Rhizomes are thick, horizontal, laterally compressed, often palmately branched, each having at its apex a depressed scar, showing longitudinal striations and occasional loose fibres, size 5-15 cm long, 3-4 cm wide and 1-15 cm thick: fracture-short, and starchy with projecting fibres. Fractured surface shows a narrow cortex, a well marked endodermis and a wide stele; the whole showing numerous scattered greyish points. Colour is buff; odour is agreeable and aromatic; taste is pungent.

Chemical Constituents : Ginger contains acrid resinous substances (5-8%), volatile oil (1-3%), starch (50%), protein (2-3%) and sugars such as sucrose, raffinose and glucose. The pungency of Ginger is due to gingerol [n=4]. The pungency is lost by boiling with 2% KOH. The other minor constituents of resin are gingediols, methylgingediol, gingediacetates and methylgingediacetates. Gingerols and shogaols are non-volatile phenolic compounds with different side-chains.

Volatile oil is a mixture of more than 25 components of monoterpenes (β-phellandrene, camphene α-and β-pinenes; cumene, myrcene, limonene, cineole, citral, borneol, p-cymene, 1,8-cineol, linalool, neral, etc.) and sesquiterpenes (zingiberene, farnesene, γ-selinene, ar-curcumene, β-sesquiphellandrene, β-eudesmol, β-elemene and bisaboline). Zingerone is also found in rhizome which is also pungent and has sweet odour. Dehydration of gingerol produces shogaol which is not present in fresh rhizomes. The oxygenated monoterpenes are 2-heptanol, 2-nonanol, *n*-nonanal, *n*-decanal, methyl heptenone, borneol, bornyl acetate, etc.

Uses : Ginger is used as an 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 sometimes benefited by chewing a piece of ginger.

Ginger stimulates the flow of saliva, raises the tonus of the intestinal musculature, and activates peristalsis.

Adulteration : Ginger may be adulterated by addition of 'wormy' drug or 'spent ginger' which has been exhausted in the extraction of 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 or seeds or *Aframomum melequeta* (grains of paradise, fam. Zingiberaceae). Such type of pungency is not destroyed by boiling with an alkali.

TURMERIC

Synonyms : Saffron Indian; Haldi (Hindi); Curcuma; Rhizoma curcumae.

Biological Source : Turmeric is the dried rhizome of *Curcuma longa* Linn. (syn. *C. domestica* Valeton).

Family : Zingiberaceae.

Habitat : The plant is native of southern Asia (Probably India) and is cultivated extensively in temperate regions. It is grown on a larger scale in India, China, East Indies, Pakistan, and Malaya.

Cultivation : Turmeric plant is a perennial herb, 2-3 ft high with a short stem and tufted leaves; the rhizomes, which are short and thick, constitute the Turmeric of commerce. The crop requires a hot and moist climate, a liberal water supply and a well-drained soil. It thrives on any soil-loamy or alluvial, but the soil should be loose and friable. The field should be well prepared by ploughing and turning over to a depth of about one ft. and liberally manured with farmyard and green manures. Sets or fingers of the previous crop with one or two buds are planted 3-inches deep at distance of 12-15 inches from April to August. The crop is ready for harvesting in about 9-10 months when the lower leaves turn yellow. The rhizomes are carefully dug up with hard picks, washed and dried.

Characters : The primary rhizomes are ovate or pear-shaped, oblong or pyriform or cylindrical and often short branched. The rhizomes are known as 'bulb' or 'round' turmeric. The secondary, more cylindrical, lateral branched, tapering on both ends, rhizomes are 4-7 cm long and 1-1.5 cm wide and called as 'fingers'. The bulbous and finger-shaped parts are separated and the long fingers are broken into convenient

bits. They are freed from adhering dirt and fibrous roots and subjected to curing and polishing process. The curing consists of cooking the rhizomes along with few leaves in water until they become soft. The cooked rhizomes are cooled, dried in open air with intermittent turning over and rubbed on a rough surface. Colour is deep yellow to orange, with root scar and encircling ridge-like rings or annulations, the latter from the scar of leaf base. Fracture is horny and the cut surface is waxy and resinous in appearance. Outer surface is deep yellow to brown and longitudinally wrinkled. Taste is aromatic, pungent and bitter; odour is distinct.

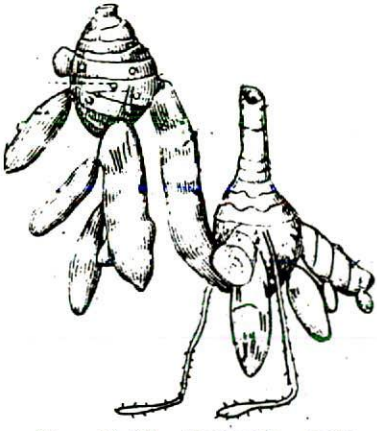


Fig. 11.10. Turmeric roots and rhizome

Chemical Constituents : Turmeric contains yellow colouring matter called as curcuminoids (5%) and essential oil (6%). The chief constituent of the colouring matter is curcumin I (diferuloylmethane) (60%) in addition with small quantities of dicaffeoylmethane (curcumin III), caffeoylferuloylmethane (curcumin II) and dihydrocurcumin. The volatile oil contains mono- and sesquiterpenes like zingiberene (25%), α-phellandrene, sabinene, turmerone, ar-turmerone, borneol and cineole. Choleretic action of the essential oil is attributed to p-tolylmethyl carbinol. Turmeric also contains arabinose (1%), fructose (12%), glucose (28%), starch grains, p-α-dimethylbenzyl alcohol, 1-methyl-4-acetyl-1-cyclohexene, and caprylic acid.

Uses : Turmeric is used as aromatic, stomachic, uretic, anodyne for billiary calculus, stimulant, tonic, carminative, blood purifier, antiperiodic, alterative, spice, colouring agent for ointment and a common house-hold remedy for cold and cough. Externally, it is used in the form of a cream to improve complexion. Dye-stuff acts as a cholagogue causing the contraction of the gall bladder. It is also used in menstrual pains. Curcumin has choleretic and cholagogue action and is used in liver diseases.

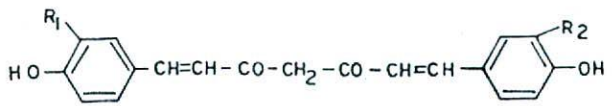
Curcuminoids have antiphlogistic activity which is due to inhibition of leukotriene biosynthesis. ar-Turmerone has

anti-snake venom activity and blocks the haemorrhagic effect of venom.

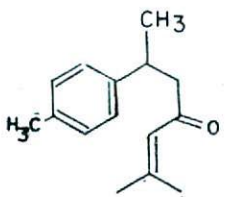
Chemical Tests

1. Turmeric powder on treatment with concentrated sulphuric acid forms red colour.
2. On addition of alkali solution to Turmeric powder red to violet colour is produced.
3. With acetic anhydride and concentrated sulphuric acid Turmeric gives voilet colour. Under U.V. light this colour is seen as an intense red fluorescence.
4. A paper containing Turmeric extract produces a green colour with borax solution.
5. On addition of boric acid a reddish-brown colour is formed which, on the addition of alkalies, changes to greenish-blue.
6. A piece of filter paper is impregnated with an alcohol extract, dried, and then moistened with boric acid solution slightly acidified with hydrochloric acid, and re-dried. Pink or brownish-red colour is developed on the filter paper which becomes deep blue on addition of alkali.

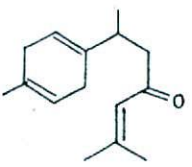
All these tests are due to the presence of curcuminoids in the drug.



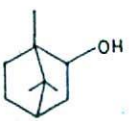
Curcumin I (R_1=R_2=OCH_3)
Curcumin II (R_1=OCH_3, R_2=H)
Curcumin III (R_1=R_2=H)



ar-Turmeron



Turmerone



Borneol



Sabinene

GALANGA

Synonyms : Galangal; Colic root; East India root; Chinese ginger; Ganlang rhizome; Rasna; Barakulanjan (Hindi); Lesser galangal; Galangal rhizome; Rhizoma galangae.

Biological Source : Galanga consists of dried rhizome of *Alpinia officinarum* Hance.

Family : Zingiberaceae.

Habitat : Galanga is grown in China, Thailand, eastern Himalayas, Bengal and south-west India.

Morphology : The plant is 1-2 m long perennial herb bearing rhizomes. The drug consists of irregularly branched cylindrical rhizomes, about 2-8 cm long and 1-2 cm thick. They are marked with fine, wavy annulations of lighter colour than the general surface which is reddish or rusty brown in colour. Taste is aromatic, and pungent; odour is aromatic, distinct, spicy and agreeable. Fracture is very tough and fibrous, the exposed surface is lighter orange or brown in colour.

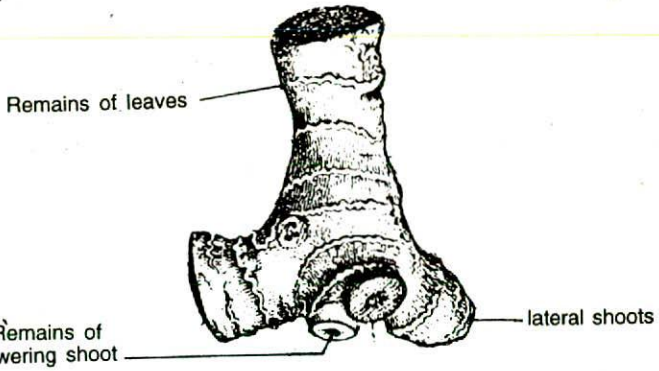


Fig. 11.11. Rhizoma of *Alpina officinalis* (Galanga)

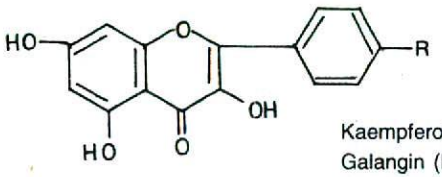
Chemical Constituents : Galanga contains volatile oil (0.5-1%), resin (20%), kaempferol, galangin, dihyoxyflavanol, galangol, phlobaphene tannins and starch in abundance. The volatile oil is a mixture of 1, 8-cineole, α-pinene, β-pinene, methyl isovalerate, camphene, limonene, p-cymene, camphor, β-elemene, α-bergamotene, terpinen-4-ol, δ-cadinene, γ-cadinene, methyl cinnamate and eugenol. Kaempferol, galangin and alpinin are the flavonoids.

Uses : Galanga is used in rheumatism, fever, catarrahal affections specially in bronchial catarrah, stomachic,

stimulant, aphrodisiac, carminative and as flavouring agent. It has antifungal and antibacterial properties.

Allied Drugs : *Alpinia galanga* (Greater galanga) rhizome, a native of Java and Sumatra and cultivated in India, is substituted to the *A. officinarum*. Greater galanga is larger is size, colour deep orange brown externally and pale buff internally. The drug does not contain any flavonoid. Alcoholic extract of the drug on filter paper does not show any fluorescence under U.V. light due to absence of flavonoids.

Adulteration : The genuine drug is not available in sufficient quantities and most of it is adulterated with the rhizomes of *Acorus calamus*.



Kaempferol (R=OH)
Galangin (R=H)

CAPSICUM

Synonyms : Chillies; Cayenne Pepper; Red Pepper; Spanish Pepper; Mirch (Hindi); Capsicum fruits; Fructus Capsici.

Biological Source : Capsicum consists of the dried, ripe fruits of *Capsicum frutescens* Linn (African Chillies) or of *Capsicum annuum* Linn. var. *conoides* (Tabasco pepper) or of *Capsicum annuum* var. *longum* (Lonusiana Long pepper), or of a hybrid between the Honka variety of Japanese Capsicum and the old Louisiana Sport Capsicum known as *Loisiana Sport Pepper*.

Family : Solanaceae.

Habitat : Capsicum is native of America and cultivated in tropical regions of India, Japan, Southern Europe, Mexico, Africa (Kenya, Tanzania, and Sierra Leone) and Sri Lanka.

Cultivation : Capsicum is cultivated mostly as a rain-fed crop. In the gangetic area, it is a cold weather crop. The crop is raised on a variety of soils, e.g. ordinary red loams, black soils and clayey loams. Good drainage is essential and water-logging is detrimental. Seedlings are first rainsed in a nursery. Seeds obtained from selected pods and mixed with ashes are sown by broadcasting. Germination occurs in about a week. The field is ploughed and manured with compost. The field is irrigated once a day until the plants

are established. Flowering starts when the plants are 2.5 - 3.5 months old. Dew and heavy rain at flowering time are injurious. Ripe and nearly ripe fruits are picked at intervals of 5, 10 and 20 days.

Characters : Capsicum is 5-12 cm long, 2-4 cm wide, globular, ovoid or oblong in shape, surface is shrievelled, orange or red in colour, pedicel is prominent and bent. Internally the fruits are divided into two halve parts by a membranous dissepiment to which the seeds are attached. Capsicum has characrteristic odour and an intense pungent taste.

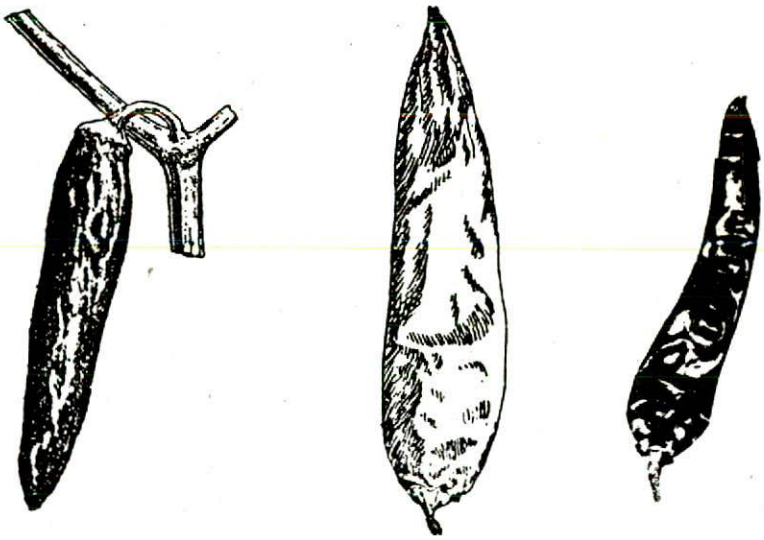


Fig. 11.12. Capsicum

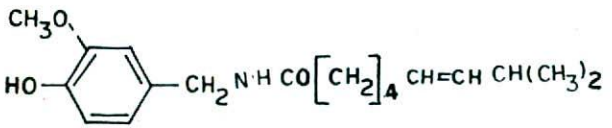
Collection : The fruits are picked as they become fully ripe. The quality of the drug is in part determined by its colour. The unripe fruits fade to pale buff upon drying. The fruits are dried in sun, graded by colour; occasionally oil is rubbed on the fruits to give a glossiness to the pericarps. Most of the calices and pedicels are removed.

Chemical Constituents : Capsicum contains fixed oils (0.1-1%), oleo-resin, carotenoids, capsacutin, capsico (a volatile alkaloid), volatile oil (1.5%) and ascorbic acid (0.2%). The

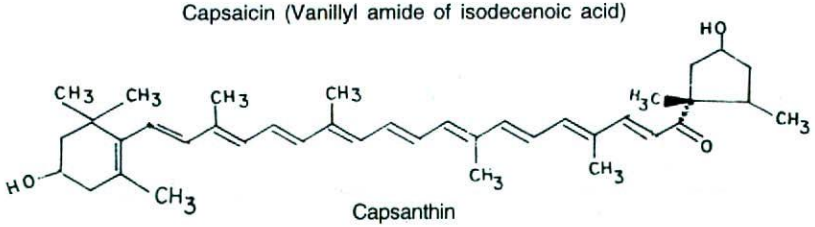
resin contains an extremely pungent principle, capsaicin, (decylenic vinillyl amide) (about 0.5%). Capsaicin retains its characteristic pungency in a dilution of 1 part in 10 million parts with water. The maximum concentration of capsaicin is in the inner walls. Its pungency is uneffected by alkalies but is destroyed by oxidising agents. Capsanthin is the main carotenoid of red fruits. It also occurs as monoester and diester along with cryptocapsin. Other carotenoids include zeaxanthin, lutein, cryptoxanthin, α- and β-carotenes and few xanthophylls. The carbohydrates reported in chillies are fructose, galactose, sucrose, fructosyl-sucrose, planteose, planteobiose, etc. Tocopherol (vitamin E) is present in trace amounts (~2.4 mg/100 g).

The pungent compounds of *C. annuum* are capsaicin (69%), dihydrocapsaicin (22%), nordihydrocapsiacin (7%), homo-capsaicin (1%) and homodihydrocapsaicin (1%).

Uses : Capsicum has been used externally as stimulant, counter irritant, rubefacient, in sore throat and scarlatina, hoarseness, dyspepsia and yellow fever. Internally it is used as carminative, stomachic, atonic dyspepsia and flatulence. In the form of ointment, plaster, medicated wool it is used for the relief of rheumatism, lumbago, etc.



Capsaicin (Vanillyl amide of isodecenoic acid)



Capsanthin

QUESTIONS

1. What are Resin and Resin combinations ? Write official source, chemical constituents and uses of Podophyllum, Cannabis and Male Fern.
2. What are balsams ? How is Balsam of Peru obtained ? Give chemical tests and constituents of it.

3. Give the sources, chemical constituents and uses of the following drugs : (a) Benzoin (b) Asafoetida (c) Ipomoea (d) Cannabis.
4. Give natural occurrence, chemistry, isolation and pharmaceutical uses of podophyllotoxin and curcumin.
5. Write short but informative notes on : (a) Ginger, (b) Podophyllum, (c) Turmeric.
6. Discuss chemistry and isolation of Curcumin from Turmeric and give its biological activities.
7. Write short notes on : (a) Balsam of Tolu (b) Sumatra Benzoin (c) Turmeric (d) Podophyllum.
8. How are the following drugs identified : (a) Myrrh (b) Asafoetida (c) Colophony (d) Benzoins.
9. Describe the biological source, chemical constituents and uses of the resin drugs belonging to the following family : (a) Berberidaceae (b) Styraceae (d) Zingiberaceae (d) Bureseraceae.
10. Describe different commercial varieties of Ginger, its chemical constituents and uses.
11. Discuss turmeric under a pharmacognostic scheme. Write its chemical constituents and tests of identification.
12. Give the physical characters, chemical constituents and chemical tests for : (a) Colophony (b) Myrrh (c) Asafoetida.

12

PROTEINS

Proteins are highly complex molecules which contain the elements of carbon, hydrogen, nitrogen, and usually sulphur. They are synthesized by living cells and are an essential part of the structure of the cell and its nucleus. The plant proteins are more easily isolated in crystalline form. Proteins are stored in plants in the form of aleurone grains. They are required for animals as the source of nitrogen in food.

The molecular weight of most proteins can be estimated only approximately by centrifugal sedimentation methods for soluble proteins, which vary from few thousand to many millions. Other methods are osmotic pressure measurements, X-ray diffraction, light scattering effects, gel filtration and chemical analysis.

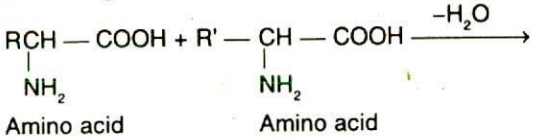
Soluble proteins form colloidal solutions which are generally viscous and may form gel. Many of them (e.g. egg albumin) are coagulated by heat or action of acids, alkalies or certain chemicals or by U.V. light. This process is known as 'denaturation' in which solubility of the protein in decreased.

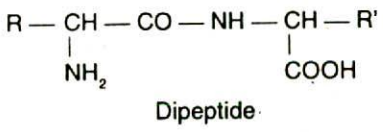
Proteins are hydrolyzed to form simpler substances and ultimately amino acids. The hydrolytic process takes place during digestion by proteolytic enzymes or in laboratory by hot acids or alkalies :

Protein → Polypeptide → Peptide → Amino acids

Proteins are built up from amino acids linked together in chains or rings. The carboxylic group of one molecule is condensed with an amino group of the adjacent molecule

with the formation of the amide linkage commonly known as peptide linkage.





Natural compounds formed in this way are called as 'polypeptide' if they have molecular weight below 10,000. Molecules with molecular weight above ~ 10,000 are known as proteins. In general, proteins and polypeptides differ in chemical and physical properties. Both type of compounds often exhibit physiological activity as in case of enzymes and hormones.

Proteins may be classified as :

(i) Fibrous proteins which serve as structural materials for animals, e.g., collagen, horn, feathers, nails, fibroin (silk), and

(ii) Globular proteins which are soluble in water and dilute acids and alkalies.

In another classification proteins are divided as

(i) Simple proteins, which yield only amino acid on hydrolysis, e.g., protamines, albumin, globulins, etc.,

(ii) Conjugated proteins, which contain a non-protein group, known as prosthetic group, e.g., nucleoproteins, chromoproteins, glycoproteins, phosphoproteins, lipoproteins, and metalloproteins, and

(iii) Derived proteins, which are the degradation products obtained by the action of acids, alkalies or enzymes on proteins. For example, denatured proteins, metaproteins, secondary proteoses, peptones, polypeptides, simple peptides and amino acids are the derived proteins.

Since proteins are present in all living organisms, they are of great importance in biochemistry. They form an

important class of food, e.g. meat, fish and egg are important source of animal proteins. Cereal grains, e.g., wheat, pulses, etc., are plant protein foods. Whole glandular products, oil-bearing plant seeds, antitoxins, serums, and globulins contain proteins in combination with other biochemical substances. These products possess therapeutic activity. Allergens are usually proteinaceous materials producing allergic reactions.

Certain proteins are highly poisonous. Among them are plant toxalbumins, ricin from castor beans, robin from locust bark, abrin from jequirty seeds, hemolysins from salamanders and various toxins, e.g., neurotoxoids from snake venum.

Properties of Proteins : Proteins are amphoteric in nature. At some definite pH, characteristic for each protein, the positive and negative charges are exactly balanced and the molecules do not migrate in an electrical field. This condition is known as 'isoelectric point' and at this pH the protein has its least solubility. All proteins are optically active and may be coagulated and precipitated from aqueous solution.

Colour Reactions : Proteins exhibit a variety of colour reactions, e.g.,

1. **Biuret Reaction :** To alkaline solution of protein (2 ml), a dilute solution of copper sulphate is added. A red or violet colour is formed with peptides containing at least two peptide linkages. A dipeptide does not give this test.
2. **Xanthoproteic Reaction :** Proteins usually form a yellow colour when warmed with concentrated nitric acid. This colour becomes orange when the solution is made alkaline. The colour is due to nitration of aromatic ring present in phenylalanine, tyrosine and tryptophan.
3. **Millon's Reaction :** Millon's reagent (mercuric nitrate in nitric acid containing a trace of nitrous acid) usually yields a white precipitate on addition to a protein solution which turns red on heating. This reaction is characteristic of phenols (e.g. the phenolic amino acid tyrosine).
4. **Ninhydrin Test :** To an aqueous solution of a protein an alcoholic solution of ninhydrin is added and then heated. Red to violet colour is formed.

5. **Nitroprusside Test :** Proteins containing sulphur group form red colour with nitroprusside solution.
6. **Lead sulphide Test :** Alkaline solution of sulphur containing proteins, on addition to lead acetate, produces a black precipitate.

GELATIN

Synonyms : Gelfoam; Puragel; Gelatinum.

Biological Source : Gelatin is a heterogenous mixture of water-soluble proteins of high average molecular weight obtained by treating specific animal tissues like skin, tendons, ligaments and bones with hot water. Gelatin is not found in nature but derived from collagen by hydrolytic action.

Preparation : For preparation of Gelatin, the insoluble collagens are converted into soluble gelatin which is then purified and concentrated to a solid form. Commercially, gelatin is obtained from by-products of slaughtered cattle, sheep, and hogs. The starting materials, e.g. bones, are defatted with an organic solvent. Sometimes these are decalcified with hydrochloric acid. The material is then heated with water at 85°C to convert collagens to Gelatin. The solution is decolourized, filtered by electro-osmosis, concentrated under reduced pressure, allowed to set into gel in shallow trays and dried rapidly in drying-rooms at 30, 40, 50 and 60° for some weeks.

Characters : Gelatin is colourless or slightly yellow, transparent, brittle, practically odourless, tasteless sheets, flakes or course powder. In water it swells and absorbs 5-10 times its weight of water to form a gel in solutions below 35-40°. It is soluble in hot water, glycerol, acetic acid; insoluble in organic solvent and is amphoteric. In dry condition it is stable in air, but when moist or in solution, it is attacked by bacteria. The gelatinizing property of Gelatin is reduced by boiling for long time.

Commercially two types of gelatin , A and B, are available. Type A has an iso-electric point between pH 7 and 9. It is incompatible with anionic compounds such as acacia, agar and tragacanth. Type B has an isoelectric point between 4.7 and 5 and it is used with anionic mxtures. Gelatin is coloured with a certified colour for manufacturing capsules or for coating of tablets. It may contain various additives.

Chemical Constituents : Gelatin consists of the protein glutin which on hydrolysis gives a mixture of amino acids. The approximate amino acid contents are : glycine (25.5%), alanine (8.7%), valine (2.5%), leucine (3.2%), isoleucine (1.4%), cystine and cysteine (0.1%), methionine (1.0%), tyrosine (0.5%), aspartic acid (6.6%), glutamic acid (11.4%), arginine (8.1%), lysine (4.1%) and histidine (0.8%). Nutritionally, gelatin is an incomplete protein lacking tryptophan. The gelatinizing compound is known as chondrin and the adhesive nature of Gelatin is due to the presence of glutin.

Uses : Gelatin is used to prepare pastilles, pastes, suppositories, capsules, pill-coatings, gelatin sponge; as suspending agent, tablet binder, coating agent, as stabilizer, thickener and texturizer in food; for manufacturing rubber substitutes, adhesives, cements, lithographic and printing inks, plastic compounds, artificial silk, photographic plates and films, matches, light filters for mercury lamps; clarifying agent; in hectographic matters; sizing paper and textiles; for inhibiting crystallization in bacteriology, for preparing cultures and as a nutrient.

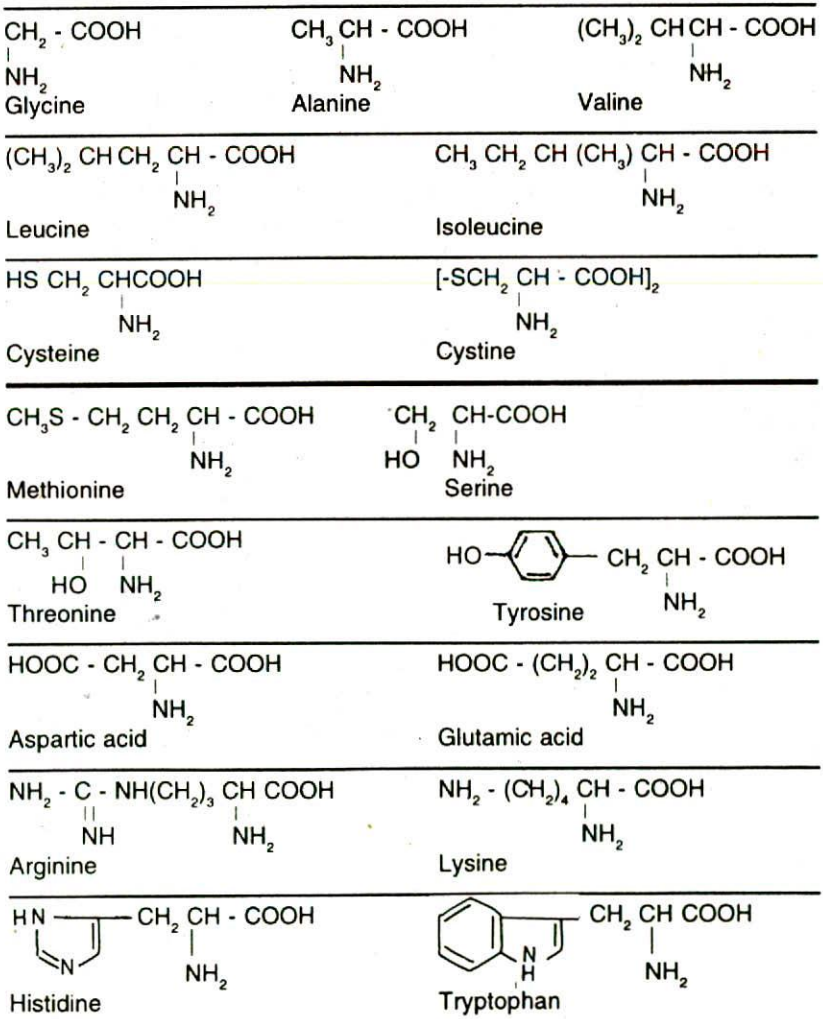
It forms glycerinated gelatin with glycerin which is used as vehicle and for manufacture of suppositories. Combined with zinc, it forms zinc gelatin which is employed as a topical protectant. As a nutrient, Gelatin is used as commercial food products and bacteriologic culture media.

Absorable Gelatin Sponge : It is a water-insoluble gelatin based sterile sponge. It is prepared from purified, specially treated gelatin to form a light, white porous, pliable, non-antigenic matrix. It is sterlized by heat. It absorbs about 50 times its weight of water and about 45 times its weight of blood. It is local haemostatic and used to control capillary oozing, bleeding of veins and operative wounds. The sponge is applied to the bleeding area, held for about 15 seconds and left.

Absorbable Gelatin Film : It is a specially prepared cellophane-type gelatin product in neurosurgery and in thoracic and ocular surgery. It consists of a thin, nonantigenic, pliable absorbable film of purified gelatin. It occurs in pieces of about 2.5 x 5 cm or 10 x 12.5 cm in size and about 0.075 mm in thickness. It is moistened by immersion in salt solution for cutting into the shape required to fit into the contours of the incision.

Chemical Test

1. Biuret test is positive.
2. Xanthoproteic test is positive.
3. Millon's test is positive.
4. Ninhydrin test is positive.
5. On heating Gelatin (1 g) with soda lime, smell of ammonia is produced.
6. A solution of Gelatin (0.5g) in water (10 ml) is precipitated to white buff coloured precipitate on addition of few drops of tannic acid (10%).
7. With picric acid Gelatin forms yellow precipitate.



YEAST

Synonyms : Dried yeast; Cerevisiae fermentum; Faex medicinalis.

Biological Source : Yeast are unicellular organisms, consists of the cells of a suitable strain of *Saccharomyces cerevisiae* Hansen (Fam. Saccharomycetaceae) dried to preserve the vitamins present.

Collection and Preparation : Yeast are commercially available as 'Brewer's yeast' which is viscid, semifluid frothy mass and consists of living cells of *S. cerevisiae* and related species. 'Compressed yeast' is the purer strain of yeast, partially dried by expression of water and admixed with a starch. 'Dried yeast' is the dried cells of *S. cerevisiae*. Dried yeast is usually obtained as a by-product from the brewing beer made from an extract of cereal grains and hops. The yeast cells are washed to free beer and dried, and may be debittered. Dried yeast may also be obtained by growing suitable strains of yeast, using media other than those required for the production of beer, and under appropriate environmental conditions. Dried yeast is obtained by heating the compressed yeast at 30°C until the moisture content is reduced to below 9 per cent.

Characters : Dried yeast occurs as a pale buff to weak yellowish orange flakes, granules or powder with characteristic indicative odour. Due to the presence of dead cells, dried yeast is inactive in fermentation process. Under microscope spherical, elliptical or ovate cells up to 8 μm long are present.

Chemical Constituents : The principal compounds of yeast are vitamins 'B-group' such as aneurine, nicotinic acid, riboflavine, folic acid and B_{12}. In addition to these yeast contains proteins (46%), carbohydrates (36%) particularly glycogen, fats, sterols and enzymes like zymase complex, glucogenase, invertase, maltase, emulsin and diastase, nucleoproteins, etc.

Uses : Yeast is used as dietary source of B vitamins and proteins, and in the treatment of furunculosis. Mostly yeast is used in baking bread, brewing; producing alcohol by fermentation of sugar, molasses, and cereals.

DIASTASE (MALT EXTRACT)

Synonyms : Maltin, Diastase of malt.

Biological Source : Diastase is a mixture of amylolytic enzymes obtained from malt.

Malt is obtained by artificially germinated barley grains, *Hordeum vulgare* Linn. (Fam. Gramineae). Barley is grown throughout the world in favourable climate. For preparing malt, wet barley grains in heaps are kept in warm room for germination until the caulicle protrudes. The grain is dried quickly to kill the embryo. The enzyme diastase in the moist warm grains converts starch to maltose which stimulates the embryo for germination. Dry malt contains maltose sugar (50-70%), dextrins (2-15%), proteins (8%), diastase and peptase enzyme. It resembles barley but is more crisp with an agreeable odour and sweet taste. It is used mainly in the brewing and alcohol industries.

Malt extract is prepared by extracting the partially germinating grains of *H. vulgare*. It contains dextrin, maltose, glucose and amylolytic enzymes. Diastase converts at least 50 times of its weight of potato starch into sugars (dextrin and maltose) in 30 minutes.

Diastase is a yellowish white amorphous powder or translucent scales obtained from an infusion of malt. It loses amylolytic power on keeping, on heating its solution at 85°, or on adding excess of acid. It is soluble in water with some turbidity; almost insoluble in alcohol.

Diastase in used to manufacture starch, converting starch into sugar and to remove starch from fabrics.

PAPAIN

Synonyms : Papayotin; Vegetable pepsin; Arbuz; Nematolyt; Caroid; Summetrin; Tromasin; Velardon; Vermizym.

Biological Source : Papain is the dried and purified latex of the green fruits and leaves of *Carica papaya* L. (Fam. Caricaceae). The plant is cultivated in Sri Lanka, Tanzania, Hawai and Florida. The plant is 5-6 m in height bearing fruits of about 30 cm length and a weight up to 5 kg.

Preparation : It is distributed throughout the plant, but mostly concentrated in the latex of the fruit.

The latex is obtained by making 2-4 longitudinal incisions, about 1/8 inch deep, on the surface of nearly mature but green fruits while still on the tree. The incisions

are made early in the morning, at intervals of 3-7 days. The exudate is collected in non-metallic containers or on cloth of *americani* type stretched wooden frames clamped to the tree. The latex is dried as soon as possible after collection. Rapid drying or exposure to sun or higher temperature above 38°C produce dark colour product with weak in proteolytic activity. The final product should be creamy white and friable. It is sealed in air-tight containers to prevent loss of activity. If 10% common salt or 1% solution of formaldehyde is added before drying, the product retains its activity for many months.

Fully grown fruits give more latex of high enzyme potency than smaller or immature fruits. The yield of Papain varies from 20 to 250 g per tree. The yield of commercial Papain from latex is about 20%.

Papain can also be obtained from the juice of stems, leaves and petioles. The enzyme has nearly the same activity as that obtained from the fruit latex.

A highly active product is obtained by dissolving the commercial product in water, saturating with hydrogen sulphide, precipitating with alcohol and drying the precipitate at low temperature.

Commercial Papain is often adulterated with arrowroot starch, dried milk of cactus, gutta percha, rice flour and pepsin. Bleaching is done for improving the colour, but this lowers the enzyme activity of the product.

Papain possesses both milk clotting and protein digesting properties. The milk clotting property is lost through oxidation with hydrogen peroxide and is regained on reduction with hydrogen cyanide or hydrogen sulphide. The pepton hydrolyzing activity is lost on oxidation with hydrogen peroxide and is regained on reduction. Oxidation, however, does not affect the Gelatin hydrolyzing activity.

Characters : Papain occurs as white or greyish - white, slightly hygroscopic powder. It is incompletely soluble in water and glycerol. It may digest about 35 times its weight of lean meat. Best-grades render digestion of 200 - 300 times their weight of coagulated egg albumin in alkaline media. A temperature range of 60-90° is favourable for the digestive process with 65° the optimum point. Best pH is 5.0, but it functions also in neutral or alkaline media. It is activated by reduction (HCN, H_2S, etc.) and inactivated by oxidation

(H_2O_2, iodoacetate).

Chemical Constituents : Papain contains several enzymes such as proteolytic enzymes peptidase I capable of converting proteins into dipeptides and polypeptides, renninlike enzyme, clotting enzyme similar to pectase and an enzyme having a feeble activity on fats.

Two enzymes, papain and chymopapain, have been isolated in crystalline form from the latex. Papain is a typical protein digesting enzyme with isoelectric point. It contains 15.5% nitrogen and 1.2% sulphur. Crystalline Papain is most stable in the pH range 5 - 7 and is rapidly destroyed at 30° below pH 2.5 and above pH 12.

Uses : Papain is used to prevent adhesions; in sloughing and infected wounds; internally as protein digestant, as anthelmintic (nemotode), to relieve the symptoms of episiotomy (incision of vulva) and in meat industry for tenderizing beef, used for treatment of dyspepsia, intestinal and gastric disorders; for the treatment of diphtheria, for dissolving diphtheria membrane; in surgery to reduce incidence of blood clots where thromboplasma is undesirable; for local treatment of buccal, pharyngeal and laryngeal disorders.

It is used in digestive mixtures, liver tonics, for reducing enlarged tonsils, in prevention of post-operative adhesions, carbuncles and eschar burns. It is an allergic agent causing severe paroxysmal cough, vasomotor rhinitis and dyspnea. It is a powerful poison when injected intravenously. In industry it is used in the manufacture of proteolytic preparations of meat, lever and casein, with dilute alcohol and lactic acid as meat tenderizer, as a substitute for rennet in cheese manufacture, in brewing industry for making chill-proof bear, for degumming natural milk, in preparation of tooth pastes and cosmetics and in tanning industry for bating skin and hides.

BROMELAIN

Synonyms : Bromelin; Ananase; Extranse; Inflamen; Traumanase.

Biological Source : Bromelain is a protein-digesting and milk clotting enzyme found in pineapple fruit juice and stem tissues of *Ananas comosus* (L.) Merr.

Family : Bromeliaceae.

Enzymes from fruit juice and stem tissue are distinguished as fruit Bromelain and stem Bromelain. From pineapple juice the enzyme is obtained by precipitation with acetone and also with ammonium sulphate. Stem Bromelain has molecular weight of about 33,000 and is probably the first proteolytic enzyme of plant origin to be established as a glycoprotein.

Unlike Papain, fruit Bromelain does not disappear as the fruit ripens. Fruit and stem Bromelains are acidic and basic proteins, respectively.

Bromelain is used as adjunctive therapy to reduce inflammation and edema and to accelerate tissue repair. Bromelain is also used to produce protein hydrolysates, in tenderizing meats, in leather industry and chill proofing agent in beer.

It is also used as food additive and bating reagent of hides. It is useful in determining antibody substances, dissolving necrogenic tissues, treating digestive troubles; when applied as an antiphlogistic it shows less after-effects.

FICIN

Synonyms : Ficus proteinase; Ficus protease; Debricin; Higueroxyl delabarre.

Biological Source : Ficin is a concentrate prepared by filtering and drying the latex of *Ficus glabrata* (Fam. Moraceae). It is a proteolytic enzyme of molecular weight about 23,800-25,500 which requires a free sulphydryl group for activity and as such as a member of a group which includes Papain and Bromelain.

Ficin occurs as a buff to cream-coloured hygroscopic powder. It has acrid odour, which grows stronger with age. It is bulky, nearly 3 ml/g, not free-flowing. It appears dry, even when 15% water is present. It is not completely soluble in water; insoluble in usual solvents. It loses about 10-20% activity when stored 1-3 years at ordinary temperature and atmospheric conditions. Aqueous solutions are inactivated at 100°, solid partially inactivated within a few hours. Solutions are relatively stable between pH 4-8.5; incompatible with iron, copper and aluminium. Gelatin coagulates egg white;

casein, meat and most proteins are hydrolyzed with aqueous Ficin solution. Ficin has tissue - dissolving property. Therefore, it must be handled with care. Ficin is 10-20 times more active as Papain in regard to milk clotting; 4-10 times as active in general.

Ficin is used as protein digestant in the brewing industry, as a chill-proofing agent in beer; in cheese industry as a substitute for rennet in the coagulation of milk; in meat industry as a meat tenderizer and as an agent for removing castings from formed sausage. In leather industry it is used for the bating of leather; in the textile industry for shrink proofing wool, for removing gelatin from sized thread, and mixed with amylases and maltases as a spot remover. It is also used in the preparation of peptones, for determining protein material in spent grains and in determination of the Rh factor. It speeds 10 times the agglutination of human blood cells by the Rh factor when in contact with the anti-Rh serum. It has been used as a trichuricide.

Ficin causes irritation to skin, eyes and mucous membranes. Large doses by mouth cause purging.

QUESTIONS

1. Give sources, methods of preparation and uses of Gelatin and Papain.
2. Write notes on the following :
   (a) Papain (b) Malt extract (c) Ficin (d) Yeast.
3. Give the methods of preparation of Gelatin and Malt extract. What chemical tests will you perform to characterize them ?
4. What do you know about proteins ? How are they classified and identified ? Discuss Papain in detail.

13

ALKALOIDS

The term alkaloid is applied to naturally occurring basic compounds and is difficult to define. The term is derived from 'vegetable alkali' (*alk* = alkali; *oid* = like). They may be defined as organic nitrogenous substances of plant origin exhibiting well-defined physiological actions. A true alkaloid has a nitrogen atom as a part of heterocyclic system; it has a complex molecular structure; it manifests significant pharmacological activity and it is restricted to the plant kingdom.

Alkaloids have been reported in various plant parts such as in whole aerial plant (Lobelia, Tylophora, Ephedra), in leaves (Datura, Belladonna, Coca), in bark (Kurchi, Cinchona), in stem (Withania), in rhizomes and roots (Ipecac, Rauwolfia, Aconite); in flowering buds (Hyoscyamus) and in seeds (Nux vomica, Physostigma, Colchicum). Several alkaloids have been found in cultures of microorganisms, e.g., in bacteria, fungi (Ergot) and algae. Amphibian alkaloids such as toad venous (bufotoxin) and salamander alkaloids (salamandarine) are of animal origin. Alkaloids with complicated chemical structures (strychnine) are less widespread in nature than simple compounds (nicotine). About 100 families out of 283 possess alkaloids.

The names of alkaloids have been derived from the plants yielding them (atropine, tylophorine, cocaine, nicotine); from physiologic activity (emetine, morphine) and from the discoverer (pelletierine, alihirsutine). As per chemical rules the names of all alkaloids should end in "ine".

Alkaloids exhibit a variety of physical and chemical properties. All of them possess carbon, hydrogen and nitrogen and in most cases oxygen as elements. Like basic compounds they form their crystalline salts with acids like hydrochloric acid, sulphuric acid, citric acid, and tartaric acid. The free alkaloids are insoluble or slightly soluble in water but their salts are freely soluble. However, they are soluble in non-polar solvents such as ether or chloroform. Therefore, alkaloids are separated from non-polar compounds by salt formation, extracting the lipid soluble portion and basifying the solution with an alkali carbonate or ammonia. Most of the alkaloids are crystalline solids with definite melting points, some of them are amorphous and few (coniine, nicotine) are liquids. They are generally colourless compounds but few are coloured substances, e.g., berberine (yellow), betaine (red), tylophorine (dull yellow), and conessine (pale yellow). They are generally bitter in taste and optically active. On treatment with phosphotungstic acid, phosphomolybdic acid, picric acid, potassium mercuri-iodide and tannic acid, they yield insoluble precipitates (double salts). The following colour tests are used to detect the presence of an alkaloid :

1. **Mayer's Reagent** (Potassium mercuri-iodide solution) : It gives a white or pale yellow precipitate except with alkaloids of the purine group and few others.
2. **Dragendorff's Reagent** (Potassium iodide + bismuth nitrate): Alkaloids form orange coloured precipitate with the reagent.
3. **Wagner's Reagent** (iodine solution) : It gives a brown or reddish brown precipitate with alkaloids.
4. **Hager's Reagent** (A saturated solution of picric acid in cold water) : It gives characteristic crystalline precipitate with many alkaloids.
5. **Tannic Acid Test :** A freshly prepared aqueous solution of tannic acid (5%, w/v) gives a precipitate with most of the alkaloids which is soluble in dilute acid or ammonia solution.
6. **Ammonia Reineckate Test** : A saturated aqueous solution of ammonia reineckate slightly acidified with hydrochloric acid gives a pink flocculent precipitate with most of the alkaloids.

In plants alkaloids act as poisonous and stimulating agents. Sparteine acts as stimulant to an aphid when feeding on *Sarothamus scoparius*. The insect changes its feeding site

according to where the highest concentration of alkaloid occurs within the host plant. Tomatin, the major alkaloid of tomato, acts as repellent. Nicotine and anabasine act as powerful repellents for many insect groups and thus protects plants from insects and herbivorous. They also act as regulatory growth factors, and reserve substances for nitrogen and other elemental supply and as end products of detoxification reactions. They occur as pigments, such as pteridine and betalains, and attract animals for pollination.

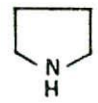
Alkaloids are capable to exhibit extensive and well-marked pharmacological activities like analgesic (cocaine, morphine, codeine), antiamoebic and emetic (emetin), anticholinergic (atropine, hyoscyamine, scopolamine), antihypertensive (reserpine, deserpine), antimalarial (quinine, cinchonine), antitumor (vinblastine, vincristine), antitussive (codeine, noscapine), cardiac depressant (quinidine), central nervous stimulant (caffeine, strychnine, brucine), diuretic (theobromine, theophylline), oxytocic (ergometrine, ergotamine) ophthalmic and cholinergic (physostigmine, pilocarpine), skeletal muscle relaxant (tubocurarine) and smooth muscle relaxant (papaverine, theophylline).

Classification

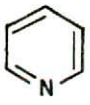
No systematic structural classification exists for alkaloids. The most widely accepted classification system is as :

1. **True Alkaloids :** True alkaloids are toxic, show a wide range of physiological activity; contain nitrogen in a heterocyclic ring, derived from amino acids and normally occur in plants, e.g., colchicine, quinine, morphine, emetine, etc.
2. **Protoalkaloids :** Protoalkaloids are relatively simple amines in which the amino acid nitrogen is not in a heterocyclic ring, e.g., mescaline and ephedrine.
3. **Pseudoalkaloids :** These alkaloids are not derived from amino acid precursors and are usually basic in nature, e.g., steroidal alkaloids (conessine) and purines (caffeine).

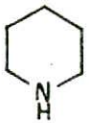
Alkaloids are generally arranged in order of increasing rings, e.g., pyrrolidine group (hygrine, tropinone), pyridine-piperidine group (coniine, pseudopelletierine, lobelia alkaloids, lupine alkaloids, nicotine), isoquinoline group (papaverine, dauricine), tetrahydroisoquinoline group (aporphine alkaloids, berberine, crytopine, emetine), phenanthrene or morphine



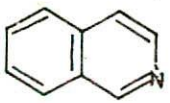
Pyrrolidine



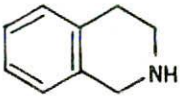
Pyridine



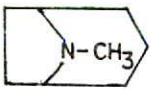
Piperidine



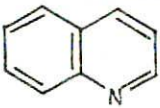
Isoquinoline



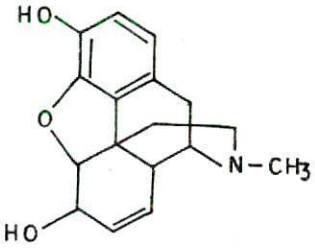
Tetrahydroisoquinoline



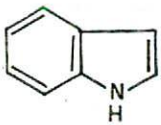
Tropane



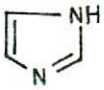
Quinoline



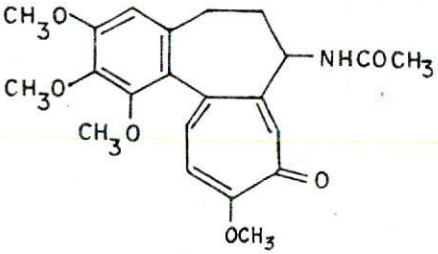
Morphine



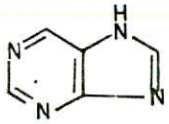
Indole



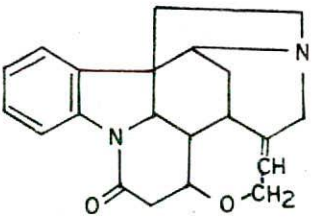
Imidazole



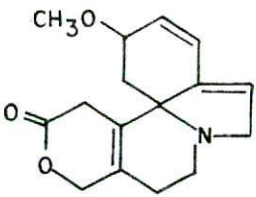
Colchiceine



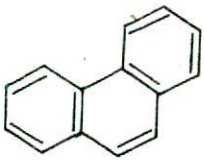
Purine



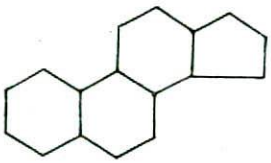
Strychnine



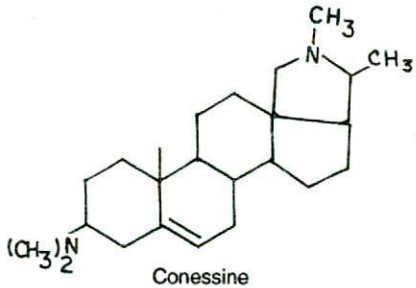
Erythroidine



Phenanthrene



Cyclopentanoperhydrophenanthrene



Conessine

group (morphine, codeine, thebaine), quinoline group (Cinchona alkaloids, quinine, cusparine, dictaminine), indole group (Ergot alkaloids, harmine, physostigmine), complex indole group (brucine, strychnine), erythrina group (β-erythroidine, erysopine) and colchicine. Atropine, hyoscyamine and scopolamine are derived from tropane, a condensed product of pyrrolidine and piperidine. Pilocarpine has the imidazole ring, caffeine and theobromine are purine bases, solanine and conessine contain steroidal nucleus.

PYRIDINE-PIPERIDINE ALKALOIDS

Reduction of pyridine coverts it into piperidine. This group includes alkaloids containing piperidine, α-propylpiperidine and derivatives of nicotinic acid.

LOBELIA

Synonyms : Lobelia Herb; Indian tobacco; Wild tobacco; Emetic herb; Asthma weed; Bladder pod; Vomit wort; Herba lobeliae.

Official Source : Lobelia consists of the dried aerial parts of *Lobelia inflata* Linn. of which 60 per cent is the stem.

Family : Lobeliaceae.

Geographical Source : The plant is indigenous to the eastern USA, Canada and Holland. It is an erect annual herb, 30-90 cm high.

Cultivation and Collection : Seeds of Lobelia are sown in March-April or autumn in rich, moist, loamy soil. On germination the plants are grown to produce stems of 30-50 cm in height.

The plant thrives in rich moist loam in the open or in partial shade. Seeds are sown in well prepared ground in rows 20 cm apart. Sometimes seeds are sown in beds and seedlings transplanted in the field. Leaves and flowering tops are collected when the plants are in flower and the lowermost capsules have become inflated in August - September. They are dried in shade to preserve green colour and compressed into rectangular cakes and wrapped in paper for export.

Macroscopical Characters

General Appearance : Entire aerial part including stems, leaves, flowers, fruits and seeds.

Stem : Stems are greenish purple, winged and very hairy in the upper part. The lower part is more rounded, channelled, and less hairy.

Leaf : Leaves are 2 cm long, broken or entire with bristly hairs, sessile, ovate to ovate-lanceolate in shape. The margin is irregularly serrate, dentate and the teeth contain water-pores; acute and yellowish green in colour, slightly pubescent with characteristic odour and taste. Hairs are present on

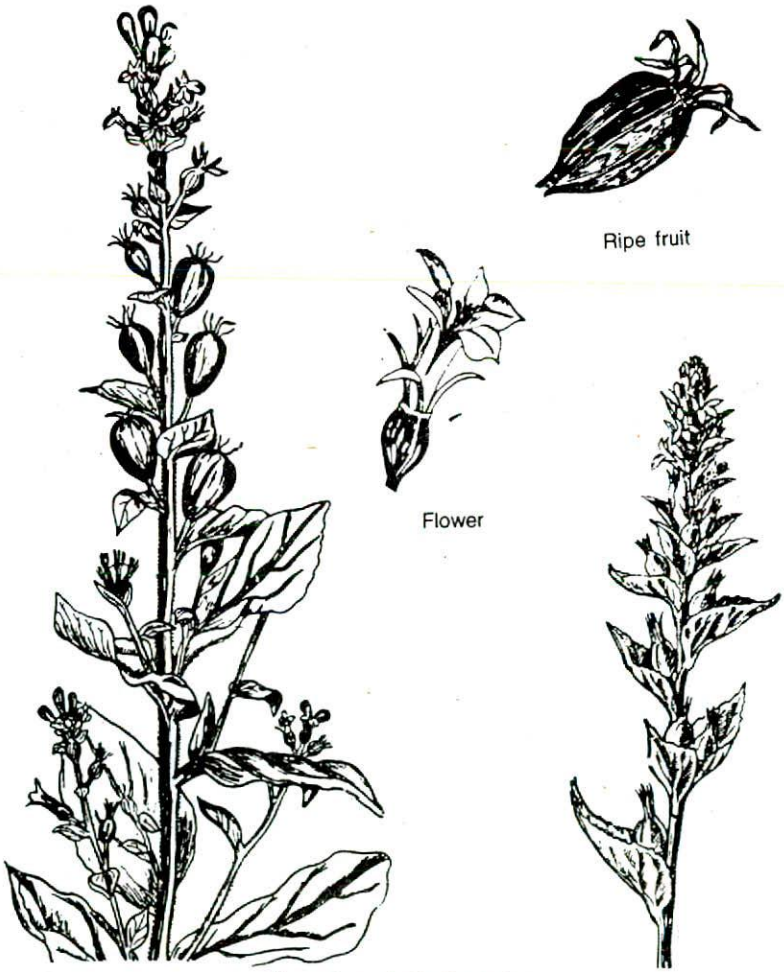


Fig. 13.1. *Lobelia inflata*

lamina. Base is wedge- shaped, entire. The upper epidermis lack stomata with very few or no trichomes whereas the lower one shows numerous ranunculaceous stomata with few-hairs. Trichomes are unicellular with rounded base and pointed tips.

Fruits are yellowish green capsule and inflated, 7-8 mm long, ovate and bilocular. Seeds are 0.5 - 0.7 mm in length, about 0.3 mm broad and brown in colour. Outer surface is covered with elongated, polygonal lignified reticulation. Odour is irritating and taste is acrid.

Chemical Constituents : Lobelia contains about 0.4 per cent alkaloidal constituents of which lobeline is the important active base.

The alkaloids of Lobelia are classified into there groups:

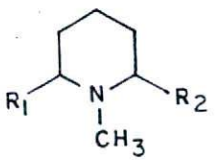
(i) Lobeline, the most active alkaloid of the drugs is similar to nicotine in action but weaker.

Lobeline group includes l-lobeline, dl-lobeline, lobelanine, *nor*lobelanine, lobelanidine and *nor*-lobelanidine.

(ii) Lelobine group contains dl-lelobanidine, l-lelobanidine I and II and norlelobanidine.

(iii) Lobinine group contains the alkaloids lobinine, isolobinine, lobinanidine and isolobinanidine.

These alkaloids possess a piperidine nucleus.



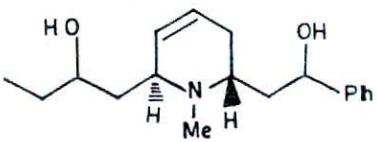
Lobelanine, $R_1 = R_2 = C_6H_5\ COCH_2$-

Lobelanidine, $R_1 = R_2 = C_6H_5\ CH(OH)CH_2$-

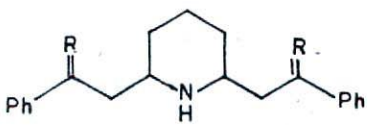
Lobeline, $R_1 = C_5H_6\ CH\ (OH)CH_2$-

$R_2 = C_5H_6\ COCH_2$-

In addition to alkaloids the drug also contains a pungent volatile oil, resin, lipids, and gum.



Lobinanidine



Norlobelanidine (R = H, OH)

Norlobelanine (R = O)

Uses : Lobelia is an expectorant used to treat spasmodic asthma and chronic bronchitis. Lobeline is a respiratory stimulant, relaxant and is given in the resuscitation of new-born infants; in gas, alcohol and narcotic poisoning; in drowning in water, electric shock and collapse. Lobelia in also used to discontinue smoking habit.

INDIAN LOBELIA.

Synonyms : Nala; Narasala (Hindi); Nali (Gujrati); Badanala (Bengali).

Biological Source : Indian Lobelia consists of dried aerial parts of *Lobelia nicotianaefolia.* (Fam. Lobeliaceae). The drug is collected in October-November and dried in shade.

It is a large biennial or perennial herb, 1.2-3.6 m high, found in western ghats from Bombay to Travancore at altitudes of 700-2200 m. The leaves and stems are larger in size than those of American Lobelia. The lower leaves are up to 30 cm long and 7 cm broad while the upper leaves are smaller up to 10 cm long and 2 cm wide. They are green in colour, have apex acute to acuminate, margin serrulate, venation reticulate, upper surface glabrous, lower surface glabrous to pubescent, upper epidermis has ranunculaceous stomata and few or no hairs mainly on prominent veins . Hairs and trichomes are absent in older leaves. The stomata are many on the lower epidermis. The stem is cylindrical, greenish-yellow, straight and hollow in the centre. Longitudinal striations and scars of leaf bases are present on the upper surface. Flower pedicels are up to 3 cm long, smaller in thin stems. The odour in similar to tobacco and the taste is acrid and nauseous.

The leaves of the species can be distinguished from American Lobelia on the basis of trichomes, stomata and quantitative values.

Chemical Constituents : Up to 0.4% total alkaloids are present in Indian lobelia. Lobelanidine, non-lobelanidine, lobeline and d-lobelanidines II and III have been isolated from the drug. The alkaloid content in *L. nicotianaefolia* plant showed seasonal variation, being in highest concentration in October and November.

Uses : Indian lobelia is used as respiratory stimulant and antispasmodic agent. An infusion of leaves is used as an antiseptic.

ARECA NUTS

Synonyms : Betel nuts; Pinang; Semina Areacae; Supari (Hindi).

Biological Source : Areca nuts are the seeds of *Areca catechu* Linn.

Family : Palmae (Palmaceae).

Habitat : The tree is cultivated in tropical India, Sri Lanka, Malay states, South China, East Indies, Philippine Islands and parts of East Africa (including Zanzibar and Tanzania). In India it is cultivated in the coastal regions of southern Bombay and Madras, Mysore, Bengal and Assam.

Cultivation : Areca palm is mostly propagated by seeds. The palm requires a moist tropical climate for luxuriant growth; it is very sensitive to drought. It grows in areas with heavy rainfall in between temperature of 15° to 38°. It is cultivated in plains, hill-slopes and low lying valleys. The seeds are collected from 25-50 years old trees.

Collection : Areca nut is a handsome palm with a tall, slender stem crowned by large elegant leaves. Each tree contains about 100 fruits per year which are detached by means of bamboo poles, and the seeds extracted. The pericarp is fibrous and surrounds a single seed which is easily separated. The seeds are usually boiled in water with the addition of a little lime and dried.

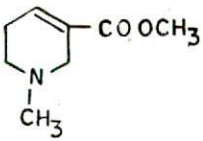
Characters : Areca nuts are about 2.5 cm in length, bluntly rounded, conical in shape and 2-3 cm wide at the base. The testa is brown and marked with a network of small depressed lines. The ruminate endosperm is opal-white. Patches of a silvery coat, the inner layer of the pericarp, occasionally adhere to the testa. The deep - brown testa is marked with a network of depressed fissures; the colour of the testa is due to the presence of tannin. In the centre basal part of the endosperm, the small embryo is situated and an external pale area indicated its position. The seed is very hard, has a faint cheese - like odour when broken and an astringent, acrid taste.

Chemical Constituents : Areca nut contains a number of alkaloids of a piperidine series such as arecoline (methyl ester of arecanine), arecaine (N - methyl guvacine), guvacine (tetrahydronicitinic acid), arecaidine, guvacoline, arecolidine and choline. Arecoline is present in about 0.1 - 0.5 per cent

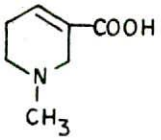
yield and is medicinally important. In addition to alkaloids, Areca nuts contain fat (14%), amorphous red tannin (15%) known as areca red of phlobaphene nature, and α-catechin. The fat consists mainly of the glycerides of lauric, myristic and oleic acids.

Uses : Powdered Areca is used as anthelmintic, and vermifuge for dogs. It has aphrodisiac action and useful in urinary disorders, as nervine tonic and emmenagogue. The chewing of Areca nut may cause mouth cancer.

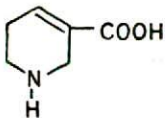
Substituents and Adulterants : Nuts from other plants, *vis. Areca caliso, A. concinna, A. ipot, A. laxa, A. nagensis, A. triandra, Caryota cumingii, Heterospathe elata,* etc. are used as substituents for Areca nuts. Sago palm nuts *(Metroxylon* species). dried tapioca *(Manihot esculenta)* and slices of sweet potato *(Ipomoea batatas)* form cheap adulterants that are mixed with slices of Areca nuts, and prove a serious menace affecting the industry. Nuts of *Caryota urens,* cut to various shapes and sizes resembling genuine Areca nuts, and coated with concentrated Areca nut extract *kali,* form the principal adulterant. Adulteration above 10% significantly increases the fibre content of the sample, which can be used as a measure of detecting adulteration.



Arecoline



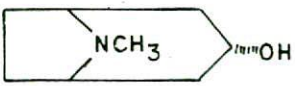
Arecaidine



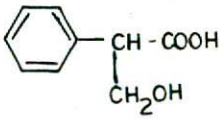
Guvacine

TROPANE ALKALOIDS

Condensation of tropane ring with piperidine constitutes the basic carbon framework of tropane nucleus. Plants of Solanaceae family are the major source of tropane alkaloids. The principal alkaloids of therapeutical interest are hyoscyamine, its more stable racemate atropine, and hyoscine. The compounds occur as esters of tropic acid with tropine (tropan-3α-ol).



Tropine



Tropic acid

HYOSCYAMUS LEAF

Synonyms : Insane root; Hog's bean; Poison tobacco; Black Henbane; Henbane; Hyoscyamus herb; Khurasani-ajvayan (Hindi); Folia Hyoscyamus; Kurasani-Yomam (Tamil); Kurashanivaman (Telgu).

Official Source : Hyoscyamus leaf consists of the dried leaves and flowering tops of *Hyoscyamus niger* Linn. containing not less than 0.05% alkaloids calculated as hyoscyamine. Egyptian henbane *(H. muticus* L.) contains about 0.5% alkaloids.

Family : Solanaceae.

Geographical Source : Hyoscyamus is cultivated in England, U.S.A, Germany, Poland, Russia and in India from Kashmir to Garhwal.

Characters : Hyoscyamus is an erect, hairy, viscid, biennial or annual herb found widely. The biennial plant has the following characteristics; stem up to 1-5 m high, leaves sessile, ovate-oblong to triangular-ovate, stalked, up to 20 cm long, margin dentate or pinnatifid, very hairy, flowers (May-June), corolla yellowish with deep purple veins. The stem of annual species is robust up to 0.5 m in height, leaves-sessile, smaller with fewer hairs than the biennial variety with less incised margin. Flowers (July-August), corolla funnel-shaped, pale in colour with less deeply veined. Drug is collected from biennial herb.

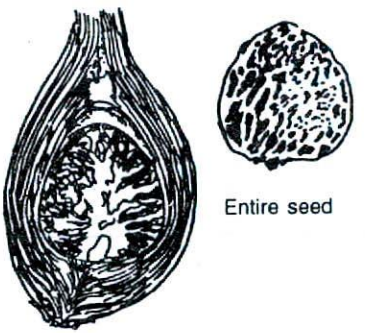


Fig. 13.2. Areca nut

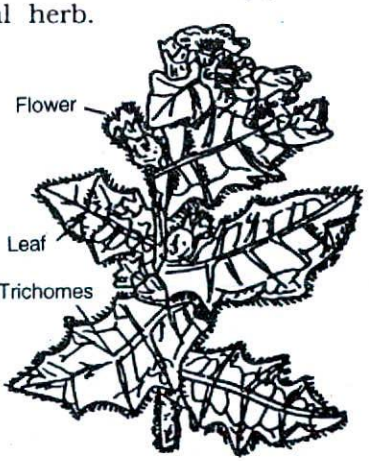


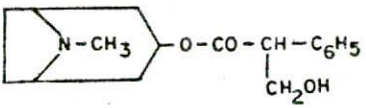
Fig. 13.3. *Hyoscyamus niger*

Cultivation : The Henbane is grown by sowing seeds in June or July. The germination of seeds is slow and often erratic.

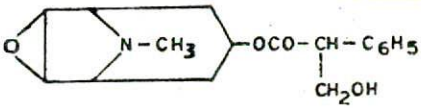
In the first year the stem is very short, leaves are in a rosette and hairy. The plant is sprayed with an insecticide if attacked by the potato beetle. The leaves and flowering tops are collected and dried rapidly at 40-50°C.

Morphology : The leaves are usually broken, crumpled, sessile, oblong to ovate, colour greyish-green, very flat broad midrib with lateral veins forming acute angles, hairy. Crowded flowers, about 2 cm long, with 4 mm long pedicel. Fruits are small, 1.5 cm long, ovoid, oblong, contain numerous dark grey-coloured flat and reniform seeds. Taste of the herb is bitter.

Chemical Constituents : Hyoscyamus contains tropane alkaloids (0.045-0.14%). l-Hyoscyamine (atropine) and hyoscine (scopolamine) are the predominent alkaloids. The petioles contain more alkaloid than the lamina and stem. During isolation optical activity of hyoscyamine is lost and racemic mixture of atropine is obtained which contains a mixture of d-and l-hyoscyamine. Hyoscipicrin and choline are also present. The alkaloid content of seeds is less than that of the leaves.



Hyoscyamine or atropine



Hyoscine or scopolamine

Uses : Hyoscyamus is smooth muscle relaxant, sedative, narcotic, anodyne, antiseptic, mydriatic and purgative agent and used in asthma and whooping cough. Atropine has stimulant action on the central nervous system. Atropine and hyoscine are used as ophthalmintic to dilate the pupil of the eye. The parasympatholytic action of Hyoscyamus is weaker than Stramonium and Belladonna.

Allied Drugs : *H. muticus* Linn (Egyptian Henbane) is a perennial herb allied to *H. niger*, distributed in the sandy parts of Egypt. It differs from Hyoscyamus obtained from *H. niger* by its striated cuticle and usually branched trichomes with unicellular heads. It contains a higher percentage of total alkaloids than *H. niger*. The leaves of *H. muticus* are smoked in Africa and India for inducing intoxication.

H. albus is a herb with white flowers, found in the Mediterranean region. Its properties are similar to those of official Henbane, for which it is often substituted.

H. pusillus, a herb occurring in Ladakh, has been reported to be poisonous.

BELLADONNA

Synonyms : Belladonna herb; Belladonna leaf; Deadly night shade leaves; Banewort; Death's herb, Dwale; Poison black cherry; Folia belladonnae.

Official Source : Belladonna consists of the dried leaves and flowering tops of *Atropa belladonna* Linn. (European Belladonna) containing about 0.3% of total alkaloids calculated as hyoscyamine.

Family : Solanaceae.

Location : *Atropa belladonna* is cultivated in U.S.A., Canada, U.K., Germany and India.

Plant : The plant is an erect, glandular-pubescent or near glabrous, perennial herb, about 1.5 meter high. Leaves on the upper part are in pairs of two, among which one leaf is larger and the other smaller.

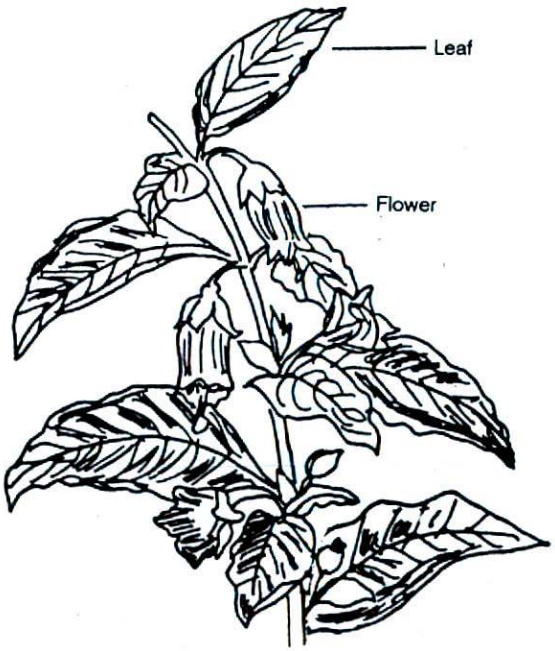


Fig. 13.4. Belladonna flowering and fruiting shoot



Fig. 13.5 Belladona root

Cultivation and Collection : Plants are cultivated by sowing seeds in nurseries and seedlings are transplanted in April to moist, calcareous and loamy soil. Weeds are removed and manure is applied for proper growth of the crop. During flowering session leaves and flowering tops are cut at least three times in a year at an interval of two months from one to three years old plants. When the plant is four years old, roots are dug out. The collected drug is dried at 40-50°C. Undried leaves deteriorate and give off ammonia. Belladonna plant infected with the fungus *Phytopthora belladonnae* should be destroyed to prevent further infection. Sometimes the leaves are damaged by flea-bettle insect and the roots by a fungus.

Morphology : The drug contains leaves, smaller stems of about 5 mm diameter, flowers and fruits. Leaves are stalked, brittle, thin, entire, long-pointed, 5-25 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 mid-rib at an angle of 60°, curving upwards and are anastomose. Flowers are pale purple, tinged with yellow or green, 1.5 cm diameter, single on drooping.

Chemical Constituents : Belladonna contains 0.3-0.6 % total alkaloids, the prominent base is l-hyoscyamine. The other components are atropine, apoatropine, asparagine, choline, chrysatropic acid, volatile bases such as pyridine; atroscine, leucatropic acid; phytosterol, N-methylpyrroline, scopoletin (β-methylaesculetin), 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.

Uses : 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.

INDIAN BELLADONNA

Synonyms : Sag-angur (Hindi); Yebruti (Bengali); Girbuti (Bombay), Bantanaku (Panjabi); Mait-brand (Kashmiri).

It consists of dried leaves and other aeiral parts of *Atropa acuminata* Royle ex Lindley (Solanaecae). The plant in found in Kashmir, Shimla, Chamba, Kangra and Kulu.

The plant is a perennial herb, 2-5 ft high, erect with dichotomous branching, leaves oblong elliptical, brownish green, 7.5-13 cm long, 4-6.5 cm wide, tapering towards apex and base, flowers are yellowish brown, drooping, funnel-shaped, solitary, fruits globular berries.

As a winter annual, it is cultivated in plains in the sub-tropical climate and in hilly areas. The plant can be propagated from seeds or from cuttings of the young shoots or from fresh rootstocks. The seeds are very small, brownish black and are obtained from berries. Seeds pre-treated with sulphuric acid, ethyl alcohol or petroleum ether give better germination than the untreated ones. The seeds are sown in well prepared nursery beds during May and July. It requires a porous, slightly acidic soil rich in mineral nutrients. The seedlings are transplanted in spring. Shading the transplants with twigs is necessary. Irrigation is required during the dry summer.

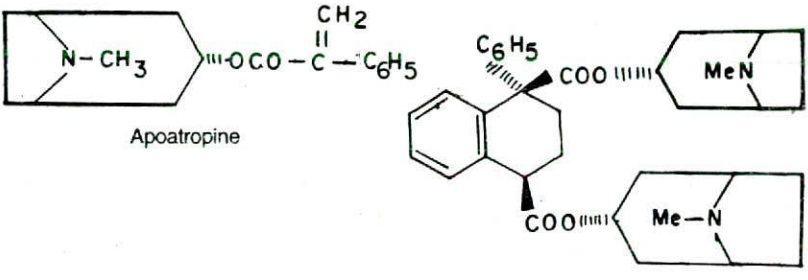
Total alkaloidal contents in Himalayan plant are 0.5% in leaves. The constituents of Indian Belladonna leaves resemble those of the European species.

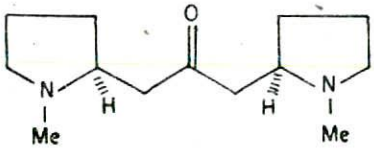
Uses : Indian Belladonna is used as sedative, tranquillizers, in labour, delirium tremens, toxic psychoses and maniacal states. Atropine and other Belladonna alkaloids are common constituent of proprietary medicines for the common cold and acute rhinitis. They induce bronchial dilation and give relief in bronchial asthma. They are employed in diseases of the gastro-intestinal tract, in heavy metal poisoning, Parkinsonism and in checking enurenis in children.

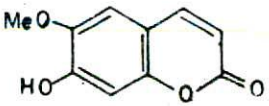
Belladonna preparations are reputed as local anodynes and counter irritants for external application for treating intercostal pains, rheumatism, lumbago, neuralgia and pleurisy. They are made into plasters and liniments for local application and into suppositories employed to relieve the spasm of anal fistula.

Belladonna leaves extract is used as proprietary pharmaceutical preparations to treat gastro-intestinal hypermotility, hyper-secretion, peptic ulcer, spastic constipation, spastic dysmenorrhoea, nocturnal enuresis, bronchial asthma and whooping cough.

Adulteration : The roots of *Althea officinalis* are sometimes mixed with Belladonna roots but they can be distinguished on the basis of their fracture and absence of starch in the exposed surface. *Phytolacca acinosa* grows side by side with Belladonna in nature and resembles the latter when not in flower. Its leaves are often substituted for Belladonna leaves. Its can be detected in commercial samples by its ovate leaves and hollow stem. The leaves of *Solanum nigrum* and other species of *Solanum* and *Datura* are often used as adulterants.







BELLADONNA ROOT

Synonym : Radix belladonnae.

Biological Source : Belladonna root consists of the dried roots or rootstock of *Atropa belladonna* L. (Fam : Solanaceae)

Collection : The plant description and geographical sources are given under the heads Belladonna and Indian Belladonna. Roots of the first and second years are small in size and not collected although the percentage of alkaloid is high. The roots of three or four years old plant are collected in autumn. The roots are dug up, washed, cut into small pieces and dried at 40-50°.

Morphology : The drug occurs in small pieces or longitudinal slices, length 10-20 cm, diameter 3-4 cm; shape cylindrical and tapering; surface longitudinally wrinkled with scars of roots; fracture short; whitish or brownish interior after

drying; cambium is distinct with porous xylem; colour-greenish brown; odour-distinct, taste bitter.

Chemical Constituents : Belladonna root contains 0.4 - 0.8 per cent total alkaloids. The important alkaloids isolated are hyoscyamine, atropine and scopolamine. The other chemical components obtained are apoatropine, belladonnine, cuscohygrine, and tropine along with β-methyl aesculetin, calcium oxalate and starch.

Allied Drugs : Indian Belladonna roots from *Atropa acuminata* : brownish grey roots, stolons, rootstock and stem bases.

Uses : Roots are narcotic, anticholinergic, sedative, diuretic, mydriatic used as an anodyne, local anaesthetic, in cough and bronchitis and to check perspiration of tuberculosis.

STRAMONIUM

Synonyms : Thornapple leaves; Jimson or Jamestown weed; Dhatura; Stinkweed; Devil's apple; Apple of Peru; Folia stramonii.

Biological Source : Stramonium consists of dried leaves and flowering tops of *Datura stramonium* Linn. or its variety *D. tatula* Linn.

Family : Solanaceae.

Geographical Source : Stramonium is found widely in European, Asian, and American countries and in South Africa. The plant grows commmonly in waste places throughout India from Kashmir to Malabar. It is cultivated in Germany, France, Hungary and South America.

Cultivation : Datura prefers a rich calcareous soil. It can be grown from seeds in spring in drills; the plants are later thinned to stand 3 m apart in raws. The plant is sensitive to frost and sheltered situations are preferred for cultivation. Entire plants are cut down when the fruits are mature. Nitrogen manuring, which favours the growth of plants, also favours alkaloid formation. At the end of August leaves and flowering tops are collected and dried at 45-50°C.

Plant Habitat and Morphology : *D. stramonium* is a bushy annual herb, 1.5 m high, having whitish roots and numerous rootlets. The stem is herbaceous, round, smooth, green branched, glabrous and shows dichasial branching with leaf adnation. Leaves stalked, ovate, 8-25 cm long, 7-15 wide,

coarsely and irregularly lobed and toothed. Flowers are solitary, axillary, short stalk, single, white, have sweet scent, calyx tubular, 5-toothed, 5-ribbed, corolla funnel-shaped. The ripe fruits are thorny capsule about 3-4 cm long. Seeds are numerous dark brown or blackish in colour, reniform in outline, 3 mm long. The testa is reticulated and finely pitted; smell is slightly unpleasant and taste is bitter.

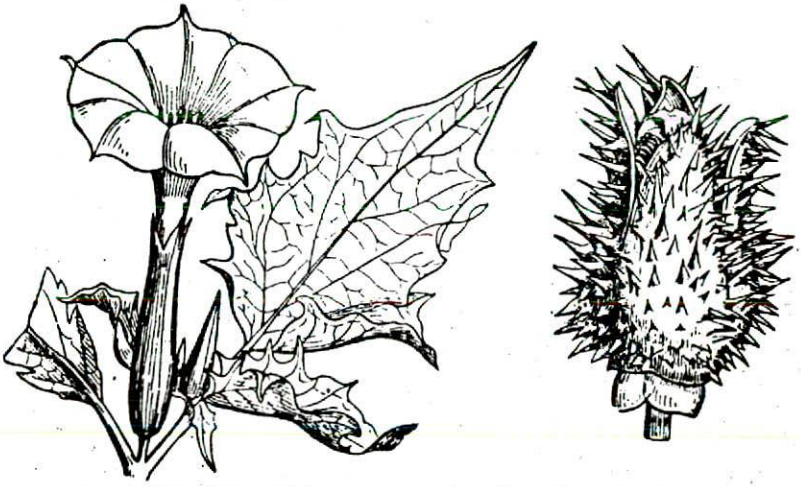
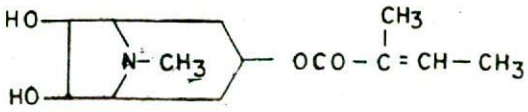


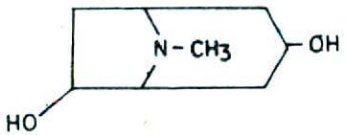
Fig. 13.6. *Datura stramonium* flowering shoot

Chemical Constituents : Stramonium contains 0.2-0.6% alkaloids. The main alkaloids are hyoscyamine and hyoscine (scopolamine). It also contains protein albumin. The Indian variety (*D. metel)* also possesses meteloidine in addition to these alkaloids. The aerial parts of *D. metel* var. *fastulosa* contains a higher percentage of total alkaloids than *D. metel.* Small amount of atropine has been reported in Stramonium. The seeds contain about 0.2% of mydriatic alkaloids and 15-30% of fixed oil.

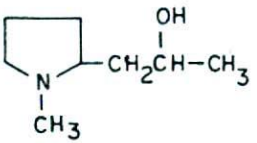
Ditigloyl esters of 3,6-dihydroxytropane and 3, 6, 7 trihydroxytropane have also been isolated from the roots in addition to hyoscine, hyoscyamine, tropine and pseudotropine.



Meteloidine



3,6- Dihydroxytropane



Hygroline

Uses : It is a narcotic, anti-spasmodic and anodyne, and is used chiefly to relieve the spasm of the bronchioles in asthma. The leaves are ingredient of *Pulvis stramonii compositus* and other powders intended to be burnt for the relief of asthma. The leaves may be made into cigarettes or smoked in a pipe to relieve asthma. They are also used in the treatment of parkinsonism, boils, sores and fish-bites. The flower juice is used to treat ear-ache.

The fruit juice is applied to the scalp for curing dandruff and falling hair. Stramonium ointment, containing lanolin, yellow wax and petroleum, is employed to cure haemorrhoids. Stramonium is one of the chief ingredient of the Ayurvedic prepartion, *Kanaka asaves*, used as demulcent, expectorant, antispasmodic and anodyne in cough, asthma and phthisis.

Atropine and hyoscine are used to dilate the pupil of the eye. The leaves are antispasmodic, anodyne, narcotic and applied to boils, sores and fish bites.

Adulterants : The leaves of *Datura innoxia* and *D. metel* are used as substitutes for Stramonium. The leaves of *Xanthium strumarium*, *Carthamus helenioides* and *Chenopodium hybridum* are used as adulterants.

WITHANIA (ASHWAGANDHA)

Synonyms : Ashwagandha; Withania root.

Biological Source : Withania consists of the dried roots of *Withania somnifera* Dunal.

Family : Solanaceae.

Geographical Source : Withania is widely distributed from southern Europe to Africa. In India it in found widely in the drier parts ascending to 1800

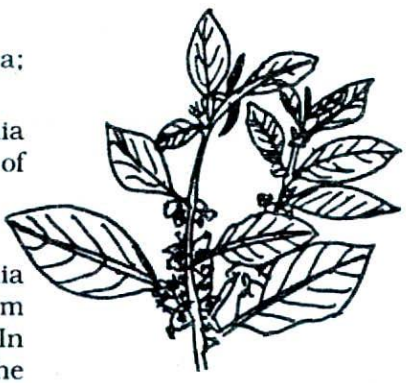


Fig. 13.7. Withania twig

meters in the Himalayas and cultivated in Neemuch near Ajmer and in Manasa (M.P.).

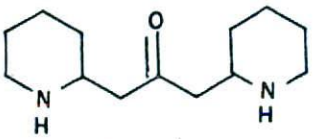
Plant Habitat and Macroscopy

The plant is tomentose, evergreen, perennial, branched, erect shrub. The tuberous roots are cut into small pieces and used. The roots are straight, unbranched, conical and 5-12 mm thick. The outer surface is longitudinally wrinkled and buff to greyish yellow. On the crown 2-6 stem bases are present. Taste is mucilaginous and bitter.

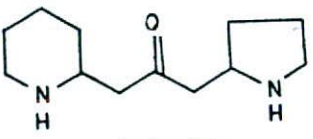
The plant is cultivated in soils that are unsuited for other crops. Seeds are sown broadcast in the nursery just before the onset of rainy season. Nitrogenous fertilizers promote heavy leaf growth. The plants flower and fruit in December. The entire plant is uprooted for roots, which are separated from the aerial parts cutting. They are transversely cut into smaller pieces for drying. The pieces are dark brown with a creamy interior. They are straight, unbranched and conical. The main root bears fibre-like secondary roots. Their outer surface is buff to grey-yellow with longitudinal wrinkles. The stem bases are variously thickened, cylindrical and green and have longitudinal wrinkles. The roots have a short and uneven fracture, a strong odour and mucilaginous bitter and acrid taste.

Chemical Constituents : Withania contains alkaloids and withanolides. The important alkaloids isolated are tropine, pseudotropine, hygrine (pyrolidine derivatives), isopelletierine (piperidine derivative), cuscohygrine (two pyrrolidine moieties), anaferine (two piperidine moieties), anahygrine (one pyrrolidine moiety and one piperidine moiety), and withasomnine (phenyl 1 : 5 trimethylene pyrrazole). The plant is a source of steroidal lactones known as withanolides such as withaferin A.

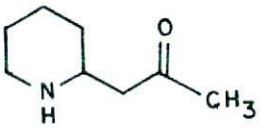
Uses : Withania is considered as alterative, aphrodisiac, tonic, deobstruent, diuretic, narcotic and abortifacient. It is used in rheumatism, consumption, debility from old age, emaciation of children, asthma, bronchitis, tuberculosis, leucorrhoea, and as anti-inflammatory drug.



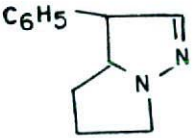
Anaferine



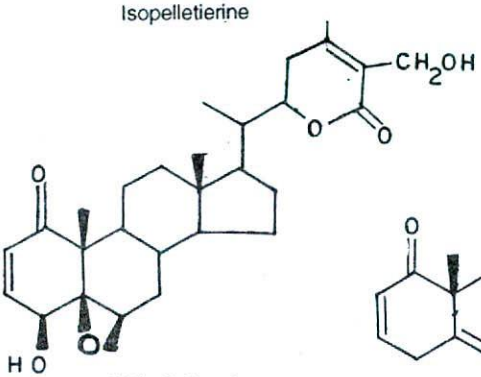
Anahygrine



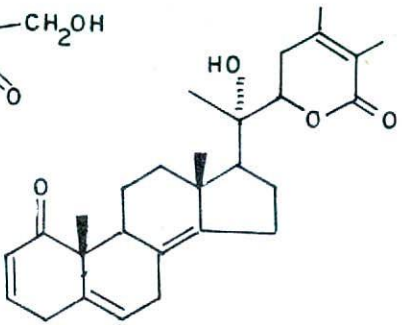
Isopelletierine



Withasomnine



Withaferine A



A Withanolide

COCA LEAVES

Synonyms : Coca; Huanaco coca, Truxillo coca; Java coca; Folia cocae.

Biological Source : Coca or coca leaves have been described as the dried leaves of *Erythroxylum coca* Lam (Huanaco Coca) or of *Erythroxylum truxillense* Rusby (Truxillo Coca).

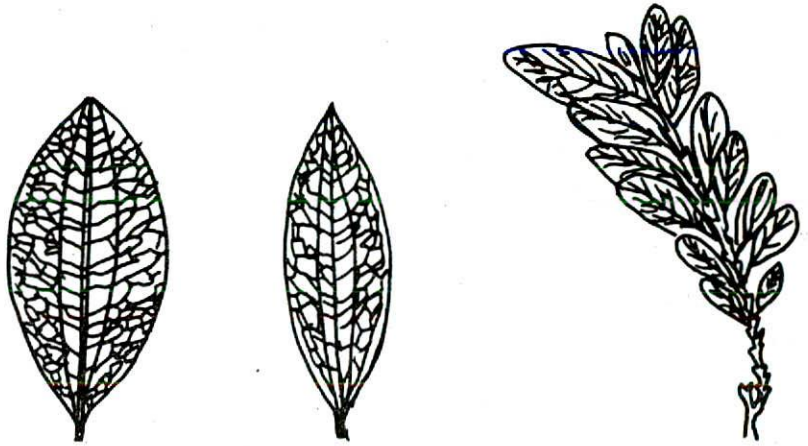
Family : Erythroxylaceae.

Geographical Source : Java, Sri Lanka, Bolivia, Peru, Indonesia, and India. It is a shrub or small tree, pyramidal in shape, up to 6 m high, with dark green, ovate leaves.

Cultivation : Coca plant is grown similarly to tea-plantation. Seeds are sown in rich, light and well drained soil at an altitude of 500-2000 meters.

It requires a humid atmosphere, rainfall not below 75-80 inch and temperature between 59-68°F. It thrives best in well drained moist loams rich in humus. The plant can be propagated by cuttings, but for raising plantations, seedlings are raised in nurseries and transplanted. The first

crop of leaves is gathered in 1-3 years after planting. Only the stiff ripe leaves, easily detached, are collected. The young leaves are reported to be rich in cinnamylcocaine and this is replaced in the old leaves by cocaine or truxilline.



Erythroxylum coca *E. truxillense* Twig

Fig. 13.8. Coca leaves

Morphology

1. Huanaco or Bolivian Coca leaves are entire, 3-8 cm long, 1.5-4 cm wide, shortly petiolated, apex-acute, base tapering, lamina-brown and glabrous, margin entire, midrib prominent on the lower surface with a ridge on its upper surface, apex acute, surface-glabrous, slightly glossy, texture thin, odour-distinct, taste-bitter.
2. Truxillo or Peruvian coca are more or less broken, pale green in colour, lamina is 1.6-6 cm long, shape elliptical, margin entire, venation is identical but ridges on lower surface are conspicuous, apex acute, base tapering, surface-glabrous, not glossy, texture-thin, fragile; odour is distinct and taste is bitter.

Chemical Constituents : Coca leaves contain 0.7-1.5% of alkaloids which are of three type derivatives of :

(i) ecgonine (cocaine, cinnamylcocaine, α-and β-truxilline)
(ii) tropine (tropococaine, valerine) and
(iii) hygrine (hygroline, cuscohygrine)

The alkaloidal composition varies according to the variety of the plant and stage of development of leaves.

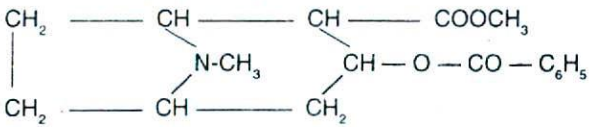
Cocaine, cinnamylcocaine and α-truxilline are the most important alkaloids.

The constituents isolated from the leaves are simple alkaloids (hygrine, dihydrocuscohygrine), tropococaine, four yellow crystalline glycosides, cocatannic acid and essential oil.

Cocaine is the methyl ester of benzoylecgonine. On hydrolysis it yields ecgonine, benzoic acid and methyl alcohol. Cinnamyl-cocaine on hydrolysis gives ecgonine, methyl alcohol and cinnamic acid, while α-truxilline forms ecgonine, methyl alcohol and α-truxillic acid.

Besides the alkaloids, coca leaves contain an essential oil (0.06 - 0.13%), the chief constituent of which is methyl salicylate. A colouring matter, coca citrin, has been reported from the leaves.

Uses : Coca leaves are stimulant and astringent. They are used in masticatory. Cocaine is local anaesthetic and has stimulant action on C.N.S. and used in dental anaesthesia and minor local surgery of ophthalmic, ear, nose and throat.



Cocaine

Adulterants : Novocaine, boric acid, sodium carbonate and bicarbonate, lime, chalk and starch are among the adulterants of cocaine. Lactose and even quinine, have been used.

QUINOLINE ALKALOIDS

Alkaloids containing quinoline as their basic nucleus have been isolated from Cinchona, Acronychia and viridicatin. Cinchona alkaloids are the compounds of therapeutic importance.

CINCHONA BARK

Synonyms : Peruvian bark; Cinchona; Calisaya bark; Jesuit's bark; Cortex cinchonae.

Biological Source : Cinchona bark consists of dried bark of stem or of the root of *Cinchona succirubra, Cinchona calisaya, Cinchona ledgeriana* or *Cinchona officinalis* or their

hybrids containing about 6.5 per cent of total alkaloids, 30-60 per cent of which are quinine-type alkaloids.

Family : Rubiaceae.

Geographical Source : Cinchona is the native of Peruvian Andes, South America. Now the plant in cultivated in Indonesia, Java, Zaire, India, Guatemala and Bolivia. In India *C. calisaya* is cultivated at elevations from 500 m - 1000 m in Sikkim and the Moyar valley in the Nilgiris. *C. officinalis* in cultivated in Ootacamund (Ooty) in the Nilgiris. *C. succirubra* is grown in the Nilgiris and Naduvattam plantation in South India, Sikkim, and in parts of Satpura range in M.P. *C. ledgeriana* is found in Bengal, on the Anamalai hills in Tinnevelly district of south India and on the Khasia and Jaintia hills.

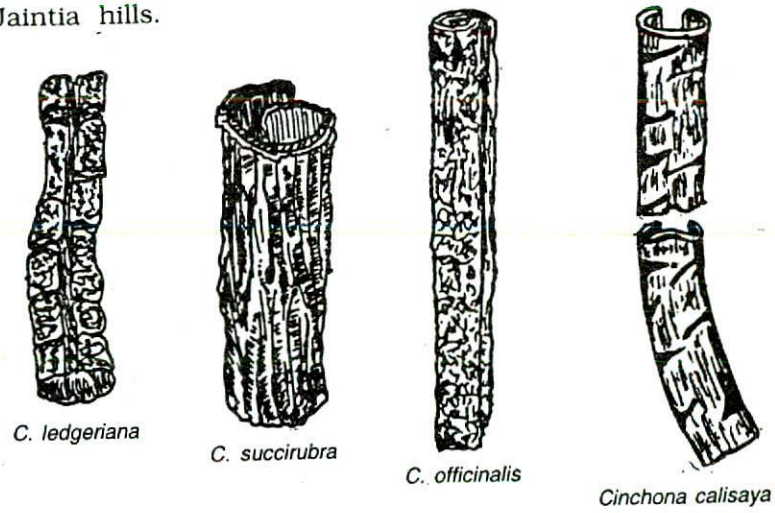


Fig. 13.9. Cinchona bark

Cultivation : For cultivation of Cinchona the seeds are sown in tropical countries. Seedings need careful treatment and propagation to avoid diseases. The temperature should be 10-30°. A rainfall from 75" to 180" per year is required and there should be no frost. Selected stains of seedlings are transplanted at a distance of 1 meter in rich, porous and well drained soils in slopes when the plant is two years old. The plants are protected from wind by growing banana trees in between them. The hybrids of *C. ledgeriana* - *C. calisaya* produce a higher amount of alkaloids. The stems grow tall, the lower branches die and drop off and the tree crown are very close. Shade favours the higher production of quinine.

The maximum amount of alkaloid in bark is obtained when the trees are 6-9 years old. The bark of trunk and roots can be removed by hand from the uprooted plants. The young bark contains three times more alkaloids than the old trees.

General Characters : The barks of different species differ in the presence of ridges, cracks, quills and protuberances. The stem bark is curved, single or double quill. Outer rough surface contains longitudinal and transverse cracks, fissures, ridges and protuberances. Cracks and fissures are distinct for each bark. Outer surface may contain greyish patches of moss or lichen. The stem bark of *C. succirubra* is reddish-brown in colour; the other barks are yellowish to brown. Barks are usually up to 30 cm long, 1.5-2 cm in diameter and 2-8 mm thick. Inner surface is striated and reddish-brown to yellow in colour. The fracture is short in the outer part but fibrous in the inner side. Odour is slight, and taste is bitter and astringent.

The root bark is found in channelled, often twisted pieces, 2-7 cm long. The outer surface is scaly while the inner surface is striated.

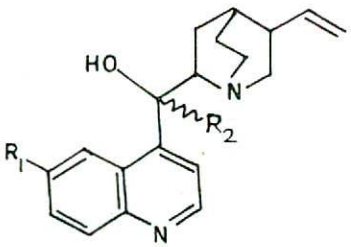
Chemical Constitutents : The Cinchona bark contains about 35 alkaloids (6.5%). The cultivated bark contains 7-10% total alkaloids. The main alkaloids are quinine (70%), quinidine, cinchonine and cinchonidine. The alkaloids are present in combination with quinic acid, quinovic acid and cinchotannic acid. Cinchotannic acid is a pholobatannin and its major amount is decomposed to give 'Cinchona red'. Other constituents are quinovin (a glycoside), which on hydrolysis gives quinovic acid and quinovose (isorhodeose), red colouring oxidase, calcium oxalate and starch. *C. succirubra* and some other varieties contain more cinchonidine and cinchonine and sometimes quinidine than the cultivated variety. A white crystalline substance, cinchocerotin, is present in the bark of *C. calisaya*. A green colouring matter, tschirchin, different from chlorophyll, is present in the bark of *C. succirubra*.

Chemical Tests

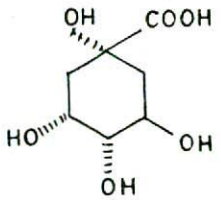
1. Cinchona, slightly moistened with glacial acetic acid, on heating in a test tube gives blood-red drops on the side of the tube.

2. Cinchona bark moistened with sulphuric acid shows a blue fluorescence in U.V. light.

Uses : Cinchona bark has antimalarial, antipyretic, and analgesic properties. Quinidine is used to treat prophylaxis of cardiac arrhythmias and atrial fibrillation. The barks and all preparations of Cinchona are specially valuable in intermittent fever. They have been prescribed as tonic in dyspepsia, gastric catarrh, adynamia and convalescence from fever, as a tonic and antiperiodic; it has been used in the prophylaxis and treatment of malaria. Ten grain dose-has been given in whooping cough, hay-fever, enlargement of spleen, hemicrania and other neuralgic affections. It has also been used in small pox, septic fevers, pneumonia, acute rheumatism, tonsillitis, nasal catarrh, pyaemia, etc. As an antiseptic it has been recommended in abscesses, cavities, ulcers, as a wash and gargle in sore-throat. The indiscriminate use of quinine in continuous and large doses produces weakness of heart, restlessness and cachexia. It is a good ingredient in dentifrice. The Cinchona alkaloids cause disturbances of C.N.S. system, deliriant conditions, spasm, convulsion, and collapse. The most usual menifestations of cinchonism are abdominal pains, cholera, nostras, paralysis of limbs, regors, cold sweats, somnolence, icterus, albuminuria, fever, cyanosis, in chronic cinchonism, emaciation and cachexia. Quinine may cause blindness and deafness preceded by violent noises in the ears. It destroys the erythrocytes and causes quinine haemolysis.

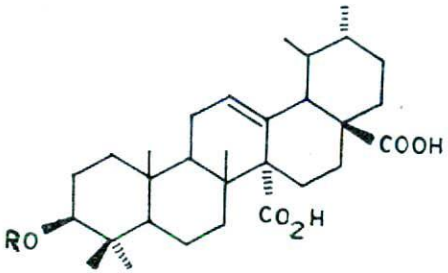


Quinine (R_1 = OCH_3, R_1 = α-H)
Quinidine (R_1 = OCH_3, R_2 = β-H)
Cinchonidine (R_1 = H, R_2 = α-H)
Cinchonine (R_1 = H, R_2 = β-H)

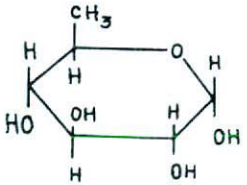


Quinic acid

Substitutes : Barks of *Cinchona lancifolia*, (Colombian bark), *C. ovata* (Naranjada bak), *Remija pedunculata* (Cuprea bark) and *Remija purdieana* are often used as substitutes for Cinchona.



Quinovic acid (R = H)
Quinovin (R = quinovose)



Quinovose

ISOQUINOLINE ALKALOIDS

Alkaloids containing the isoquinoline structure have been isolated from Ipecac, Hydrastis, Berberis, Sanguinaria, Curare, and Opium.

IPECAC

Synonyms ; Ipecacuanha; Brazilian or Johore Ipecac; Hippo; Ipecacuanha root; Radix ipecacuanhae.

Biological Source : Ipecac consists of the dried root or rhizome of *Cephaelis ipecacuanha* (B.) A. RIch. (Rio or Brazilian Ipecac) or of *Cephaelis acuminata* Karst. (Cartagena, Nicaragua or Panama Ipecac). It should contain about 2% of ether soluble alkaloids calculated as emetine.

Family : Rubiaceae.

Geographical Source : The plant is indigenous to Brazil and also found in Colombia, Cartagena, Nicaragua, Savanilla, Malaya, Burma, Panama and west Bengal. In India it is cultivated at Mungpoo (Darjeeling), on Nilgiris near Kollar and in Sikkim.

Collection : The plant is a low, straggling shrub containing slender rhizome with annulated wiry roots.

The roots are smooth, slender and whitish when young, develop on maturation, a thick brownish bark with numerous closely placed transverse furrows.

The plant is unusually slow-growing. It thrives best in forest areas on sandy loams in humus, potash, magnesia and lime. A maximum rainfall of 90 inch is required throughout the year, a temperature between 15-40°C shaded

situations are essential for successful cultivation. Temperature fluctuations should be narrow and the soil should be well drained. Propagation is by stem or root cuttings planted about a foot apart each way. Roots are harvested when the plants are about 2.5 years old and the alkaloid content exceeds 20 per cent. The plant may be dug up at any time of the year and the roots washed and dried in shade.

Morphology : The rhizome is thin, or sometimes thick and annulated. Rhio Ipecac is 5-15 cm long, 6 mm in diameter, shape is cylindrical, slightly tortuous, external surface is broadly annulated, brick red to brown in colour, the ridges are rounded and encircle the root, fracture of root is short and shows a thick, greyish bark and small dense wood. Odour is slight and taste is bitter and acrid.

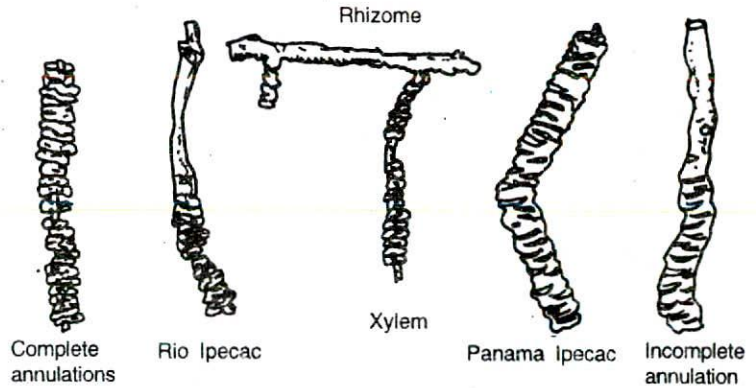
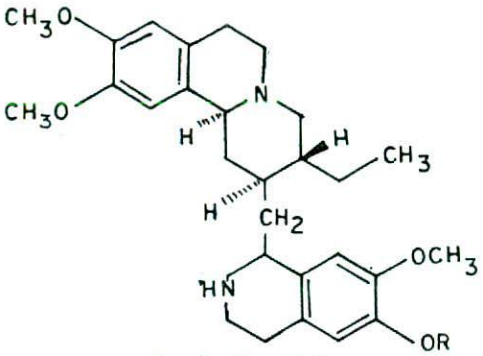


Fig. 13.10. Ipecacuanha

Cartagena Ipecac is 4-6.5 mm in diameter greyish-brown in colour, less crowded and less projecting annulations, has transverse ridges. Half of the portion contains bark.

Chemical Constituents : Ipecac contains 2-2.5% alkaloids of which 30-75% is emetine. The predominant alkaloids are emetine (40-70%), cephaeline, psychotrine, psychotrine methyl ether, protoemetine and emetamine. A crystalline glucosidal tannin, known as ipecacuanhin or ipecacuanhic acid, a neutral monoterpenoid isoquinoline glycoside (ipecoside), traces of ipecamine and hydroipecamine, malic acid, citric acid, saponins, starch, calcium oxalate and resin have also been reported from the root. Indian root contains 1.98% of total alkaloids and 1.39% emetine. The Cartagena or Nicaragua Ipecac generally contains 2.6 - 3% total

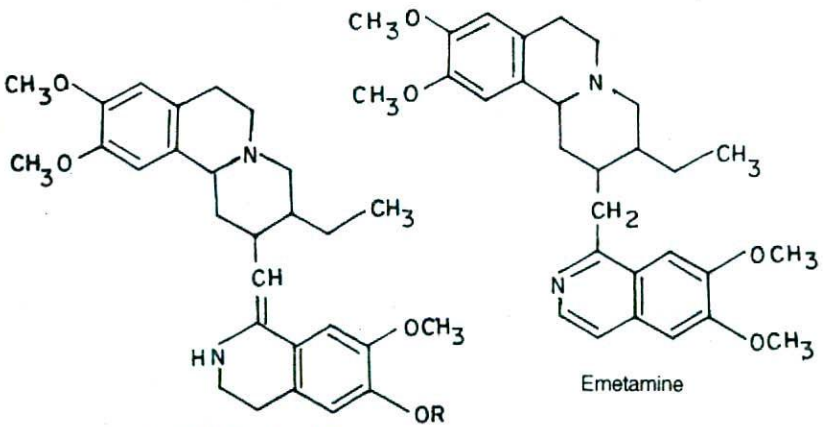
alkaloids, cephaeline present to a larger extent than in Rio Ipecac. The Rio variety contain total 2% alkaloids of which about 60-75% is emetine. The Cartagena variety contains 40-50% emetine.



Emetin (R = CH_3)
Cephaeline (R = H)

Test of Emetine

Powdered drug (0.5g) is mixed with HCl (20 ml) and water (5 ml), filtered and to the filtrate (2 ml) potassium chloride (0.01) is added. If emetin is present, a yellow colour develops which on standing for 1 hour gradually changes to red.

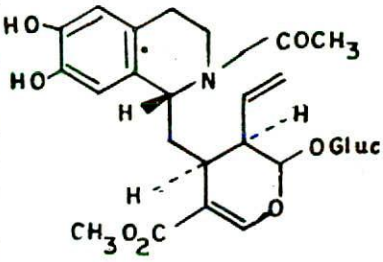


Psychotrine (R = H)
Psychotrine methyl ether (R = CH_3)

Emetamine

Uses : Ipecac is emetic and used as an expectorant and diaphoretic and in the treatment of amoebic dysentery. The alkaloids have local irritant action.

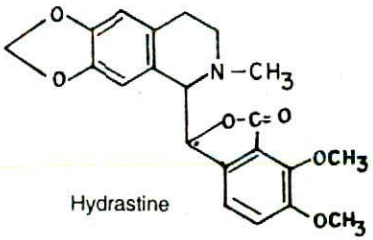
Adulterants : The chief adulterant of the drug is the aerial stem of the plant. It can be distinguished from the root by the longitudinal striation, presence of distinct pith composed of cells with lignified walls and by the surface scars. The drug is often substituted by stem and roots of *Richardsonia scabra*, *Cryptocoryne spiralis*, *Psychotria emetica*, *Manettia ignita*, *Hybanthus ipecacuanha*, *Asclepias curassavica*, *Anodendron paniculatum*, *Calotropis gigantea* and others. The powdered drug is often adulterated with almond meal.



Ipecoside

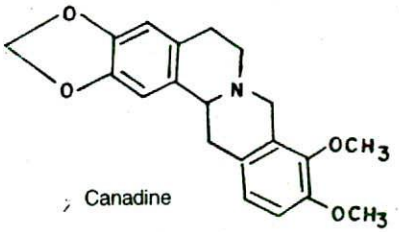
HYDRASTIS

Synonyms : Golden seal; Yellow Root; Orange root; Yellow puccoon; Indian Turmeric; Hydrastis rhizome; Rhizoma hydrastis.



Hydrastine

Biological Source : Hydrastis consists of the dried rhizome and roots of *Hydrastis canadensis* Linn. containing not less than 2.5% ether soluble alkaloids.



Canadine

Family : Berberidaceae or Ranunculaceae.

Geographical Source : Canada, eastern USA and Europe.


Fig. 13.11 : Hydrastis

Characters : The plant propagates from rhizome buds. In autumn the terminal buds are replanted. The rhizomes are cylindrical, 1-5 cm long and 2-10 mm in diameter. They possess numerous, short branches, which terminate in cup-shaped scars and bear encircling

cataphyllary leaves. Scale leaves are present on the rhizome. The outer surface of rhizome is yellowish-brown or greyish brown. The roots originate on the ventral and lateral surface, are long and wiry. The fracture of the drug is short and waxy. The odour is slight and distinct and taste in bitter.

Chemical Constituents : Hydrastis possesses the alkaloids hydrastine, (1.5-4%), berberine (0.5-6.0%) and canadine; some volatile oil and resin.

Uses : Hydrastis is used as astringent in inflammation of the mucous membrane to check uterine haemorrhage and in the treatment of caterrhal conditions of the genito-urinary tract.

BERBERIS

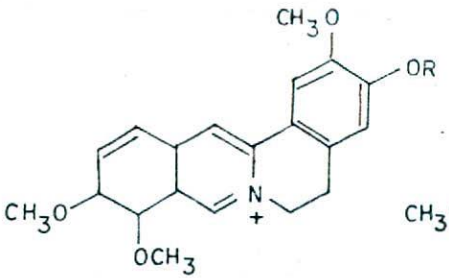
Synonyms : Oregon Grape Root; Berberis aquifolium; Indian or Nepal or Ophthalmic burberry; Tree-Turmeric; Holly-leaved burberry; Mountain grape.

Biological Source : Berberis consists of dried rhizome and roots of *Mahonia* species chiefly from *Mahonia aquifolium* Nuttall (Family : Berberidaceae).

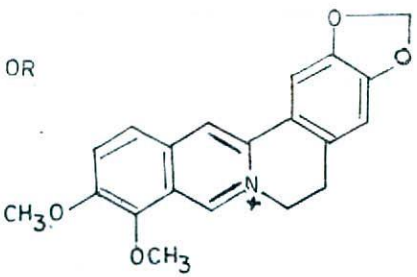
Geographical Source : Rocky mountains of British Columbia, U.S.A.

The plants are law trailing shrubs. The chief chemical constituents of Berberis are berberine, oxycanthine, and berbamine which is an isomer of oxycanthine.

The root bark of *Berberis vulgaris* Linn. found in U.S.A., *B. asiatica* Roxb ex. DC of Himalayan region and *B. aristata* DC of India are similarly used as *Mahonia* species. *B. asiatica* grows in dry valleys of Himalayas in Bhutan, Gharhwal, Kullu, Bihar and on the Parasnath Hill, Afghanistan. Its stem is diaphoretic and laxative and the roots are used as tonic and antiperiodic.



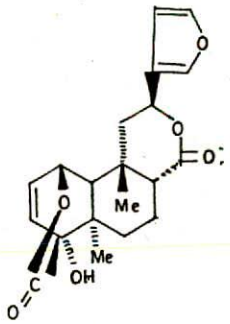
Palmatine (R = CH_3)
Jatrorrhizine (R = H)



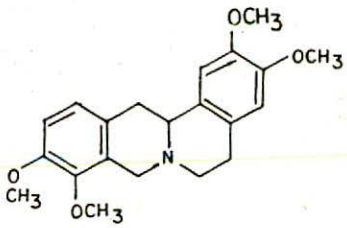
Berberine

B. lycium Royle grows in dry hot places of western Himalayas. From the roots of *B. asiatica* berberine, palmatine, jatrorrhizine, columbamine, tetrahydropalmatine, berbamine, oxyberberine, and oxycanthine have been isolated. Berberine and palmitine occur as chlorides. *B. lycium*, a good source of berberine, contains all these compounds in addition to berberine acetone complex.

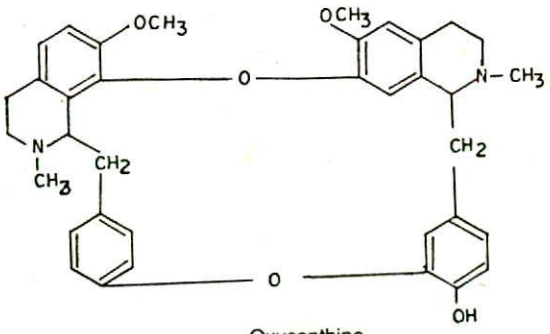
Uses : Roots of *Berberis lycium* has antipyretic, febrifuge, carminative, aperient, anticancer and antiprotozoal properties. They are used in eye diseases, piles, diarrhoea and menorrhagia. Berberine has anti-inflammatory activity and is effective in intestinal and hepatic amoebiasis, in cholera and for controlling gastroentritis.



Columbin



Tetrahydropalmatine



Oxycanthine



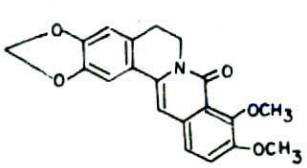
Fig. 13.12 : Berberis

SANGUINARIA

Synonyms : Blood root; Red puccoon; Ped root; Puccoon root; Tetterwort; Rhizoma sanguinariae.

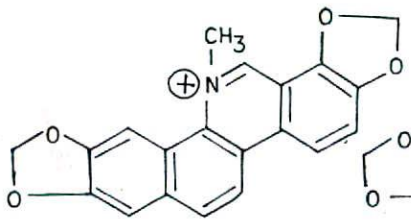
Biological Source : Sanguinaria consists of dried rhizome of *Sanguinaria canadensis* Linn. (Fam. Papaveraceae).

The plant is found in Canada. It is a low perennial herb with horizontal branching rhizome.

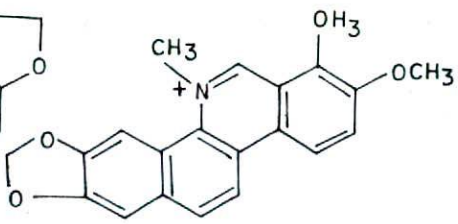


Oxyberberine

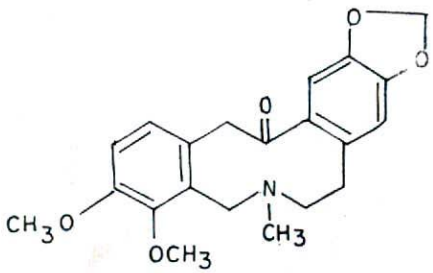
Chemical Constituents : Alkaloids of protopine series have been isolated from Sanguinaria in addition to sanguinarine (1%), chelerythrine, protopine, allocryptopine, homochelidonine and resin.



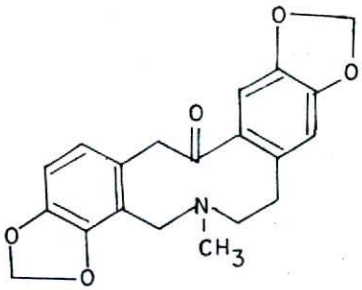
Sanguinarine



Chelerythrine



Allocryptopine
(β-Homochelidonnine)



Protopine

Uses : Sanguinaria has stimulating and emetic properties. An extract of Sanguinaria is used as toothpaste base, in gingivatis and in periodical diseases.

CURARE

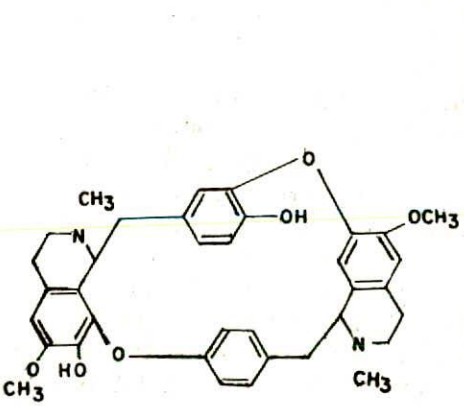
Synonyms : Ourari; Urari; Woorari; Woorali, South American arrow poison; Wourara.

Biological Source : Curare is a crude dried extract from the bark and stems of *Strychnos castelnaei*, Wedd., *S. toxifera*, Benth., *S. crevauxii* G. Planchon, *S. jobertiana* (Family. Loganiaceae) and from *Chondodendron tomentosum* Ruiz et Pavon and *C. microphylla.* (Fam. Menispermaceae).

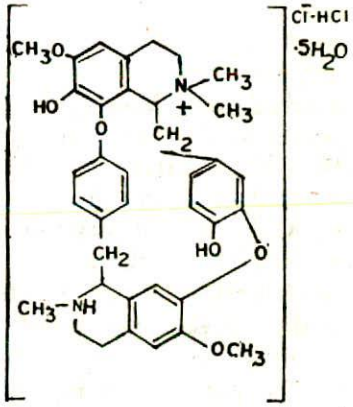
The plants generally occur in Southern America.

Chemical Constituents : The drug contains several alkaloids and quaternary compounds. The most important constituent is d-tubocurarine which is a quaternary compound of *bis* benzylisoquinoline structure. *C. microphylla* possesses non quaternary base (+) - bebeerine while (-) - bebeerine has been isolated from *C. tomentosum*. *Menispermaceous curare* has (+) - tubocurarine, (+) - isochondrodendrine, isochondrodendrine dimethyl ether, curine (bebeerine), and (+) - chondrocurine.

Loganiaceous curare contains 12 crystalline quaternary alkaloids, the toxiferines I-XII.



Bebeerine



Tubocurarine chloride

Uses : Curare is used as a source of alkaloids. Tubocurarine chloride has muscular relaxation in surgery and is used to control convulsions of strychnine poisoning and of tetanus.

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. It contains not less than 2.5 per cent of morphine in its moist conditions as anhydrous morphine.

Family : Papaveraceae.

Geographical Source : Turkey, Russia, Yugoslavia, Tasmania, India, Pakistan, Iran, Afghanistan, China, Burma, Thailand, Laos, etc. In India Opium is cultivated in M.P. (Neemuch) and U.P.

Plant Habit : The opium is an annual herb. The flowers are large, regular, terminal, solitary, white to pink in colour. It contains about eight capsules. Laticiferous vessels are found in all aerial parts which are maximum in capsule.



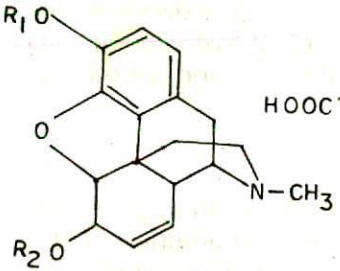
Fig. 13.13. *Papaver somniferum* capsule

Cultivation and Collection : Opium is cultivated under licence 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 incision must not penetrate into the interior of the capsule otherwise latex will be lost. The latex tubes open 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. 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.

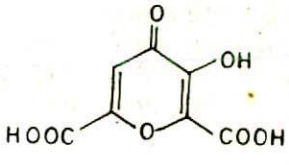
Characters : Opium occurs in rounded or flattened mass which is 8-15 cm in diameter and weighing from 300 g to 2 kg each. The external surface is pale or chololate-brown, texture is uniform and slightly grannular. It is plastic like when fresh and turns hard and brittle after sometime. Fragment of poppy 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 25 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 type of alkaloids isolated are :

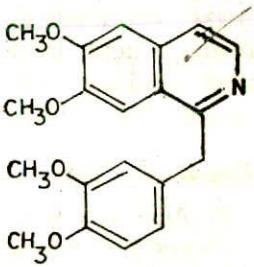
(i) **Morphine Type :** Morphine, codeine, neopine, pseudo-or oxymorphine, thebaine and porphyroxine.



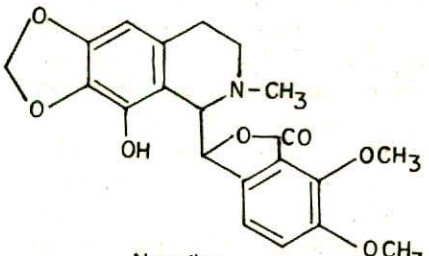
Morphine ($R_1 = R_2 = H$)
Codeine ($R_1 = CH_3$, $R_2 = H$)



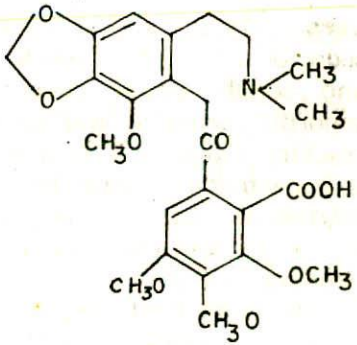
Meconic acid



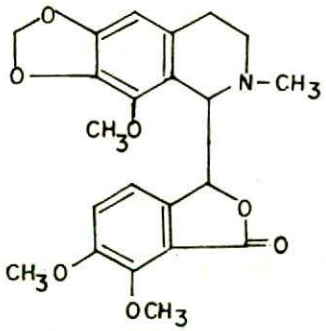
Papaverine



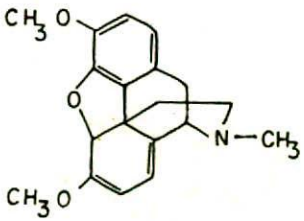
Narcotine



Narceine



Noscapine



Thebaine

(ii) **Phthalide Isoquinoline Type** : Hydrocotarnine, narcotoline, l-narcotine, noscapine, oxynarcotine, and narceine.

(iii) **Benzyl Isoquinoline Type** : Papaverine, xanthaline, dl-laudanine, laudanidine, codamine and laudanosine.

(iv) **Cryptopine Type** : Protopine, cryptopine

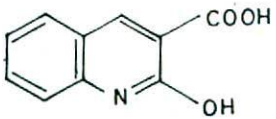
(v) **Unknown Constituents** : Aporeine, rhodeadine, meconidine, papaveramine and lanthopine.

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

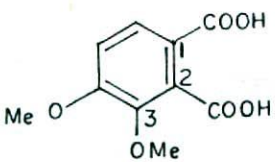
Chemical Tests

1. Aqueous extract of Opium with $FeCl_3$ solution gives deep reddish purple colour which persists on addition of HCl.
2. Morphine gives dark violet colour with conc. H_2SO_4 and HCHO.

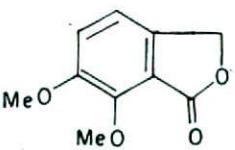
Uses : Opium and morphine have narcotic, analgesic and sedative action and used to relieve pain, diarrhoea, dysentery and cough. Poppy capsules are astringent, somniferous, soporific, sedative and narcotic and used as anodyne and emollient. Opium is first stimulant, then narcotic, anodyne, antispasmodic, aphrodisiac, astringent and myotic. As astringent, Opium checks haemorrhages, lessens bodily secretions and restrains tissue changes. Generally Opium is anodyne, hypnotic, antispasmodic, diaphoretic, narcotic, myotic, intoxicant and cerebral depressant. Morphine is an analgesic. Codeine is mild sedative and is employed in cough mixtures. Noscapine is not narcotic and also has cough suppressant action acting as a central antitussive drug.



2-Hydroxycinchonic acid



Hemipinic acid



Meconine

Papaverine has smooth muscle relaxant action and is used to cure muscular spasms. Opium, morphine and the diacetyl derivative heroin, cause drug addiction. Abouse leads to habituation of addiction.

INDOLE ALKALOIDS

The important alkaloids possessing indole as a part of their structures are strychnine and brucine (Nux vomica), lysergic acid and its derivatives (Ergot), physostigmine (Physostigma), reserpine (Rauwolfia) and vinblastine and vincristine (Catharanthus). The compounds usually contain two nitrogens, one is present in the indole nucleus and the second is usually two carbons apart from the β-position of the indole ring.

NUX VOMICA

Synonyms : Nux vomica seeds; Kuchla (Hindi); Quaker buttons; Bachelor's buttons; Poison nut; Dog buttons; Vomit nut; Crow fig; Semina strychni.

Biological Source : Nux vomica is the ripe, dried seed of *Strychnos nux-vomica* Linn. which should contain 1.2% of strychnine.

Family : Loganiaceae.

Geographical Source : The plant is native of the East Indies and found in the forests of Sri Lanka, Malabar coast, and northern Australia. In India it also grows in forests of Gorakhpur, Bihar, Orissa, Konkan, North Kanara, North Circars, and west of Tamil Nadu up to 1300 m.

Plant Habitat and Morphology : The plant is a small tree, 12 meters in height. The fruit, collected from November to

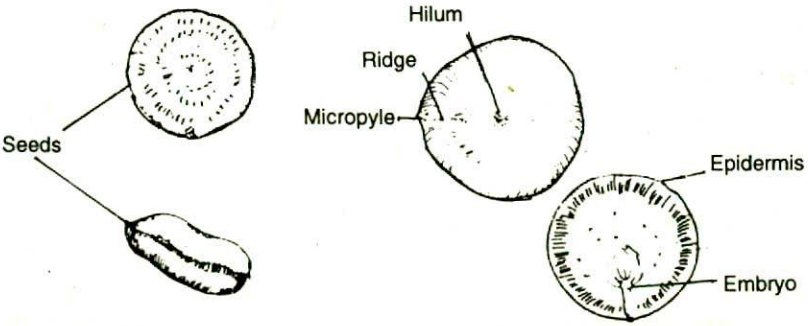


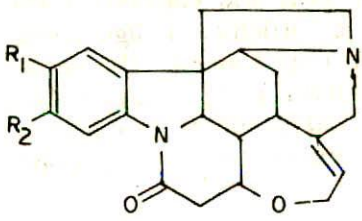
Fig. 13.14. *Strychnos nux-vomica* seeds

February by the natives, is a berry and contains 3-5 seeds which are adhered with the white and mucilaginous bitter pulp. The epicarp is separated and seeds are obtained and washed to remove adherent pulp. The dried seeds are very hard, greenish-grey in colour, disc-shaped, 10-30 mm in diameter, 4-6 mm thick, flat and some concavo-convex type. The edge is acute or rounded. Numerous silky, closely appressed, radiating hairs are present on the testa. Hilum is distinct which is present on the flattened side. From the hilum a radial ridge connects the micropyle at the circumference. A small embryo with two cordate cotyledons and a cylindrical radicle, directing towards the micropyle, is embedded in a grey, horny endosperm. A slit-like cavity is located in the centre of the seeds. The dried seeds are odourless and have a very bitter taste.

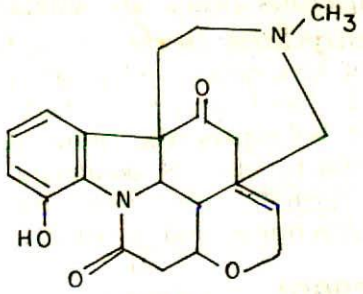
Chemical Constituents : About 1.8-5.3% of total alkaloidal base is present in Nux vomica. The main alkaloids of therapeutic importance are strychnine (1.25%) and brucine (1.5%) which are present in large thick-walled cells of endosperm. The high concentration of strychnine is present in cells near the centre of the seeds while brucine is concentrated in the outer cells near the epidermis. The other minute alkaloids present in the drug are α-colubrine, β-colubrine, icajine, 3-methoxyicajine, protostrychnine, vomicine, novacine, N-oxystrychnine, pseudostrychnine and isostrychnine. The seeds also contain chlorogenic or igasuric or caffeotannic acid (a condensation product of caffeic acid and quinic acid), loganin (a glycoside), fixed oils (3%) and proteins. Loganin is also present in the fruit pulp up to 5% along with secologanin. Hemicellulose consisting of mannan and galactan is present in the thick cell wall of endosperm. Aleurone grains are present in the endosperm of the seed.

Chemical Tests

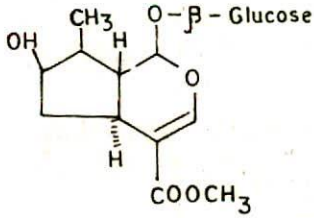
1. **Strychnine Test :** A mixture of ammonium vanadate and sulphuric acid on addition to strychnine or a thick section of endosperm gives purple colour.
2. **Potassium Dichromate Test :** Addition of potassium dichromate and conc. H_2SO_4 with strychnine forms violet colour.
3. **Brucine Test :** Addition of conc. HNO_3 to brucine or thick section of endosperm produces yellow to orange colour.



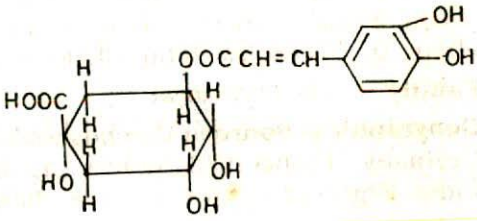
Strychnine, $R_1 = R_2 = H$
Brucine $R_1 = R_2 = OCH_3$
α-Colubrine, $R_1 = H, R_2 = OCH_3$
β-Colubrine, $R_1 = OCH_3, R_2 = H$



Vomicine



Loganin



Chlorogenic acid
(Caffetannic acid)

4. **Hemicellulose Test :** When iodine and H_2SO_4 are added to a thick section, the cell walls are stained blue.
5. **Biological Test :** Strychnine (2/1000 mg) when injected to a tail of a mouse (2 weeks old), then palpitation of the tail takes place.

Uses : Strychnine is used as circulatory stimulant and bitter tonic. Nux vomica increases the tone of intestine. It is given in atonic dyspepsia, as nervine and sex tonic, circulatory stimulant in surgical shock, alcohol poisoning and as vermine killer. Strychnine improves the appetite and digestion. It is a powerful poison in large doses, producing tetanic convulsions and death.

Allied Drugs : *Ignatius beans* are dried ripe seeds of *Strychnos ignatii* Bergius (Family-Loganiaceae). The plant is found in Philippines and Vietnam. The fruits are larger than those of Nux vomica and contain about 30 seeds. The seeds are 1.5 cm long, ovoid and dark grey. They possess irregularly arranged greyish hairs. The seeds contain 2.5-3% of total basic compounds among which strychnine is 46-62 per cent.

Ignatius beans are similarly used as Nux vomica.

Strychnos tieute : It is found in Java and contains 1.4% of strychnine and small amount to brucine. *S. ligustrina*, *S. rheedii* and *S. aculeata* contain only brucine. The seeds of *S. triplinervia* from Mexico contain 1.8% of strychnine and brucine. *S. potatorum* Linn. (India) and *S. nux-blanda* (Burma), substituted for Nux vomica, do not contain strychnine and brucine.

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, developing in the ovary of rye plant, *Secale cereale* (Family Gramineae). Ergot should yield about 0.15% of the total alkaloids calculated as ergotoxine.

Family : Clavicipitaceae.

Geographical Source : Czechoslovakia, Hungary , Switzerland, Germany, France, Yugoslavia, Spain, Russia and India. In India Ergot is cultivated at Kodaikanal (T.N.).

Cultivation : 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 condiospores (asexual spores) 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.

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.

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 a large number of 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.

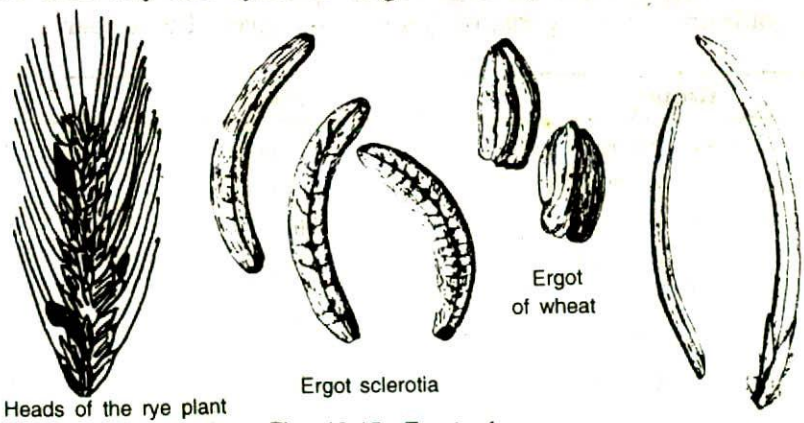


Fig. 13.15. Ergot of rye

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.

Morphology : 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.

Storage : Ergot should be thoroughly dried, and the sclerotia kept entire and stored in a cool place. If the moisture content is maintained below 8 per cent, alkaloidal loss is negligible. If this figure is exceeded, deterioration is proportional to the excess moisture. The drug is liable to attack by mites and various insects, but this can be avoided by sprinkling with carbon tetrachloride.

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
I.	Ergometrine group (Water soluble)	Ergometrine Ergometrinine
II.	Ergotamine group (Water-insoluble)	Ergotamine Ergotaminine Ergosine Ergosinine
III.	Ergotoxine group (Water-insoluble)	Ergocristine Ergocristinine Ergocryptine Ergocryptinine Ergocornine Ergocorninine

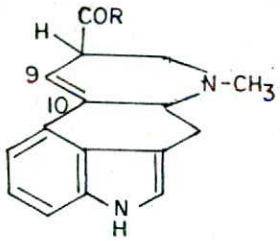
Only the first group, ergometrine group, belongs to water-soluble compounds. Alkaloids of Group II and III are polypeptides in which lysergic acid or isolysergic acid is linked to amino acids. Alkaloids obtained from lysergic acid are physiologically active compounds. In the first group, e.g. ergometrine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

The other chemical components isolated from Ergot are histamine, tyramine and other amines, putrescine, cadaverine, agmatine, amino acids, acetylcholine, colouring matters, sterols like ergosterol and fungisterol, elymoclavine, sclereythrin, ergonovine, ergothioneine, clavicepsin, ergochrysin, ergoflavin, ergotic acid, histamine, choline, betaine, clavine, fat (15-30%), mannitol, lactic acid and succinic acid. The cell walls of Ergot are made up of chitinous layer in place of plant cellulose.

Chemical Tests

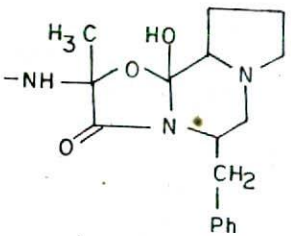
1. Ergot under UV light shows a red-coloured fluorescence.
2. Ergot powder is extracted with a mixture of $CHCl_3$ and sodium carbonate. The $CHCl_3$ layer is separated and a mixture of p-dimethylaminobenzaldehyde (0.1g), H_2SO_4 (35%, v/v, 100 ml) and 5% ferric chloride (1.5 ml) is added. A deep blue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

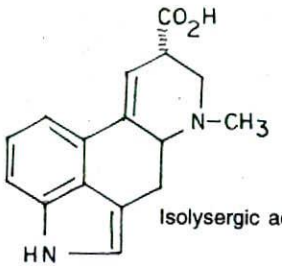
Uses : Ergot is oxytocic, vasoconstrictor, and abortifacient and used to assist delivery and to reduce post-partum haemorrhage. Ergotamine is used to treat migraine. Lysergic acid diethylamide (LSD - 25), obtained by partial synthesis from lysergic acid is a potent specific psychotomimetic. Ergometrine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



Lysergic acid, R = OH
Ergine (Lysergic acid amide), R = NH_2
Ergometrine, R = NHCH (CH_3) - CH_2OH
Methylergometrine, R = NHCH (CH_2CH_3) CH_2 OH
Ergotamine,

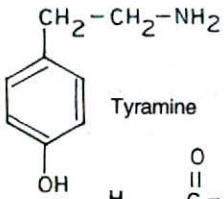
R=





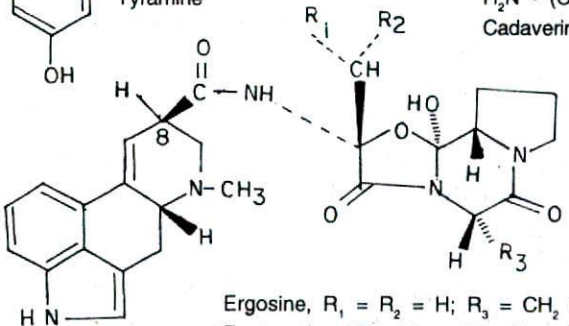
Isolysergic acid

H_2N-CH_2-CH_2CH_2-CH_2-NH_2
Putrescine

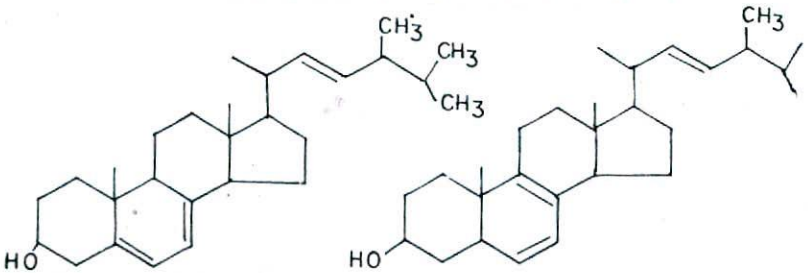


Tyramine

OH
$(CH_3)_3$ N - CH_2 CH_2O - $COCH_3$
Acetylcholine
H_2N - $(CH_2)_5$ - NH_2
Cadaverine

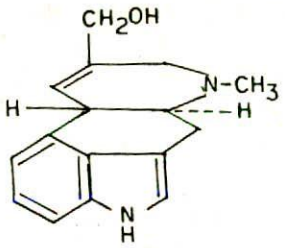


Ergosine, R_1 = R_2 = H; R_3 = CH_2 CH $(CH_3)_2$
Ergocornine, R = R_2 = CH_3, R_3 = CH_2 CH $(CH_3)_2$
Ergocristine, R_1 = R_2 = CH_3, R_3 = $CH_2C_6H_5$
Ergocryptine, R_1 = R_2 = CH_3, R_3 = CH_2CH $(CH_3)_2$

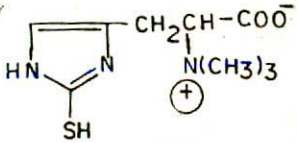


Ergosterol

Fungisterol



Elymoclavine



Ergothioneine

PHYSOSTIGMA

Synonyms : Calabar bean; Ordeal bean; Chop nut; Split nut; Esere nut; Semina physostigmatis.

Biological Source : Physostigma is the dried ripe seeds of *Physostigma venenosum* Balfour.

Family : Leguminosae.

It is a perennial woody climber found on the banks of streams of West Africa (near mouths of Niger and Old Calabar rivers), introduced into India and Brazil.

Characters : The plant is a perennial woody climber, bears typical papilonaceous flowers, with legumes of 15 cm length, each containing two or three seeds. The beans are flattened, reniform shape, 1.5 - 3.0 cm long, 1-1.5 cm wide and 1.5 cm thick. The seeds are very hard, dark brown testa is smooth with a grooved hilum running whole length of the convex side. Physostigma is odourless with starchy taste at first and acrid afterwards.

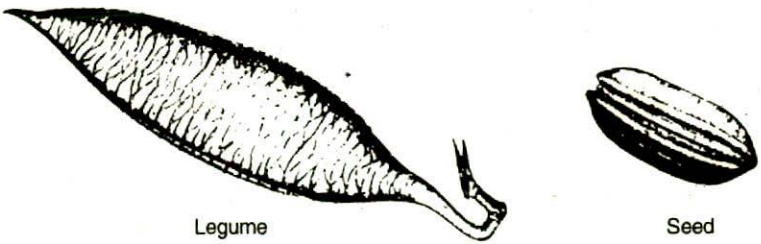


Fig. 13.16. *Physostigma venenosum*

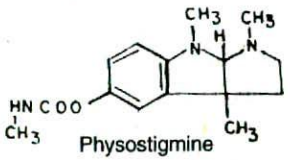
Chemical Constituents : The seeds contain 0.15-0.3% alkoloids. Physostigmine (eserine) (0.15%), eseridine, eseramine, isophysostigmine, physovenine, geneserine, N-8-

norphysostigmine, calabatine and calabacine are the alkaloids isolated from the seeds. Exposure of the chief alkaloid, physostigmine, to heat, light or air leads to oxidation and a red compound, rubreserine, is formed. Therefore, physostigmine should be protected from air and light. Physostigmine occurs as a white, odourless, finely crystalline powder.

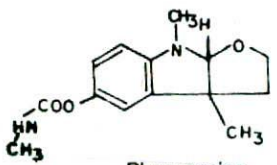
Uses : Physostigmine is cholinergic and miotic and used in atony of gastrointestinal tract. Its salicylate compound is used for contracting the pupil of the eye especially in mydriatics and glaucoma.

Calabar beans are odourless with starchy taste at first and acrid afterwards. The beans are extremely poisonous causing paralysis of lower limbs and death by asphyxia, and in large doses, paralysis of the heart. The poisonous principle in the seed is destroyed by boiling and scorching the seed.

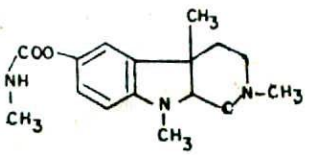
Physostigmine salicylate is used in ophthalmology to reduce intraocular tension in glaucoma and to correct the dilation of the pupil. It is also used in post-operative distension and atony of the intestine or urinary bladder, and in tetanus, strychnine and atropine poisoning. It is also useful as an antispasmodic in rheumatoid arthritis, fibrositis, bruitis and in veterinary medicine for colic in horses.



Physostigmine



Physovenine



Geneserine

RAUWOLFIA

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

Biological Source : Rauwolfia consists of dried roots of *Rauwolfia serpentina* Benth.; sometimes pieces of rhizome and aerial stem bases are attached.

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 1300 meters, east and west ghats of Tamil Nadu, in Bihar (Patna and Bhagalpur), Konkan, Kanara and Bengal.

Cultivation : Rauwolfia grows in tropical forests at an altitude of 1200-1300 meters at temperature 10-40°. 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.

Collection : The drug is collected mainly from wild plants. Roots and rhizomes are dug out in October-November when the plant roots are 2-4 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.

Morphology : 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



Fig. 13.17. *Rauwolfia serpentina*

ends. Slight odour is felt in recently dried drug which decreases with age; taste is bitter.

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, raunescine and deserpidine. The other alkaloidal components are ajmalinine, ajmaline (rauwolfine), ajmalicine (δ-yohimbine), serpentine, serpentinine, tetrahydroreserpine, raubasine, reserpinine, isoajamaline, rauwolfinine and alstonine. The other substances present are phytosterols, fatty acids, unsaturated alcohols and sugars. Raugustine and isoraunescine are the inactive alkaloids.

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 employed in labours to increase uterine contractions and in certain neuropsychiatric disorders.

Allied Species : There are about 86 Rauwolfia species and most of them have been examined for reserpine and related alkaloids. *R. tetraphylla (R. canescens* Linn., *R. hirsuta)* is widely distributed in tropical areas of south America, Caribbean, India, and Australia. Its roots had been substituted for *R. serpentin...* It is recognized by its non-stratified cork, and sclereid groups in the phloem. The alkaloids reserpine and deserpidine are isolated on commercial scale from *R. tetraphylla.*

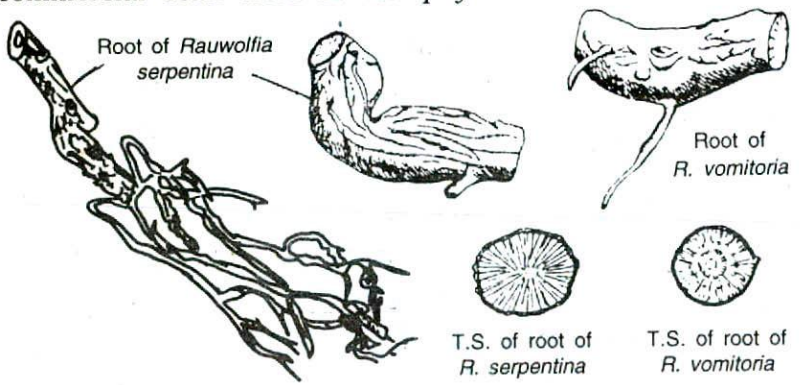
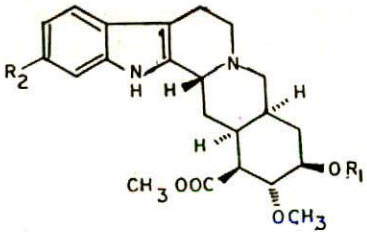
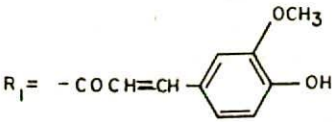
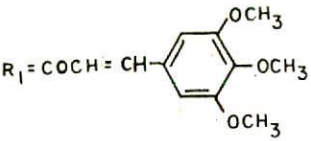


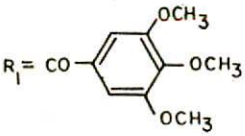
Fig. 13.18. Rauwolfia

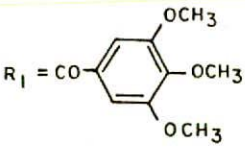
R. nitida is found in West India. From its root-bark 33 indole alkaloids have been isolated.

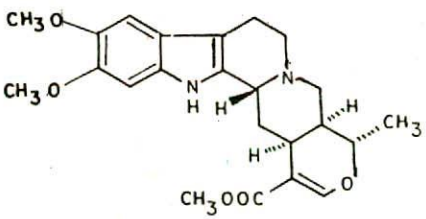


Rescimetol,  $R_2 = OCH_3$

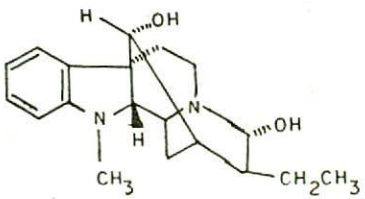
Rescinnamine,  $R_2 = OCH_3$

Reserpine,  $R_2 = OCH_3$

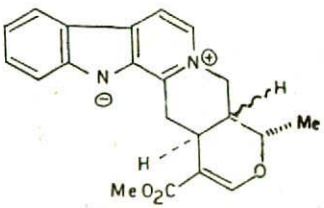
Deserpidine,  $R_2 = H$



Reserpiline

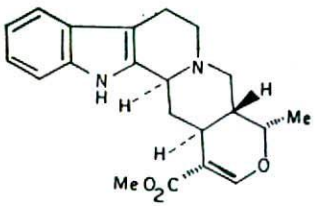


Ajmaline

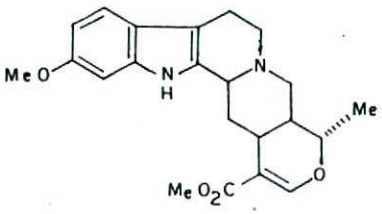


Serpentine (β-H)
Alstonine (α-H)

Adulterants : The roots are commonly adulterated with other parts of the plants such as the stems, and root stumps with some portions of stem attached to them. Roots of other *Rauwolfia* species such as *R. beddomei, R. densiflora, R. micrantha, R. perakensis* and *R. tetraphylla* and those of *Ophiorrhiza mungos*, and white and red-flowered *Clerodendrus* species have been used as adulterants. Stems of the plant contain less quantity of alkaloids. The roots can be easily distinguished from the stems since they have a more wrinkled surface, are less flexible, thicker, more tortuous and less branched.



Ajmalicine



Reserpinine

CATHARANTHUS

Synonyms : Vinca; Madagascar perivinkle; Shadaphul (Mar); Rattanjot (Punj.).

Biological Source : Catharanthus is the dried whole plant of *Catharanthus roseus* G. Don (syn. *Vinca rosea* Linn.).

Family : Apocynaceae.

Geographical Source : The plant is indigenous to Madagascar but now found in tropical regions and cultivated as an ornamental plant in southern Florida, Africa, India, Thailand, Taiwan, eastern Europe and Australia.

Plant Habitat : Catharanthus is an erect, everblooming pubescent herb or subshrub, 40-80 cm high, woody at the base. The leaves are oblong, with petiolate acute base, rounded apex, entire margin and oppositely arranged. The flowers are axillary, violet, rose or white or white with red eyes, 4-5 cm in diameter. The fruit is a divergent follicle. It has slight odour and taste is bitter.

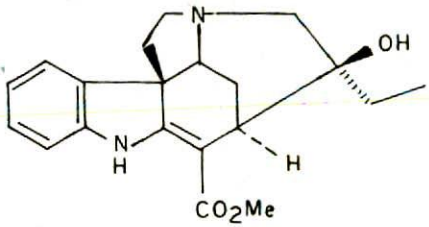
Chemical Constituents : About 90 alkaloids have been reported from *C. roseus*. Vindoline, and catharanthine are indole monomeric alkaloids. The alkaloids such as

ajmalicine, lochnerine, reserpine, serpentine and tetrahydroalstonine are also present in other genera of Apocynaceae. About 20 dimeric alkaloids, including vindesine, vincristine and vinblastine, have been isolated from Catharanthus. These alkaloids possess antineoplastic activity. In addition to alkaloids, monoterpenes, sesquiterpene, indole and indoline glycoside have also been reported.

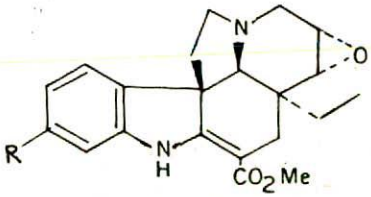
Uses : Catharanthus is used to cure diabetes and in wasp-sting. Vinblastine sulphate is an antitumor alkaloid employed to cure Hodgkin's disease and chlorionepithelioma. Vincristine sulphate is a cytotoxic compound and used to treat leukaemia in children. Catharanthus alkaloids are antineoplastic in nature.



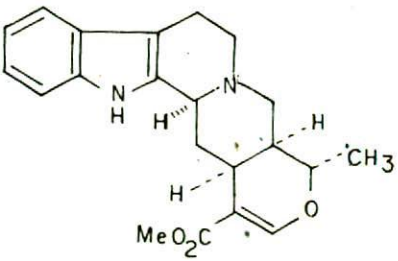
Fig. 13.1 *Catharanthus roseus* flowering part



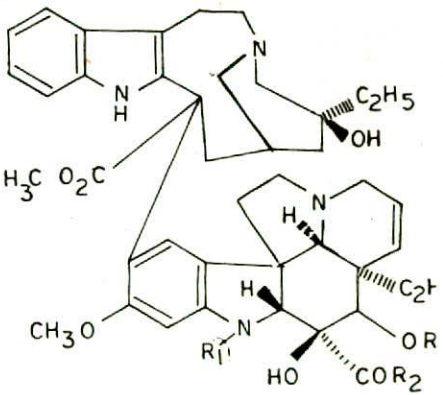
Lochneridine



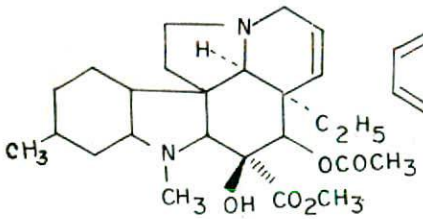
Lochnerinine (R=OCH_3)
Lochnericine (R=H)



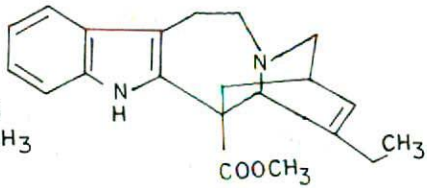
Tetrahydroalstonine



Vinblastine, $R_1 = CH_3$, $R_2 = OCH_3$, $R_3 = COCH_3$
Vincristine, R = CHO, $R_2 = OCH_3$, $R_3 = COCH_3$
Vindesine, $R_1 = CH_3$, $R_2 = NH_2$, $R_3 = H$



Vindoline



Catharanthine

STEROIDAL ALKALOIDS

The steroidal alkaloids possess a cyclopentenophenanthrene nucleus. Alkaloids with C_{27} group are known as *Solanum* alkaloids, e.g., solanidine, and tomatidine. The alkaloids found in the Apocynaceae (*Holarrhena* and *Funtumia* species) and in the Buxaceae, possess 21 carbon atoms. The important drugs of this group are Kurchi bark and Veratrums.

KURCHI BARK

Synonyms : Holarrhenna; Kurchi (Hindi).

Biological Source : Kurchi bark consists of dried stem bark of *Holarrhena antidysenterica* Wall. obtained from 8-12 years old tree.

Family : Apocynaceae.

Geographical Source : The plant is found more or less throughout India, ascending to 1250 m in the Himalayas, especially in wet forests.

Collection : Kurchi is a deciduous laticiferous shrub or small tree, 9-10 m high. The bark is collected from the tree by making suitable transverse and longitudinal incisions. The alkaloidal content is high soon after the rains when new shoots are produced which declines during winter months.

Morphology : The pieces of Kurchi bark are small and recurved both longitudinally and transversely. The size and thickness vary from piece to piece. Outer surface is buff to reddish brown and bears numerous prominent circular or transversely elongated horizontal lenticels, longitudinal wrinkles. The thicker pieces are rugose and show numerous yellowish warts; inner surface cinnamon-brown longitudinally striated, frequently with portions of pale yellow wood

attached; fracture is brittle. The taste is acrid and bitter while the odour is not distinct.

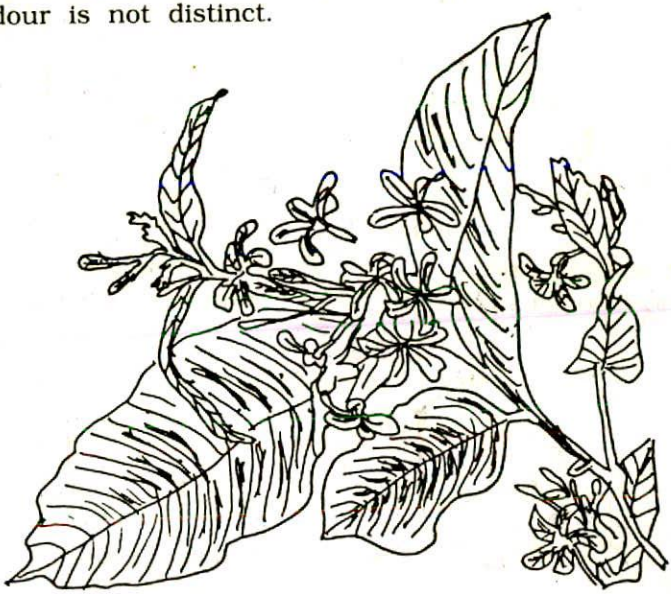


Fig. 13.20. Kurchi flowering shoot

Chemical Constituents : The total alkaloidal constituents of Kurchi bark vary from 1.1 to 4.72 per cent. The main steroidal alkaloid is conessine (20-30%). The other alkaloids isolated include conarrhimine, conimine, conamine, conessimine, isoconessimine, dimethyl conkurchine, 3α-aminocon-5-ene, conkuressine, dihydroisoconessimine, dihydroconessine, 7β- and 7α-hydroxyconessines, kurcholessine, holacine, holacimine, regholarrhenines A, B, C, D, E and F, kurchessine, holarrhimine, holarricine, etc. In addition to alkaloids the bark also contains 5, 20 (29)-lupadien 3β-ol (lupenic triterpene) and sitosta-5, 23-dien-3β-ol (sterol), gum, resin, tannin and lupeol.

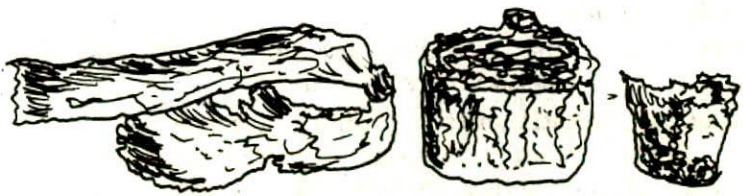
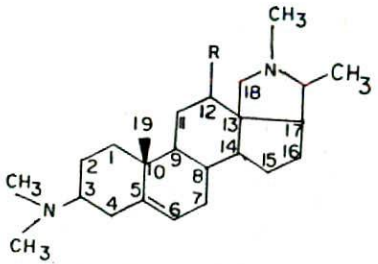
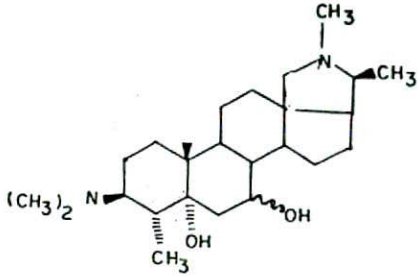


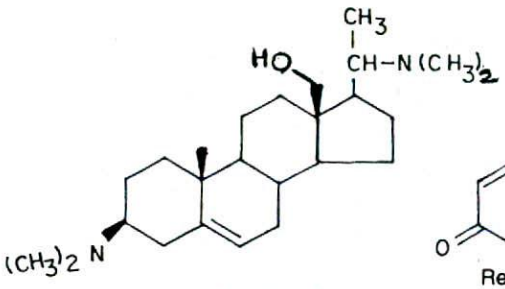
Fig. 13.21. Kurchi bark



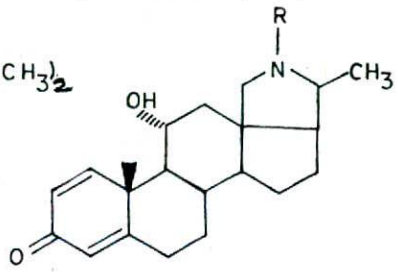
Conessine (R = H)
Holarrhenine (R = OH)



Kurcholesine (β-OH)
Regholarrhenine E (α-OH)



Regholarrhenine F



Regholarrhenine A (R = Me)
Regholarrhenine B (R = H)

Uses : The bark is considered to be stomachic, astringent, tonic, antidysenteric, febrifuge and anthelmintic. The dried bark is rubbed over the body in dropsy. Kurchi bark is used to cure amoebic dysentery and diarrhoea.

VERATRUMS

Synonyms : American Hellebore; Green Hellebore; American Veratrum; Indian poke.

Biological Source : Veratrum consists of dried roots and rhizomes of the perennial herbs, *Veratrum viride* Aiton and *Veratrum album* Linn. found in Canada, USA, Carolina, Tennessee, Georgia, etc. The herb is erect, fleshy rhizome. The powdered drug is odourless and bitter and acrid in taste.

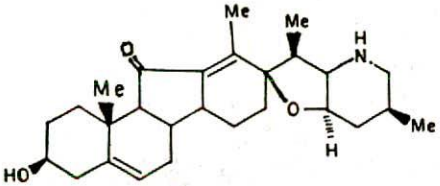
Family : Liliaceae.

Collection : The rhizomes are dug in autumn season, cleaned, cut longitudinally and dried.

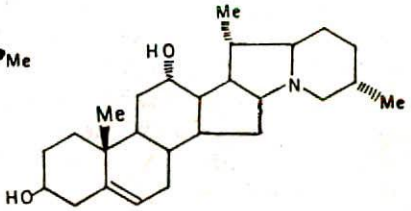
Chemical Constituents : Various steroidal alkaloids have been isolated from Veratrums. The important alkaloids are jervine, pseudojervine, rubijervine, cevadine, germitrine, germidine, veratralbine, veratroidine, neogermitrine, neoprotoveratrine, protoveratrine and veratridine.

Pseudojervine and veratrosine are glycosides of alkamine. Germine, jervine, rubijervine and veratramine are alkamines.

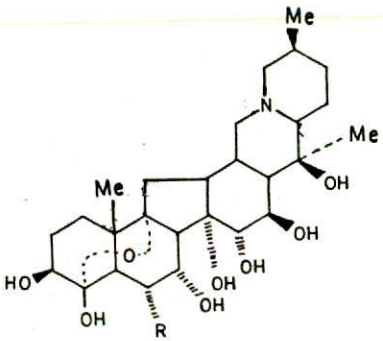
Uses : Veratrum is used as antihypertensive and insecticides. It is also used for relief in irritation of the nervous system, in convulsions, mania, neuralgia, headache, febrile and inflammatory affections of the respiratory organs and acute tonsillitis. The rhizomes are also used for insecticidal purposes in the form of sprays and in dusts. The alkaloids, especially proveratrines A and B, are effective in reducing blood pressure.



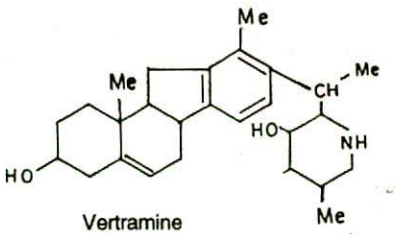
Jervine



Rubijervine



Germine (R = H)
Protoverine (R = OH)



Vertramine

ALKALOIDAL AMINES

The alkaloids of this class do not possess nitrogen in a ring system. Most of them are simple derivatives of phenylethylamine. The important drugs of this group are Ephedra and Colchicum corm.

EPHEDRA

Synonyms : Ma-haung; Tsaopen Ma-huang.

Biological Source : Ephedra consists of whole aerial parts

of *Ephedra sinica* Stapf, *E. equisentina* Ma Huang and other species of *Ephedra*

Family : Ephedraceae (Gnetaceae).

Geographical Source : Ephedra is indigenous to China, India and Pakistan. It is most abundantly found near the sea coast in southern China.

Collection : The plant is a low dioecious, usually leafless shrub and 60-90 cm in height. It is collected in the autumn season, dried and packed in bags.

Characters : The stems of Ephedra are slender pieces, containing numerous ridges, nodes and internodes and fine longitudinal ridges on the outer surface. The distance of internodes are nearly 3-6 cm and the diameter of the node is about 1-2 mm. The leaves are small, connate at the base, about 4 mm in length, decussate, in whorls of two, with a subulate recovered apex and a whitish lamina. The characteristic features of Ephedra species are as follows:

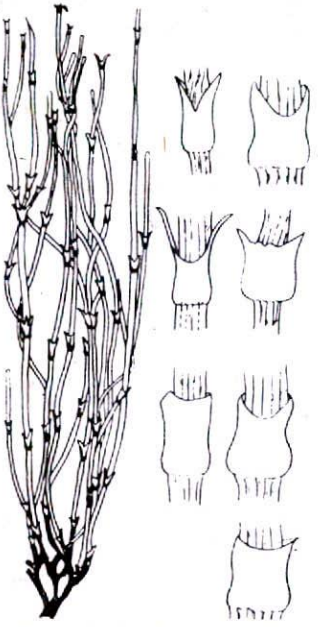


Fig. 13.22. *Ephedra sinica*

Ephedra sinica : The stems are slender, about 30 cm long, 4-7 mm thick, with 3-6 cm long internodes, erect, small ribbed and channeled. Branches are green, rough with longitudinal ridges. Diameter of lowest green node is 1-2 mm. Leaves are opposite, whitish, 4 mm long with subulate and recurved apex. Lamina is whitish and the base is reddish brown. Small blossoms appear in summer.

Ephedra equisentina : The stems are more woody and branched, 25-200 cm long, yellowish green in colour, internodes are shorter, 1-2.5 cm long. The leaf apex is shorter and it is not recurved. Leaves are brownish-purple colour. Ephedra is odourless and taste is bitter.

Ephedra gerardiana is a small, erect shrub, variable in size, few cm in height. It bears dark green, cylindrical striated, often curved branches arising in whorls; internodes of

branchlets, 1-4 cm long and 1-2 cm diameter. Fruit ovoid, red, sweet and edible, containing 1 or 2 seeds, enclosed by succulent bracts. This species is found scattered in the drier regions of temperate and alpine Himalayas.

Ephedra nebrodensis (syn. *E. major)* is an upright, rarely ascending, densely branched shrub, up to 2 meters high. The twigs of this species closely resemble those of *E. gerardiana*.

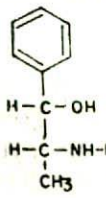
The plants are propagated by seeds or divisions of the rootstock. The alkaloid content increases with the age of the plant, and the best time to collect the green twigs is when the plants are 4 years old and are in blossom. Rainfall has a marked adverse effect. The alkaloidal content of the green twigs is greater than that of the woody stem. The twigs should be dried in sun. Artificial drying should be avoided. The dried drug must be stored dry. Air-dried drug stored in dry, closed containers, protected from light, retains the activity without loss for a long period. Among the Indian species, *E. major* is the richest source of ephedrine.

Chemical Constituents : Ephedras contain about 0.5 - 2.0% total alkaloid. The chief alkaloid is ephedrine (30-90). The other alkaloids isolated are pseudo-ephedrine, 1-methyl ephedrine, norephedrine and dimethylephedrine.

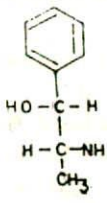
Chemical Tests

To the drug (10 mg) in water (1 ml) dil. HCl (0.2 ml), copper sulphate solution (0.1 ml) and sodium hydroxide solution (2 ml) are added; the liquid turns violet. On adding solvent ether (2 ml) and shaking vigorously, the ethereal layer turns purple and the aqueous layer becomes blue.

Uses : Liquid extract of Ephedra is used for controlling asthmatic paroxysms. Tincture of Ephedra is useful as cardiac and circulatory stimulant. Decoction of stems and roots is a remedy for rheumatism and syphilis in Russia. Ephedrine is sympathomimetic, has been used to counteract hypotension associated with anaesthesia, as a mydriatic; in



L-Ephedrine (R = CH_3)
Norephedrine (R = H)



D-Pseudoephedrine

allergic reactions and as a CNS stimulant, for the relief of asthma, rhinitis, whooping cough and hay fever. Ephedrine is also a bronchodilator.

COLCHICUM CORM

Synonyms : Meadow Saffron: Autumn Crocus: Wild Saffron; Meadow Crocus; European Colchicum seed; Colchicum root.

Biological Source : Colchicum seed and corm are obtained from *Colchicum autumnale* Linn. Indian drug is obtained from the species *C. luteum* Baker.

Family : Liliaceae.

Geographical Source : The plant is an annual herb found in England, Poland, Czechoslovakia, Yugoslavia, U.S.A. and Holland. In India *C. luteum* is used as a substituent for *C. autumnale.*

Cultivation and Collection : Fresh seeds are sown which germinate up to about 30%. In August-September 2-6 flowers bloom which are identical to Saffron and has liliac or pale purple colour. More than half the length of the flower is below in ground. Leaves and capsular fruit are produced in the next spring. The fruit is a three lobbed, three-celled and septicidal capsule. On expension of leaves in the spring the fruit comes out the ground. It is collected in July or August before its dehiscence and kept in muslin bags. Numerous seeds are liberated on septicidal dehiscence of the fruit into three valves. The matured seeds are dark in colour and surrounded by a sweet saccharine secretion. Before flowering corms are dug out for medicinal use, their outer membraneous scales are removed, cut in transverse or longitudinal pieces and dried up to 65°C.

Morphology : Seeds are ovoid or globular in shape and 2-3 mm in diameter. The outer surface is dark reddish brown, pitted and very hard. Endosperm is hard and oily. Small embryo is embedded at one end near the surface of the seeds at the opposite side of the hilum. A distinct strophiole is present which extends for about one quarter of the circumference from hilum. The seed is odourless and bitter in taste.

Fresh corm is conical in shape, 4 cm long and 3 cm wide. One side of the corm is convex and the opposite side is flat. At the apex base flowering stem is present. The outer surface is yellow to brown in colour and slightly wrinkled. A cavity having a bud is seen at the base of the flat side.

New stem germinates from this bud. At the base of the corm numerous fibrous roots or their scars are present. Inner surface is fleshy and white and has fibrovascular bundles.

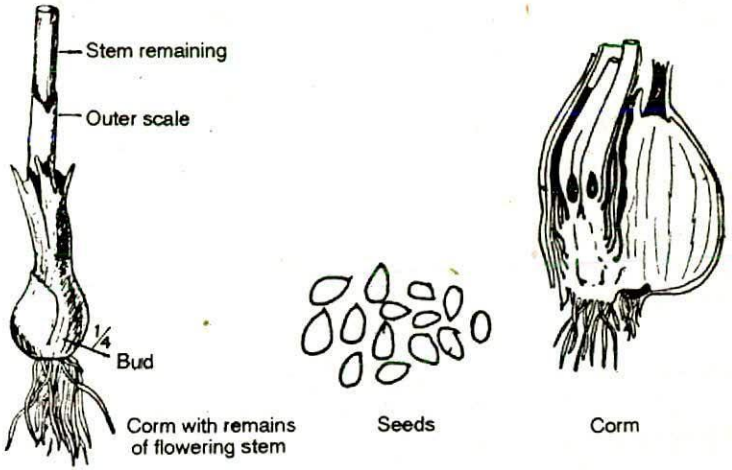
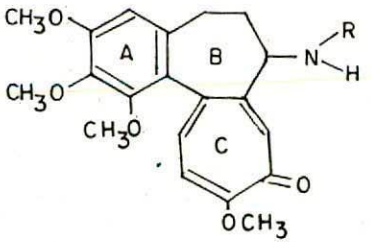


Fig. 13.23. Colchicum



Colchicine (R = $COCH_3$)
Demecolcine (R = CH_3)

Dried corm consists of transverse or longitudinal slices which are 3 cm long and 2-5 mm thick. The shape is reniform to ovate with a groove on the flat side. Colour is dark brown. Fracture is short and strachy. The corm is almost odourless. Taste is bitter and acrid.

Chemical Constituents : Colchicum contains the alkaloids colchicine (0.3 - 0.8%), colchicein, colchicoresin, demecolcine, starch, etc. Colchicine is an amorphous, yellowish white alkaloid, readily soluble in water, alcohol, or chloroform.

Indian Colchicum corms contain abundant starch and alkaloid. On exposure to UV light, colchicine is changed to lumicolchicine.

Chemical Test : Colchicum corm with sulphuric acid (70%) or conc. HCl produces yellow colour due to colchicine.

Uses : Colchicum corm or colchicine is gout depressant and

used to cure gout and rheumatism. Its higher doses cause vomiting and diarrhoea. It is also prescribed to treat myeloid leukaemia. Colchicine is also used to produce polyploidy in biological experiments. Anti-cancer activity of Colchicum has also been reported.

DITERPENE ALKALOIDS

Diterpene alkaloids have been isolated from the drug Aconite.

ACONITE

Synonyms : Monkshood, Wolf's-bane; Friar's cowl; Mouse-bane; Aconite root; Mithazahar (Hindi); Radix aconiti.

Biological Source : Aconite is the dried roots of *Aconitum napellus* Linn. collected from wild or cultivated plants.

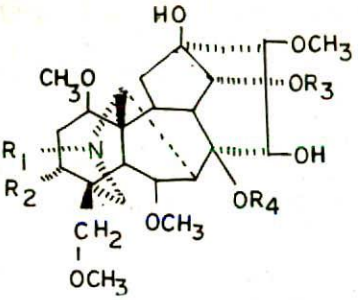
Family : Ranunculaceae.

Geographical Source : The plant has been originated from the mountanoeous and temperate regions of Europe. It occurs in Alps and Carpathian mountains, hills of Germany and Himalayas.

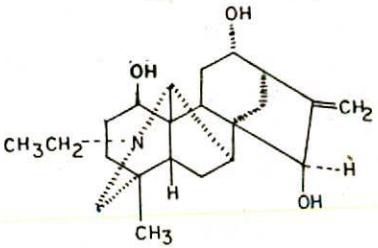
Cultivation and Plant Habitat : Aconite is a perennial herb with a fusiform tuberous root. The plant is propagated from the daughter tubers. In the autumn season the aconite root becomes thick. An apical bud on the apex and six lateral buds on its surface are developed. A lateral shoot bearing a thin lateral root is produced from each lateral bud. The lateral roots are called daughter roots and the main root is known as parent root. The daughter root develops gradually, becomes thick in autumn and buds are produced on its apex and surface.

Daughter roots are planted in soil containing leaf mould and some amount of lime. The roots are collected in autumn. Collection of Aconite from wild plants is done during flowering season. Roots are dried at 40-50°. Thus Aconite arises from one or more lateral shoots which develop into conical daughter tubers.

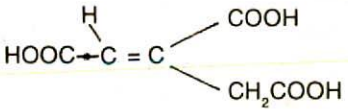
Morphology : Appearance of Aconite varies from season to season. Aconite collected in autum in England is conical in shape and tapering below. Surface is slightly twisted bearing longitudinal ridges. Some Aconites may contain fibrous rootlets or their scars. On the top of parent root some



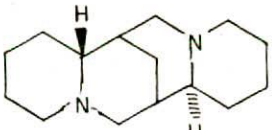
Aconine (R_1 = C_2H_5, R_2 = OH, R_3 = R_4 = H)
Neoline (R_1 = Et, R_2 = H, R_3 = R_4 = H)
Benzoylaconine (R_1 = C_2H_5, R_2 = OH, R_3 = COC_6H_5, R_4 = H)
Aconitine (R_1 = C_2H_5, R_2 = OH, R_3 = CO C_6H_5, R_4 = $COCH_3$)
Hypaconitine (R_1 = Me, R_2 = H, R_3 = PhCO, R_4 = Ac)



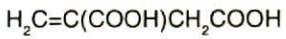
Napelline



Aconitic acid



Sharteine



Itaconic acid

remains of stem base are present which are more shrivelled. An apical bud is present at the apex. The colour is dark-brown. The root is 4-10 cm in length and 1-3 cm in diameter at the crown. Rootlets may be present. The fracture is short and starchy. The fractured surface is 5-8 angled, contains stellate cambium and a central pith. The odour is slight. Taste is sweet at first followed by tingling and numbness.

Chemical Constituents : Aconite contains aconitine (0.4-0.8%), hypaconiticine, mesaconitine, aconine, napelline (isoaconitine, pseudoaconitine), neoline, ephedrine, sparteine, and are mixed with those *A. spicatum* and *A. ferox.*, *A luridum*, an erect plant, is a potent drug as *A. ferox.*, *A.*

picraconitine, acotinic acid, itaconic acid, succinic acid, malonic acid, fat, starch, and levulose (fructose). The aconitines are diacyl esters of polyhydric amino alcohols and are extremely poisonous. Atisines are also amino alcohols but have low toxicity. The basic skeleton of aconite alkaloid is consisted of a pentacyclic diterpene which is derived from phyllocladene. The toxicity of alkaloids is decreased on hydrolysis.

Uses : Aconite is cardiac effective. It is used externally as a local analgesic in liniments and to treat neuralgia, rheumatism and inflammation. Tincture Aconite is antipyretic in small doses. Aconitine in amount 2-3 mg can lead respiratory failure, heart failure and in the end death.

INDIAN ACONITES

About 28 *Aconitum* species have been reported from India, mostly present in the alpine and sub-alpine belt of Himalayas. The roots of nine species are commonly found in the Indian markets.

Aconitum atrox (Syn. *A. balfourcii)* is an erect, glabrous herb. Roots are biennial, paired; or ternate and tuberous with several attached hardened rootlets. It is a poisonous species and is one of the common constituents of *Aconitum ferox* of commerce. The roots resemble those of *A. deinorrhizum* but are somewhat shorter and thicker. They contains 1.20 - 2.04 % of total alkaloids, of which pseudaconitine is 0.4-0.5 per cent.

Aconitum bisma (syn. A. palmatum) is a biennial herb. Roots are tuberous, paired, the mother root is often dry and cylindrical, the daughter root conical to long-cylindrical, external surface somewhat smooth, light brown. The roots contain five diterpene alkaloids, viz. palmatisine, vakognavine, vakatisine, vakatisinine and vakatidine. Benzamide is also present. The root is intensely bitter like quinine and is used in combination with long pepper for pain in the bowels, for diarrhoea, vomiting, rheumatism, sharp cuts, wounds and as a tonic.

Aconitum chasmanthum is an erect, perennial herb. Roots are biennial, paired and tuberous. This species is identical to *A. napellus*. Its roots are smaller, shorter and thicker; the mother tubers are deeply grooved and wrinkled and are black outside and brown inside. The daughter tubers

are conic to conic-cylindrical with a broad base having numerous root fibres. Fracture is cartilaginous, hard and white within the cambium ring and brownish outside. The drug is collected in September. It has the same uses as *A. ferox*. The alkaloid content of the roots ranges from 2.98 to 3.11%. The alkaloids isolated are indaconitine, chasmaconitine, chasmanthinine, chasmanine, and homochasmanine.

Aconitum deinorrhizum is an erect, tall plant with long terete stem. Daughter root is conical, brown externally, mother tubers are more or less similar, but have longer filiform root fibres. *A. atrox* is the principal constituent of the Aconite of commerce. The drug is very hard and horny and its starch is gelatinized during drying. The roots contains 0.9% total alkaloids of which 0.51% is pseudoaconitine.

Aconitum ferox is a perennial herb. Roots are biennial, tuberous, paired, daughter tuber ovoid-oblong to ellipsoid, with filiform root fibres, dark brown, taste indifferent. It is known as Indian Aconite. The total alkaloid content varies from 0.63 to 4.7%. The alkaloids pseudaconitine, chasmaconitine, indaconitine, bikhaconitine, veratroyl pseudaconitine and diacetyl pseudaconitine are present. The roots are used after mitigation to treat neuralgia, muscular rheumatism, inflammatory joint affections, nasal catarrh, tonsillitis, sore throat, gastric disorders, debility and fever.

Aconitum heterophyllum is a tall herb. Root are biennial, tuberous, paired; daughter tuber cylindric or conic. The roots yield 0.79% of total alkaloids like atisine, heteratisine, histidine, heterophyllisine, heterophylline, heterophyllidine, atidine, hetidine, etc. Atisine is much less toxic than aconitine and pseudaconitine. Therefore, this species is often regarded as non-poisonous. It is used as a febrifuge and bitter tonic. The roots are used to treat hysteria and throat diseases.

Aconitum spicatum is a robust and typical species. Roots are biennial, tuberous, paired and brown or blackish. The roots are used as poison. The fresh roots are soft and flexible; dried roots are hard and dark brown. The roots yield 1.75% of alkaloids which contain mainly pseudaconitine and bikhaconitine.

Aconitum falconeri is an erect herb. The biennial, paired roots yield two alkaloids, bishaconite and bishatisine are used to treat disease of nervous and digestive systems, and for rheumatism. *A. laciniatum* biennial roots are slightly bitter

rotundifolium contains two alkaloids in the aerial portion. *A. violaceum* is an erect plant, found mixed with the commercial varieties of Aconites. It contains 1% indaconitine.



Fig. 13.24. *Aconitum napellus.*



Fig. 13.25. Aconite with a daughter root.

QUESTIONS

1. What are alkaloids ? Write short notes on the following alkaloid containing drugs : (a) Physostigma (b) Opium (c) Ephedra (d) Aconite.
2. Give official source, morphology, chemical constituents and uses of a drug belonging to the following families: (a) Solanaceae (b) Rubiaceae (c) Papaveraceae (d) Loganiaceae (e) Clavicipitaceae (f) Apocynaceae.
3. Write notes on : (a) Opium, (b) Rauwolfia (c) Vinca (d) Nux-vomica.
4. What are Solanaceous drugs ? Give sources, constituents and substitutes of drugs containing tropane alkaloids.
5. Give the official sources, salient morphological characters, chemical constituents and uses of the following : (a) Opium (b) Ergot (c) Ephedra (d) Lobelia.
6. Give the biological source, identification test, chemical nature and therapeutic uses of the following phytoconstituents : (a) Scopolamine (b) Glycyrrhetinic acid (c) Reserpine (d) Quinine (e) Conessine.
7. Discuss the general methods of extraction of alkaloids. Write an account of piperidine alkaloids.
8. Give the distribution and biogenesis of tropane alkaloids. Comment upon the various sources for scopolamine and give a suitable scheme for its isolation.
9. Give distinguishing features of the following :
   (a) Hyoscyamine and Atropine
   (b) *Cinchona succirubra* and *Cinchona officinalis.*
   (c) Nicotine and nornicotine
   (d) *Cephaelis ipecac* and *Cephaelis acuminata*
10. Give the distinguishing features of the following : (a) Quinine and quinidine (b) Codeine and thebaine (c) Arecoline and arecaidine (d) Reserpine and rescinnamine (e) Strychnine and brucine (f) Emetine and cephaeline.
11. Give general methods of extraction and isolation of an alkaloid and suggest suitable scheme for the isolation of antitumor alkaloids of Catharanthus.
12. What is Ergot ? Describe various stages of development of this fungus, its chemical constituents and clinical importance.

14

INDIGENOUS TRADITIONAL DRUGS

Medicinal plants have been playing a significant role in the treatment of various ailments in India. The important traditional methods in our country are Ayurvedic, Homoeopathy, Unani and Sidha systems of medicine. Ayurveda offers traditionally a highly scientific health-care therapy as a divine gift, and as a result, the global interest of the medical profession is nucleated on the Ayurvedic and Unani systems of medicine. A traditional ingredient is fundamentally preventive, protective, nutritive and curative. Therefore, traditional medicines are safe, sure and harmless which treat the patients and does not end at rendering relief.

In spite of phenomenal progress in the area of development of new drugs from synthetic sources and appearance of antibiotics as major therapeutic agents, plants continue to provide basic raw material for some of the most important drugs. An analysis of prescriptions dispensed from community pharmacies in USA was carried out in 1973, and this showed that as many as 41% prescriptions contained one or more products of natural origin as the therapeutic agent. Of these prescriptions, 25% were based on drugs from higher plants, some 13% represented metabolities of microbes and about 7% were of animal origin. Among 200 most frequently prescribed drugs in USA, 25% were of natural origin. The situation would appear to be similar for many other countries including India, Russia, Germany, England, Italy, China and Japan. About three hundred herbal

drugs of Indian origin are used in England to treat various diseases. The *Pharmacopoeia of the Peoples Republic of China*, issued in 1978, describes 882 crude drugs of which 637 are of plant origin. *Japanese Pharmacopoeia X* released in 1981, contained 102 plant drugs.

In India there are about 700 naturally occurring drugs used in various formulations. There are about 20 large scale manufacturers of traditional drugs in addition to 1200 small manufacturers and thousands of miniature manufacturing units running by vaids and hakims.

More frequently traditional drugs are used to cure the following ailments :

Cold and Cough : Senega, Ipecac, Squill, Glycyrrhiza and Ginger contain expectorant activity. The leaves of *Angelica archangelica*, *Pimpinella anisum* (Anise fruit), *Allium sativum* (Garlic), *Thymus vulgaris*, *Mentha spicata* (Mint), *Ocimum sanctum* (Tulsi), *Viola odorata* (Banafsha) and *Eucalpytus* sp. are used to treat cough, cold and bronchitis. Dried stigma of *Crocus sativus* (Saffron or Kesar) are used in cough preparations. Most of these drugs contain essential oils which are responsible for the biological activity.

Gastrointestinal Disorders : Gastrointestinal disorders include colitis, constipation, diarrhoea, duodenal ulcers, dyspepsia and hyperacidity. Dried extract of *Acacia catechu* and *Geum urbanum*, leaf and bark of *Hamamelis virginiana* and root bark of *Myrica cerifera* are used to treat the inflammation of colon (colitis). Constipation is treated by seed husk of Plantago, leaves of Senna, bark of Cascara, Aloe juice, Rhubarb and Honey. Stomachic drugs include Chirata, Garlic, Kalmegh, Kapur kachari, Saffron, Nux-vomica and Picrorhiza. Agar, Aloe, Cascara, Guar gum, Isapgol, Myrobalan, Rhubarb and Senna. Carminative drugs contain volatile oils and they are Asafoetida, Black pepper, Capsicum, Caraway, Cardamom, Cinnamon, Coriander, Dill, Fennel, Garlic and Mentha oil. The herbal drugs like Ipecac, Isapgol, Kurchi and Sankhpusphi are anti-dysenteric drugs which generally contain mucilage or alkaloids. Diarrhoea is treated with Bael, Isapgol, Kurchi, Pale Catechu and Pectins.

Urinary Disorders

Saxifraga liqulata and *Tribulus terrestris* (Gokhru) are used to break and disintegrate urinary stones. Guargum,

Gurmarbuti and Vijayasar are employed as anti-diabetic drugs. Cholagogue disorder is treated with *Eclipta alba* (Bhringraja), *Phyllanthus fracternus* (Jar-amla), Kalmegh and Picrorhiza. The crude drugs like Gokhru, Arjuna and Punarnava are used to cure diuretic ailments.

Liver Diseases

There are about 33 formulations containing traditional drugs for the treatment of liver ailments. Some of them are Liv 52, Stimulive, Liomyn, Livergen, Livotrit and these formulations are prepared from Kalmegh, Picrorhiza, Bhringraja, Sarponkha *(Tephrosia purpurea)*, *Boerhaavia diffusa* (Punarnava), *Trianthema portulacastrum* and Chirata.

Antiarthritic Agents

Rasna *(Alpinia officinarum, Pluchea lanceolata, Vanda roxburghii,* and *Vitex negundo)* is used as a traditional remedy to cure rheumatism and arthritis. The resin obtained from *Commiphora mukul* (Gugul) and the exudate of *Boswellia serrata* (Sallai gugul) are also employed as antiarthritic agents. *Aconitum napellus* also contains anti-rheumatic activity.

Sedative and Tranquillizers

The sedative traditional drugs include Aswagandha, Belladonna, Brahmi, Datura, Cannabis, Hyoscyamus, Jatamansi, Myrrh, Rauwolfia, Valerian, Vaj and Wild Cherry bark. Most of these drugs are the source of alkaloids. Celery, Chamomile and Valerian exhibit mild sedative effects. Indian Valerian is superior than European one due to higher concentration of active constituents. Valepotriates are more tranquillizers and sedatives than meprobamate. Jatamansi contains safe sedative and spasmolytic agent.

Cardiac Drugs

Cardiovascular diseases are the major cause of mortality all over the world. The most popular drug is digoxin isolated from Digitalis. The cardiotonic glycoside, peruvoside, obtained from an Indian ornamental plant Kaner, *Thevetia peruviana*, (Fam. Apocynaceae) has been introduced in German under the trade name 'Encordin'. Forskolin (Coleonol) is another antihypertensive compound isolated

from a fragrant herb *Coleus forskohlii* (fam. Labiatae). Asclepin, obtained from *Asclepias curassavica*, is more potent than digoxin. The popular Ayurvedic drug 'Sarpgandha' *(Rauwolfia serpentina)* shows hypotensive and tranquillizing effect. Strophanthus and Urginea are also used as cardiotonic.

Other Disorders

Cannabis and Opium are used as analgesics and narcotics. Anthelmintic drugs include Artemisia, Chenopodium oil, Kapur kachari, Vidang, Male Fern. Ephedra, Lobelia, and Sankhpushpi.

Vasaka and Tylophora are anti-asthmatic drugs. Turmeric, Punarnava, Aswagandha, Kapur kachari and Colchicum are used as anti-inflammatory drugs. Malaria is treated with Cinchona bark and Artemisia. Balsam Tolu, Benzoin, Camphor, Clove, Neem (*Azadirachta indica*), Eucalyptus, Myrrh, Neem, Mint, Tulsi, Turmeric and Pine oil are used as antiseptic drugs. Antitumor agents are Podophyllum and Vinca. Asafoetida, Belladonna, Caraway, Datura, Fennel, Hyoscyamus, Kapur kachri, Kesor, Aswagandha and Mentha oil show antispasmodic property and some of them possess aphrodisiac action. Amla, Arjuna, Ashoka, Bahera, Black Catechu, Myrobalan and Tannic acid exhibit astringent action. Chirata, Gentian, Kalmegh, Picrorhiza, Orange peel and Quassia are used as bitter tonics. Acacia, Honey, Isapgol, Aswagandha, Linseed, Sesame oil, Starch and Tragacanth have demulcent property while emollient action is exhibited by the drugs such as Arachis oil, Kokum butter, Lanolin, Linseed oil and Sesame. Ergot and Vasaka are reputed as oxytocic drugs. Coffee beans, Cocaine, Coriander, Dill, Ginger, Nux-vomica, Pipal, Rasna and Storax show stimulant action.

KAPUR KACHARI

Synonyms : Spiked ginger lily; Karpur (sans.), Sitruti (Hindi).

Biological Source : Kapur kachari consists of the dried slices of roots and rhizomes of *Hedychium spicatum* Hem ex Smith.

Family : Zingiberaceae.

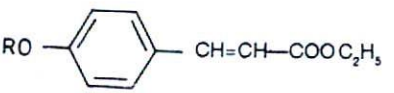
Habitat : The plant is found in subtropical Himalayas, Nepal and Kumaon at an altitude 1,700-2,000 m.

The plant is a one meter high perennial rhizomatous herb cultivated as an ornamental plant. It bears white ascending flowers growing in terminal spikes.

Characters : The drug occurs as reddish brown flat or spherical slices. The outer surface is rough, rootlets are attached here and there. Odour is intense aromatic and taste is bitter and camphor-like.

Chemical Constituents : The drug contains essential oil (4%), furanoid diterpene, 7-hydroxyhedychinone, organic acids, resinic acids and starch (50%). The principal constituent of the volatile oil is ethyl p-methoxycinnamate (68%); the others being limonene, β-phellandrene, p-cymene, linalool, β-terpineol, β-caryophyllene, ethyl cinnamate (10%), d-sabinene (4%), 1,4-cineole (6%), sesquiterpenes (5.5), and sesquiterpene alcohol (4.7%).

Uses : The drug is used as stomachic, carminative, tonic, stimulant, emmenagogue, expectorant, in liver complaints, vomiting, diarrhoea, inflammation and pains. It is also used as insect-repellent, flavouring agent in tobacco and cosmetic industry, for preserving clothes and in dyspepsia in the form of powder or decoction.



Ethyl p-methoxycinnamate (R=CH_3)
Ethyl cinnamate (R = H)

PIPAL

Biological Source : Pipal consists of stem bark of *Ficus religiosa* Linn. (Family Urticaceae/Moraceae).

Habitat : Pipal is found in sub-Himalayan forests, Bengal, Central India, Sri Lanka and Burma as wild or cultivated plant.

The plant is a large evergreen deciduous tree up to 35 m in height. The leaves are typically cordate, tapering towards the apex forming a linear lanceolate tail. The fruits are small berries with purple colour on ripening.

Characters : The bark is greyish, occurring as irregular pieces, 2-2.5 cm thick. Young bark is smooth, the old bark is covered with greyish patches of lichens. It is odourless and taste is astringent.

Chemical Constituents : Pipal contains tannins (4%) and other phenolic constituents.

Uses : The bark is astringent and used in gonorrhoea.

PUNARNAVA

Synonyms : Hog weed; Sant; Beshakapori (Hindi).

Biological Source : Punarnava consists of the herb *Boerhaavia diffusa* Linn.

Family : Nyctaginaceae.

Habitat : The plant is a weed found throughout India during rainy season.

Description : Stem is greenish-purple, stiff, slender, cylindrical, thickened at nodes, minutely pubescent or glabrous, prostrate or ascending, divertically branched. Leaves are opposite in unequal pairs; petiolate, ovate-oblong or suborbicular, apex is rounded or slightly pointed; base is subcordate or rounded. Lamina is green and glabrous above and whitish below, margin is entire or subundulate, turned up and pinkish in certain cases. Flowers are very small. Fruit is one-seeded nut, 6 mm long, clavate, 5-ribbed, viscidly glandular.

Chemical Constituents : The active constituent is a mixture of alkaloids 'punarnavine'. Xanthine derivatives, ursolic acid, β-sitosterol, fatty acids such as stearic acid and arachidic acid, have been isolated from the drug. The plant also contains inorganic salts such as potassium nitrate, potassium sulphate and chlorides.

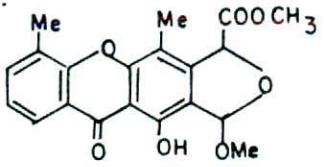
The roots contain alkaloids (0.05%), triacontanol, hentriacontane, β-sitosterol, ursolic acid, 5, 7-dihydroxy-3,4-dimethoxy-6, 8-dimethyl flavone, glucose, fructose, sucrose, ecdysone and hypoxanthine-9-arabinoside.

Recently, a purine nucleoside, identified as hypoxanthine-9-L-arabinofuranoside, a dihydroisofuranoxanthone (borhavine), C-methyl flanone, 6'-O- ester of sitosteryl D-glucose, and rotenoid analgues like boeravinones A, B, C, D, E and F have been isolated from punarnava.

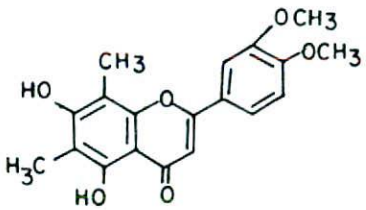
Uses : Punarnava is diuretic, useful in nephrotic syndrome, chronic oedema and liver diseases.

The plant is used as a maintenance drug, in abdominal tumors and cancer. It also possesses anti-inflammatory,

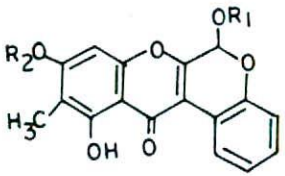
antibacterial and cardiotonic properties. The roots are credited with anti-convulsant, analgesic, laxative, diuretic and expectorant properties.



Borhavine



C-Methyiflavone



Boeravinone A : $R_1=CH_3$, $R_2=H$

Boeravinone B : $R_1=R_2=H$

Adulterant : Punarnava is substituted with *Trianthema portulacastrum* (Family-Ficoidaceae), a prostrate weed, with branches up to 2 m long found in South India, Gujarat, Rajasthan and U.P. Leaves are oblong, elliptic, the opposite pair somewhat unequal, flowers are dense, axillary. *T. portulacastrum* cantains an alkaloid trianthemine and ecdysterone. The leaves are diuretic, used in oedema and dropsy and in cases of ascites especially due to liver, peritoneal and kidney conditions.

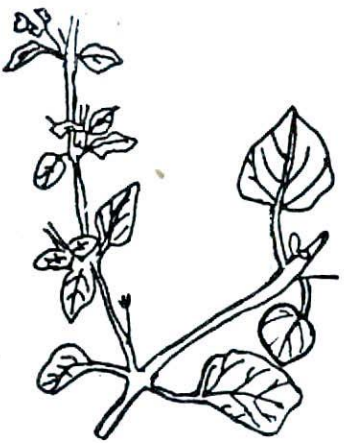


Fig. 14.1. Punarnava *(Boerrhaavia diffusa).*

SHANKHPUSHPI

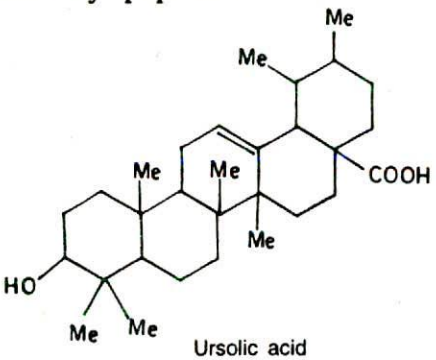
Biological Source : Shankhpushpi consists of the whole aerial parts of *Convolvulus pluricaulis* Choisy (syn. *Convolvulus microphyllus* Sieb) and *Evolvulus alsinoides* Linn.

Family : Convolvulaceae.

Habitat : Both the plants grow widely in plains of India.

Convolvulus pluricaulis : Plant is a procumbent shrub. Stem is woody at the base, 10-30 cm long, leaves are 2.5-3 cm long linear, oblong, villous on both sides, tapering at base, flowers are small, funnel shaped, light pink or white

coloured; fruits are small, up to 2.5 mm long, glabrous, scarcely papillose.



Ursolic acid

$CH_3(CH_2)_{18}COOH$

Arachidic acid.

Chemical Constituents : The drug contains an alkaloid known as 'shankhpushpine', volatile oil, n-triacontane, higher fatty alcohols, kaempferol, its 3-D-glucoside, 2, 3-dihydroxycinnamic acid, β-sitostoerol, carbohydrates such as glucose, rhamnose, sucrose, starch and potassium chloride.

Uses : The drug is used as a brain tonic, in hypertension and as tranquillizer.

Evolvulus alsinoides : It is a perennial herb with prostrate branching developing from a small woody rootstock. Stems are numerous, about 30 cm long, prostrate, spreading, slender, wiry with hairs. Leaves are simple sessile, alternate, lanceolate to suborbicular. Flowers are light blue, solitary, peduncles very long, filiform, and axillary. Fruit is a four angled capsule.

Chemical Constituents : The herb contains betain [$(CH_3)\ CH_2COOH$] and evolvine in addition to proteins, amino acids, and phenolic compounds.

Uses : The plant is used as tonic, febrifuge, vermifuge and in dysentery. Cigarettes containing leaves are smoked in chronic bronchitis and asthma. Oil of the plant is used for promoting growth of hair.

VASAKA

Synonyms : Adhatoda, Vasaka folium, Adulasa (Hindi).

Biological Source : Vasaka consists of the fresh or dried leaves of *Adhatoda vasaka* Nees.

Family : Acanthaceae.

Habitat : The plant is found throughout the plains of India in the sub-Himalayan tracts up to 13,00 m, Sri Lanka, Burma and Malaya.

It is an evergreen, gregarious, stiff, perennial shrub growing on waste lands. It can be raised from seeds or cuttings.

Characters : Leaves are entire when fresh and crumpled or broken when dried. Shape is lanceolate to ovate-lanceolate, margin is slightly crenate to entire; apex is acuminate, base-tapering; petiole 2-8 cm long. The leaves are 10-30 cm long and 3-10 cm broad, venation is pinnate, midrib and 8-10 pairs of lateral veins, surface is glabrous or slightly pubescent, green when fresh, on drying the colour changes from brown to grey. Odour is characteristic and taste is bitter.

Chemical Constituents : Vasaka leaves contains alkaloids (0.25%) which include vasicine, vasicinone, 6-hydroxyvascine, 1-peganine (1-vasicine), betaine and vasakin as well as volatile oil, fat, resin, sugar, mucilage, adhatodic acid, triacontane, β-sitosterol and vitamin C. The oil is golden yellow which contains limonene.



Fig. 14.2. Shankhpushpi : *Convolvulus pluricaulis*

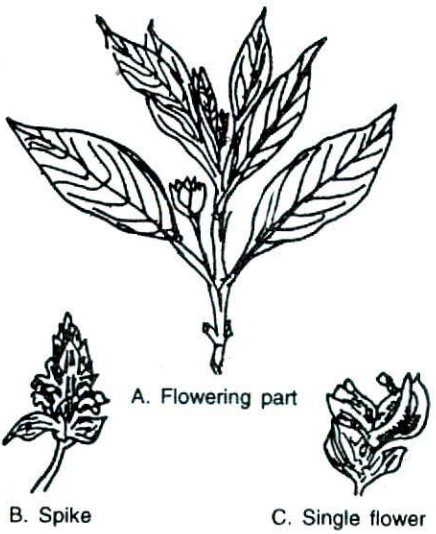
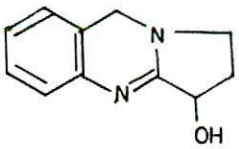


Fig. 14.3 Vasaka

Uses : Vasaka is used to treat cold, cough, whooping-cough, chronic bronchitis and asthma, as sedative, expectorant, antispasmodic and as anthelmintic. The drug is employed

in different forms, such as fresh juice, decoction, infusion and powder; also given as alcoholic extract and liquid extract or syrup. The dried leaf is smoked as a cigarette. It is also given along with other expectorants, and forms a part of several proprietary compounds. The cough is relieved and the sputum is liquefied and is easily expelled. The leaf-juice cures diarrhoea, dysentery and glandular tumor, and is given as emmenagogue. The powder is used as poultice on rheumatic joints, as counter-irritant on inflammatory swellings, on fresh wounds, urticaria and in neuralgia.

The flowers and fruits are bitter and aromatic and their uses are similar to those of the leaves. The flowers are also given to improve the circulation of blood and in ophthalmia. They contain vasicine, vasicinine, β-sitosterol, an essential oil, colouring compounds luteolin, quercetin and kaempferol, α-amyrin, tritriacontane, etc.



1-Vasicine (1-Peganine)



Vasicinone

PIPER LONGUM

Synonyms : Piplamul, Pippali.

Biological Source : The drug consists of transversely cut pieces of roots or underground stems or of fruits of *Piper longum* Linn.

Family : Piperaceae.

Habitat : The plant is native of Phillipine and found in hotter states of India, Sri Lanka and Malaya.

The plant is a slender aromatic climber with perennial woody roots.

P. longum is cultivated on a larger scale in limestone soil by layering of mature branches or by suckers planted at the beginning of the rainy season. The vines are well manured with cow dung cake and start bearing 3 or 4 years after planting. The spices are harvested in January, while still green and unripe, as they are most pungent at this stage. They are dried in the sun when they turn grey. The roots and thicker parts of stem are cut and dried.

Description : Drug occurs 0.5 to 2.5 cm long and

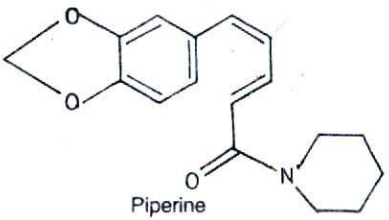
2-7 mm in diameter; shape is cylindrical, sraight or slightly curved and some with distinct swollen internodes, showing a number of leaf rootlets and scars. Colour is light brown, odour is characteristic, taste is bitter and pungent producing numbness on the tongue.

Fruits are also used as drug. They are small, ovoid, yellowish-orange, sunk in fleshy spikes which is 2.5 - 3.8 cm, ovoid long, erect, blunt, blackish-green; odour is aromatic and taste is pungent.

Chemical Constituents : Both roots and fruits have alkaloids like piperine, piperlonguminine, piplartine and piperlongumine. Fruits also contain volatile oil, resin, a waxy alkaloid N-isobutyl 2, 4-decadienamide, and sesamine.

The other constituents of the drug are triacontane, dihydrostigmasterol, reducing sugars and glycosides.

Uses : Both Piplamul and fruits are used for diseases of respiratory tract like cough, bronchitis, asthma, cold, etc; as counter-irritant and analgesic when applied locally for muscular pain and inflammation; internally as carminative, sedative, and general tonic.



Piperine



Piperlongumine



Piperlonguminine



Sesamine

$CH_3(CH_2)_4$ CH=CH-CH=CH-CO-$NHCH_2$ CH $(CH_3)_2$

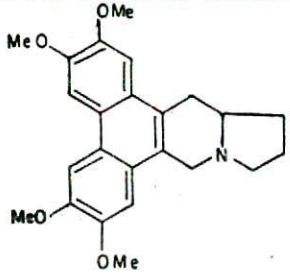
N-Isobutyl 2, 4-decadieamide

TYLOPHORA

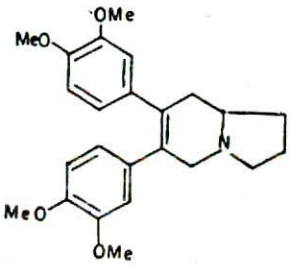
Synonym : Anantmul.

Biological Source : The drug consists of dried leaves of *Tylophora Indica* (Burm f.) Merr (syn. *T. asthmatica* W. & A.) (Family Asclepiadaceae).

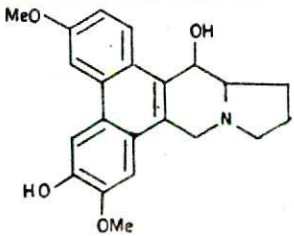
Habitat : The plant is a perennial branching climber with long fleshy roots. It grows widely in planes and hilly places of India up to altitude of 1,000 m in Bengal, Assam, Cachar, Orissa, Konkan, Kanara and Southern India.



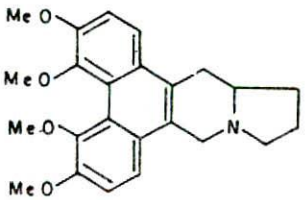
Tylophorine



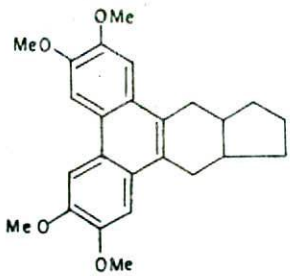
Septicine



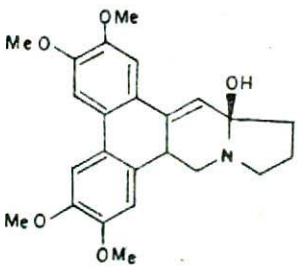
Tylophorinidine



Tyloindicine A



Tyloindane



Tyloindicine G

Characters : Leaves are 5-10 cm. long, 2.5-5.7 cm wide, ovate or elliptic-oblong, acute or acuminate, often apiculate, glabrous, pubescent beneath, base usually cordate, petioles

6-13 mm long. The whole plant is of a pale yellow brown colour and has no marked odour but has a sweetish and subsequent acrid taste.

Chemical Constituents : The active constituents of *Tylophora indica* are phenanthroindolizidine alkaloids like tylophorine, tylophorinine, tylophorinidine and septicine. Recently some rare alkaloids, namely tyloindicines A, B, C, D, E, F, G, H, I and J have been isolated from *T. indica* aerial parts by the author. Apart from alkaloids the plant also contains cetyl alcohol, phytosterol, wax, resin, coutchone, pigments, tannin, glucose, calcium salts, potassium chloride, α-amyrin, quercetin, kaempferol and tyloindane. Steam distillation of an alcoholic extract of the air-dried root powder gave p-methoxysalicylaldehyde and a small amount of oil matter.

Uses : The dried leaves are emetic, diaphoretic and expectorant, useful in over-loaded states of the stomach, in dysentery, catarrh and as emetic. The roots possess stimulant, emetic, cathartic, expectorant, stomachic and diaphoretic properties and are used in the treatment of asthma, bronchitis, whooping cough, dysentery and diarrhoea. They are recommended in rheumatic and gouty pains. They possess bacteriostatic properties and are good natural preservative for foods.

SHATAVAR

Synonym : Shatavari.

Biological Source : The drug is derived from dried tuberous roots of *Asparagus racemosus* Willd. It has been found that the commercial 'Shatawar' may not be the root of *A. racemosus*.

Family : Liliaceae.

Habitat : The plant is a climber found all over India, especially in northern region.



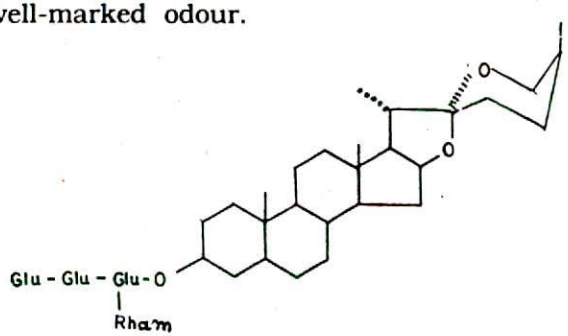
Fig. 14.4. Shatavar, *Asparagus racemosus*.

It is an extensively scandent, much-branched, spinous under-shrub, with tuberous, short rootstock bearing numerous fusiform, succulant tuberous roots. Stem is woody, whitish grey or brown armed with strong, straight or recurved spines.

The plants can be grown successfully in black cotton soil mixed with river sand. They can be propagated from adventitious roots which are dipped in liquid cow dung for 24 hours before planting. The sprouted saplings are transferred to beds. They require hoeing and weeding during the rainy season.

Morphology : The roots of *A. racemosus* are borne in a compact bunch and are fleshy, and spindle shaped. They are silvery white or light ash-coloured externally and white internally, smooth when fresh.

Macroscopy : The roots are peeled, dried, cylinclrical, fleshy tuberous, straight or slightly curved, tapering towards the base and swollen in the middle; white to buff in colour, length 5-10 cm; diameter 1-2 cm; fracture is irregular; longitudinal furrows and minute transverse wrinkles on upper surface. Drug is hard, swells in water; taste is bitter; lack a well-marked odour.



Shatavarin I

Chemical Constituents : The active constituents are steroidal saponins, viz. shatavarin I - IV (0.1 - 0.2%). The aglycone unit is sarsapogenin. In shatavarin I three glucose and rhamnose molecules are attached whereas shatavarin IV possesses two glucose and one rhamnose molecules.

Uses : Roots are refrigerant, demulcent, aphrodisiac, antiseptic, alterative, antidysenteric and galactagogue. Shatavarin I has antioxytocic property. In Ayurveda Shatavar is used to cure threatened abortion and safe delivery.

GOKHRU

Biological Source : In Ayurveda two types of Gokhru are used. The smaller or Chhota Gokhru is the dried ripe seeds of *Tribulus terrestris* Linn. (Family : Zygophyllaceae). The large or Bara Gokhru consists of dried ripe fruits of *Pedalium murex* Linn. (Fam. Pedaliaceae).

***Tribulus terrestris* (Chhota Gokhru) :** The plant is an annual, prostrate herb with yellow flowers growing throughout India up to 3600 m in Kashmir.

Morphology : The fruits are yellowish globose, diameter nearly 1.2 cm containing five woody, densely hairy, spiny cocci. Each coccus possesses two large sharp, pointed spines directed towards the apex. The other two smaller shorter spines are directed downwards. Each coccus contain several seeds.

Chemical Constituents : The fruits of *T. terrestris* contain saponins which produce diosgenin, ruscogenin and gitogenin on hydrolysis. The fruits also contain flavone glycosides, viz. kaempferol 3-rhamnoside and kaempferol 6"-p-coumaroyl 3-D-glucoside; traces of alkaloid, fixed oil, potassium nitrate, essential oil and resin.

Uses : The fruit has cooling, diuretic, tonic, aphrodisiac properties and used in painful micturition, calculus affections, urinary discharges and impotency. In the form of infusion it is useful as a diuretic in gout, kidney diseases and gravel.

Pedalium murex (Bara Gokhru)

Pedalium murex is an annual succulent herb found near seacoasts of Kathiawar, Gujarat, Konkan, Southern Peninsula, Sri Lanka and Africa. It is also found in Rajasthan, Punjab and Delhi in autumn session.

The plant is annual, diffuse, succulent herb. The fruits are four-sided, about 2 cm long, pyramid-ovoidal shape and tapering at the base and apex. Each fruit has four spines and it tapers into a hollow cylindrical tube at the base.

The fruits conain mucilage, fatty oil, resin, and an alkaloid.

The fruits have demulcent, diuretic, antiseptic, aphrodisiac and tonic properties and given for incontinence

of urine, spermatorrhoea, nocturnal emission, dysuria, gonorrhoea and impotency.

BRAHMI

Synonyms : Indian pennywort; Mandooki.

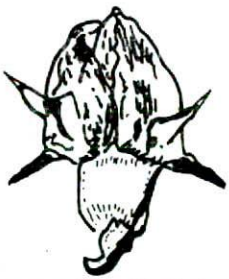
Biological Source : Brahmi is the fresh or dried herb of *Centella asiatica* (L.) Urban (syn. *Hydrocotyle asiatica* Linn.) (Family Umbelliferae).

Habitat : The plant is found throughout India in marshy places up to 2,000 m; in Pakistan, Sri Lanka and Madagascar.

Morphology : It is herbaceous creeping herb with long prostrate reddish stem possessing long internodes and rooting at the nodes. Leaves are reniform or orbicular arising from each node of the stem, cupped, entire, crenate, glabrous on both sides; petioles are 7.5 - 15 cm long, channelled, glabrous, stipules short, sheathing base. Flowers are pink, sessile, umbel consisting of 3-4 flowers.



A. Small Gokhru *(Tribulus terrestris)*



B. Large Gokhru *(Pedalium murex)*

Fig. 14.5. Gokhru

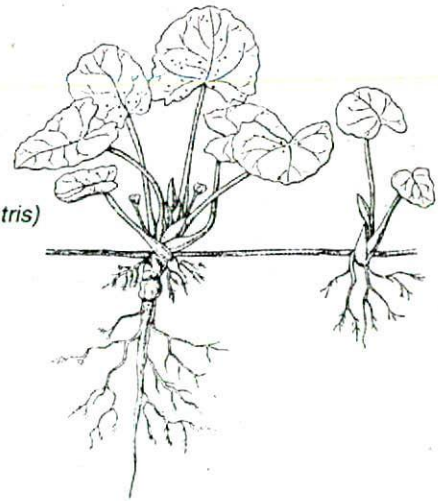
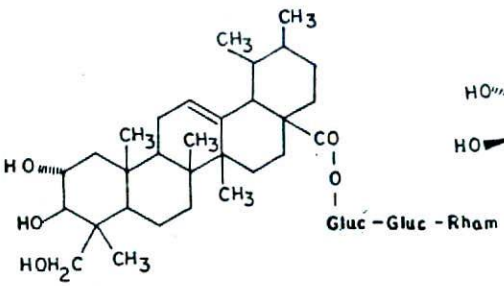


Fig. 14.6. *Centella asiatica* (Brahmi)

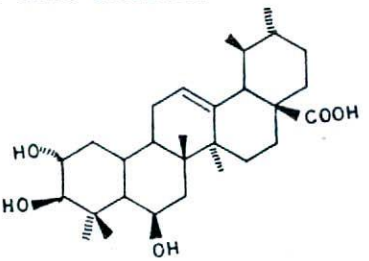
Chemical Constituents : The drug contains triterpenoid saponin glycosides called asiaticoside, oxyasiaticoside, brahmoside, brahminoside and thankuniside. Sugar moieties are attached at carboxylic group. Hydrolysis of asiaticoside affords two molecules of glucose, one rhamnose and the

aglycone asiatic acid. In addition to these the drug contains alkaloids, sterols (β-sitosterol, stigmasterol), tannins, amino acids (aspartic acid, glycine, glutamic acid, α-alanine and phenylalanine), and inorganic salts (chloride, sulphate, phosphate, iron, calcium, magnesium, sodium and potassium). Triterpenes reported in free state are brahmic acid, isobrahmic acid, betullic acid, indocentoic acid and asiatic acid. Mesoinositol and centellose have also been reported. Hydrolysis of thankuniside yields tritrerpenic acid, thankunic acid. A new triterpenic acid, medasiatic acid, isolated from Brahmi, has been identified as 2α, 3β, 6β - trihydroxyurs-12-enoic acid.

Uses : The plant has been used in diseases of skin, nerves and blood. Leaves are taken as tonic and for improving memory and useful in syphilitic skin diseases.



Asiaticoside



Medasistic acid

Allied drug : Herb of *Bacopa monnieri* (L.) Pennell (syn. *Herpestis monniera* (L.) H.B. & K. or *Moniera cuneifolia* Michx) is also used as Brahmi. (Fam. Scrophulariaceae). The plant is found in wet, marshy and damp places throughout India and, therefore, known as Jalbrahmi or Nirbrahmi. It is a succulent, creeping herb with 10-20 cm long stem rooting at nodes. It produces numerous branches and sessile, decussate leaves, 0.6-2.5 cm long, obovate, and oblong.

The drug contains alkaloids brahmine and herpestine, D-mannitol and saponins, bacosides A and B. The saponins on hydrolysis yield the same triterpenoid aglycone bacogenin A and sugars arabinose and glucose.

The plant is used as nervine tonic, diuretic and aperient and to treat asthma, epilepsy, insanity and hoarseness.

ARJUNA BARK

Synonyms : Arjuna (Sans.); Arjun (H).

Biological Source : Arjuna bark is the dried bark of *Terminalia arjuna* W. & A.

Family : Combretaceae.

Habitat : The plant is found throughout India.



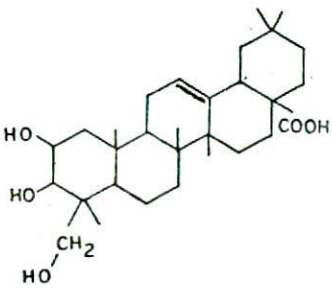
Fig. 14.7. *Terminalia arjuna* branch



Fig. 14.8 Arjuna bark

Arjuna is a large deciduous evergreen tree, 20-30 meters in height. Bark is collected and dried. It occurs in flat pieces of various sizes, 3-15 cm long, 1-10 cm wide, 3 mm - 1 cm thick; outer surface is smooth and grey-coloured; inner surface is striated and brown; fracture is short and fibrous; odourless, taste is astringent.

Chemical Constituents : Arjuna bark contains tannins (12%), β-sitosterol, triterpenoid saponins, arjunine, arjunetin, arjunolic acid, essential oil, reducing sugars, calcium salts and traces of aluminium and magnesium salts.



Arjunolic acid

Uses : Arjuna bark is used as tonic, astringent, in heart diseases as a cardiac tonic, bilious afffections, diuretic, for sores and

as an antidote to poisons.. It has styptic, tonic, febrifugal and anti-dysenteric properties. The bark gives relief in hypertension.

CHIRATA

Synonyms : Chiretta; Chirayita; Bitter stick; East Indian Balmony.

Biological Source : Chirata is the entire dried plant of *Swertia chirata* Linn. collected during formation of capsules. It should contain about 1.3 per cent bitter principles.

Family : Gentianaceae.

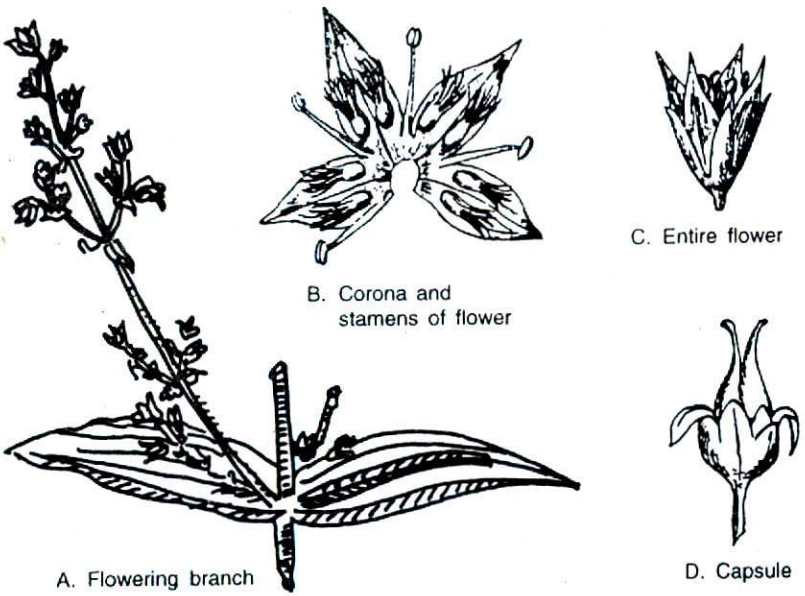


Fig. 14.9. *Chirata*

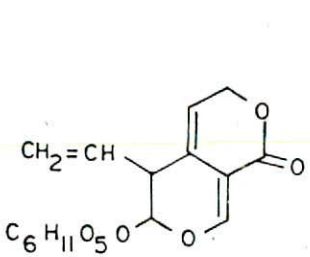
The plant spread quickly from seed which is shed during October-November. The herb can be cultivated in suitable localities in the temperate Himalayas. The seeds, which are very small; should be sown in a nursery and the seedlings transplanted later in the field. Flowering occurs from July to October and the plants are collected when the capsules are fully formed. The stem forms the major portion of the drug which are 1 m long, brown or purplish brown, contains a large, continuous and easily separable pith. The drug is odourless, but it has an extremely bitter taste. The whole

plant is medicinal but the root is the most powerful part. The root is generally small, 5-10 cm long, light brown, somewhat twisted and gradually tapering.

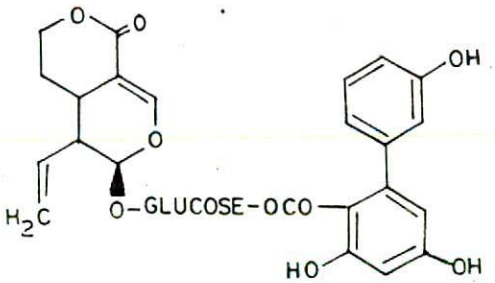
Habitat : The plant is found in temperate Himalayan region, 1300-3300 m, from Kashmir to Bhutan and Khasia Hills.

Characters : Chirata is a small, hairy, erect, annual herb. The stem is round, purple at the base and angular and yellowish brown at the upper side. The upper part is much branched. Leaves thin, opposite, unequal, sessile, decussatte, ovale oblong with 5-7 veins. Flowers are purple, solitary, calyx and corolla are of the same size. The fruits are ovate capsules. The drug is odourless and taste is very bitter.

Chemical Constituents : Chirata contains a bitter glycoside gentiopicrin; amarogentin, chiratin, ophelic acid and a xanthone, swerchirin.



Gentiopicrin



Amarogentin

Uses : Chirata is used as bitter tonic, ferbrifuge, stomachic and laxative. In excess dose it may cause nausea and oppresses the stomach.

The most important adulterant of Chirata is *Swertia angustifolia* which is distinguished by its inferior bitter tonic properties. The roots of *Rubia cordifolia* are also used as adulterant and distinguished by their purple colour. Green Chiratta *(Andrographis paniculata)* is also used as an adulterant.

PICRORHIZA

Synonyms : Kathi; Kuru (Hindi); Katvee.

Biological Source : It consists of dried rhizome of *Picrorhiza kurroa* Royle ex Benth., cut into small pieces and freed from attached rootlets.

Family : Scrophulariaceae.

Habitat : The plant is common on the alpine Himalayas, from Kashmir to Sikkim, 3,000 to 5,000 meters.

Characters : It is low, hairy herb with a perennial woody bitter rhizome, 15-25 cm long, covered with dry leaf-bases. It occurs as pieces, 2-4 cm long and 0.3-1.0 cm in diameter. Scales at distant intervals are present; frequently small protuberances, which probably represent accessary buds, are observed both at the rhizomes and the stolones.

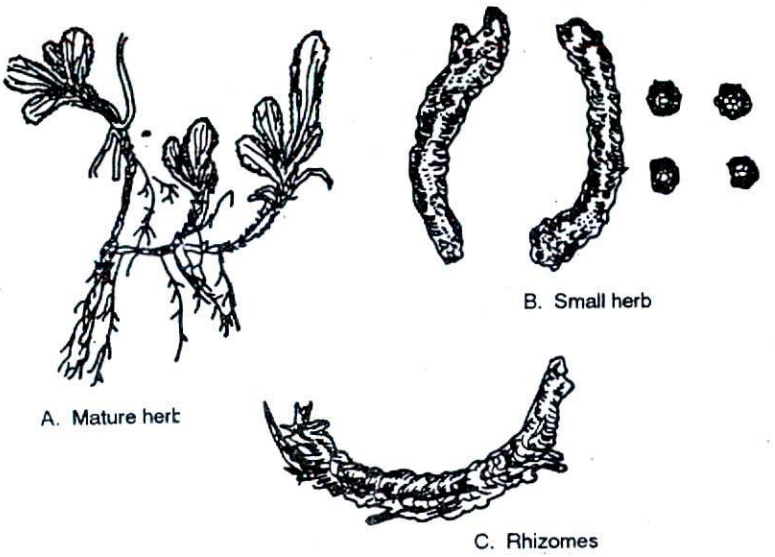
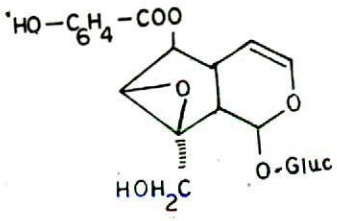


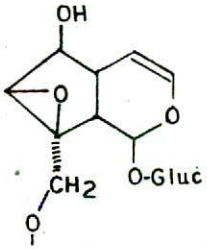
Fig. 14.10. *Picrorhiza kurroa*

The drug consists of small pieces. Colour is greyish-brown, light, cylindrical, straight or slightly curved, often with remains of aerial stem which is very dark brown and wrinkled longitudinally, upper and lower surfaces bear a few small root scars, numerous scale leaves and thin scars; odour-slightly unpleasant, taste-very bitter.

Chemical Constituents : The active constituents of Picrorhiza is picrorhizin, a glucoside which yields picrorhizetin and dextrose on hydrolysis. It also contains kutkin, a glucosidal bitter principle, picroside-I, picroside-II, picroside-III, D-mannitol, vanillic acid, kurrin, kutkiol, kutki-sterol, apocynin, phenolic glycosides picein and androsin, and seven cucurbitacin glycoside.

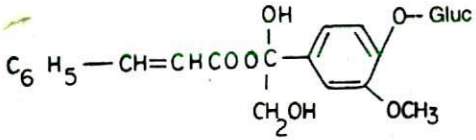


Picroside I

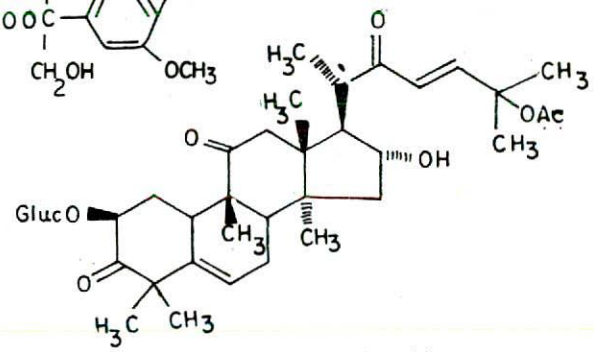


Vaniloyl

Kutoside



Kutkin



Cucurbitacin β-2-glucoside

Uses : Picrorhiza is bitter, cathartic, stomachic, used in fever and dyspepsia and in purgative preparations. It is reputed as an anti-periodic and cholagogue, as febrifuge including as antimalarial. Different types of jaundice are cured with Picrorhiza. It removes kidney stone, used as emmenagogue, emetic, abortifacient, antidote for dog-bite; externally it is used in skin diseases and improves eye-sight. It is a valuable bitter tonic almost as efficacious as Gentian. It is laxative in small doses and cathartic in large doses.

It is used as an adulterant or substituted for Indian Gentian *(Gentiana kurreo).*

KALMEGH

Synonyms : Andrographis, King of bitters, Chiretta; Bengal Chirata; Green Chirata; Kiryet (Hindi).

Biological Source : Kalmegh consists of leaves or entire aerial part of *Andrographis paniculata* Nees.

Family : Acanthaceae.

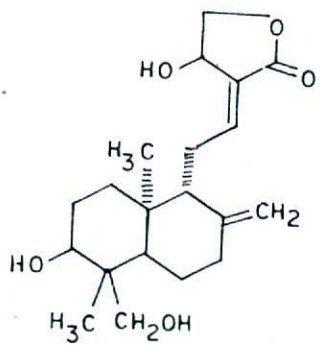
Distribution : The plant occurs thoughout the plains of India and sometimes cultivated. It is an annual herb, 1-3 ft in height.

The plant is gregarious and grows abundantly in moist, shady waste grounds. It prefers a sunny situation.The seeds are sown during May-June. The seedlings are transplanted at a distance of 60 cm × 30 cm. Two or three irrigations may be given during the dry period. It flowers during August-November, and the whole plant starts maturing during February-March when it is harvested for the drug. The whole plant is dried in shade and sold.

Morphology : The stem is erect, greenish brown, woody, 1-3 ft in height, and quadrangular particularly in the upper regions with four bulges arising on the four corners. The leaves are dark green, lanceolate, with a small winged petiole, 7 cm long, 2-5 cm broad, margin is entire, lamina is glabrous, apex is acuminate, slightly waxy and base tapering. The midrib varies in outline at different regions of the leaf. Stem branching is profuse which bears small and solitary flowers. The dried drug is odourless and taste is extremely bitter.

Chemical Constituents : The plant possesses kalmeghin, a bitter crystalline diterpene lactone, viz. andrographolide flavonoids and phenols.

The lactones isolated from Kalmegh are andrographolide, 14-deoxy-11-oxo-andrographolide, 14-deoxy-11, 12-didehydroandro-grapholide, 14-deoxyandrographolide and a non-bitter constituent, and neoandrographolide. From the leaves of Bangladesh plant homoandrographolide, andrographosterol, andrographane, andrographone, a wax and two esters have been isolated.



Andrographolide

The roots also contain a monohydroxytrimethylflavone, andrographin, a dihydroxy-dimethoxyflavone, a 5-hydroxy tetramethoxyflavone and panicolin.

Uses : Kalmegh has febrifuge, tonic, alterative, anthelmintic, astringent, anodyne, alexipharmic and cholagogue properties. It is useful in debility, cholera, diabetes, swelling, itches,

consumption, influenza, piles, gonorrhea, bronchitis, dysentery, dyspepsia, fever and in weakness. A decoction of the plant is a blood purifier. It is used as a cure for torphid and jaundice. It forms the major constituent of the Ayurvedic drug *SG-I Switradilepa* which is effective in treating vitiligo - a dermatological disease. The pills prepared from macerated leaves and certain spices (e.g. Cardamom, Clove and Cinnamon) are given for stomach ailments of infants. A tincture of root is tonic, stimulant and aperient.

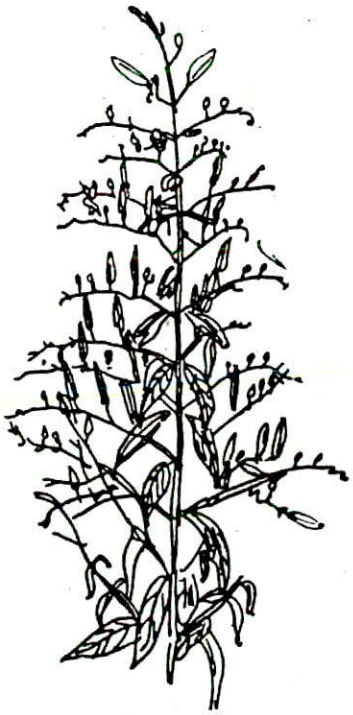


Fig. 14.11. Kalmegh :*Andrographis paniculata*



Fig. 14.12 Psoralea corylifolia twig (Bvbchi)

Sometimes, the drug is mixed with the genuine Chirata *(Swertia chirata)* but can be distinguished from the latter by the green colour of its stem, numerous erect, slender, opposite branches and its lanceolate, green leaves.

BAVCHI

Synonyms : Psoralea; Bavachi fruits; Bavachi seeds; Malaya tea.

Biological Source : The drug consists of the dried fruits and seeds of *Psoralea corylifolia* Linn.

Family : Leguminosae.

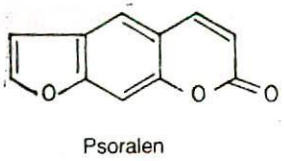
Natural Distribution : The plant grows widely throughout India.

Morphology : The plant is an annual herb attending a height of 60 cm to 1 m. Prominent groove of glands and white hairs are present on the stem and branches. Bluish purple flowers bloom from August to November. Fruits are minute, ovate, oblong, glabrous, rounded or mucronate and pitted; about 4 mm long, 2-3 mm broad; dark chocolate or black in colour, with pericarp attached to seeds; odourless, taste is bitter, acrid and unpleasant. Seeds are kidney shaped, 2-4 mm long, 2-3 mm broad, smooth exalbuminous with straw coloured hard testa.

Chemical Constituents : Bavchi contains fixed oil (10%), essential oil (0.2), resin and the furanocoumarins like psoralen, isopsoralen, psoralidin, isopsoralidin and corylifolean. The seeds contain flavonoids such as bavachalcone, bavachinin, isobavachalcone, bavachin and isobavachin; monoterpenoid phenol named bakuchiol. Other compounds isolated from the seeds are 4-O-methylbavachalcone, 7-O-methylbavachin, neobavaisoflavone, bavachromene, triacontane, β-sitosterol-D-glucoside and corylidine. The seed oil yielded limonene, α-elemene, β-caryophyllene oxide, 4-terpineol, linalool, geranyl acetate, angelicin, psoralen and bakuchiol.

Fruits of Psoralea also contain isoflavones corylin, corylinal, neobavaisoflavone, psoralenol and chalcones like 5-formyl-2, 4-dihydroxy-4'-methoxychalcone and bavachromanol.

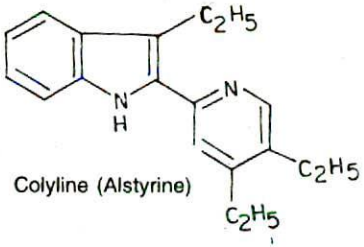
Uses : Bavchi is used to cure leucoderma and other skin diseases. Seeds are used as stomachic, deobstruent, anthelmintic, diuretic, diaphoretic, febrile conditions, billious affections, in leprosy, psoriasis and inflammatory diseases of the skin and leucoderma. The drug in taken orally as well as locally applied in the form of paste or ointment. Psoralen and isopsoralen possess the curative action of Psoralea in leucoderma.



Psoralen



Psoralidin



Colyline (Alstyrine)

ASHOKA BARK

Synonyms : Ashoka (Hindi); Asoka (Bengali).

Biological Source : Ashoka is the dried bark of stem of *Saraca indica* Linn.

Family : Leguminosae.

Habitat : Ashoka tree is found in central and eastern Himalayas, eastern Bengal, western Peninsula, Burma, Sri Lanka and Malaya.

Morphology : Ashoka bark is available in channeled pieces, 40 cm long, 4-6 mm wide and 5-8 thick. External surface is yellowish to grey, smooth with circular lenticels, transversly ridged or cracked. Inner surface is reddish-brown, smooth and longitudinally straight. Fracture is short and fibrous; odourless; taste is astringent and bitter.

Chemical Constituents : Ashoka bark contains tannins (6%), catechol, sterol, haemotoxyline, phlobaphenes, organic calcium compound and a ketosterol.

Uses : Ashoka bark is astringent, used in uterine affections, biliousness, dyspepsia, dysentery, colic, piles, ulcers, pimples and in menorrhagia (excessive mensturation) and leucorrhoea.

Adulterant : The bark of *Polyalthia longifolia* (Fam. Anonaceae), known as Asopalava bark, is used in place of Ashoka bark.

AMLA

Synonyms : Embelic myrobalan; Embelica, Indian goose berry.

Biological Source : Amla consists of the fresh or dried fruits of *Emblica officinalis* Gaertn. (syn. *Phyllanthus emblica* Linn).

Family : Euphorbiaceae.

Habitat : The plant is a middle-sized tree commonly found in the mixed deciduous forests of India, Sri Lanka, China and Malaya ascending to 1,500 m on the hills. It is often cultivated in gardens and homeyards.

Amla is usually propagated by seeds or by budding, cutting and inarching. The plant is sensitive to frost and drought. The tree coppices well and the coppice shoots grow vigorously. Flowers usually appear in the hot season and fruits ripen during the following winter.

Morphology : The fruit is drupe, fleshy globose, 1.5-2.5 cm in diameter, smooth, shiny with light coloured specks. It is distinctly marked in six lobes. The fruit is green when tender but the colour changes to light yellow or brick red on maturity. A minute depression is present at one end which is left due to removal of peduncle. The taste is sour and astringent giving feeling of sweetness afterwards.

Chemical Constituents : The principal chemical constituent of Amla is vitamin C (650 - 900 mg/100 g). The fruit juice contains about 20 times more vitamin C than orange juice. It also contains tannins (5%), glucose, pectin, and minerals like iron, phosphorus and calcium. Tannins are the mixture of gallic acid, ellagic acid and phyllembin. The presence of the tannins prevents the oxidation of the vitamin.

Uses : Fruit has acrid, cooling, refrigerant, diuretic and laxative properties. Dried fruit is useful in haemorrhage, diarrhoea, diabetes and dysentery. In combination with iron it is used to treat anaemia, jaundice and dyspepsia. Fermented liquor prepared from the fruit is used in jaundice, dyspepsia and cough. It has antibacterial, antifungal and antiviral activities. Amla is an ingredient of the Ayurvedic formulation 'Triphala' and 'Chyavanprash'. Triphala is a laxative and used to treat headache, biliousness, dyspepsia, constipation, piles, enlarged liver and ascites. Acute bacillary dysentery is cured by drinking a sherbet of Amla with lemon juice. The exudation from incisions on the fruit is used as an external application for inflammation of the eye. The fruits are also used in the preparation of writing inks and hair dyes. The dried fruit is detergent and is used as shampoo

for the head. A fixed oil extracted from the fruit is reported to promote hair growth.

BAHERA

Synonyms : Beleric Myrobalan; Bahira (Sanskrit).

Biological Source : Bahera is the dried ripe fruit of *Terminalia belerica* Roxb.

Family : Combretaceae.

Habitat : The plant is found throughout the forests of India, Burma and Sri Lanka below elevations of about 1000 m except in dry and acrid regions of Sind and Rajasthan.

Bahera is a large handsome, deciduous tree, with characteristic bark, 20-35 m high and 2-3 m in girth.

The good seed crop, high germinative capacity of the healthy seeds and their quick and easy germination are favourable for the natural regeneration. The plant can be raised in fields by direct sowing. The tree is not subjected to fungal attack of any consequence.

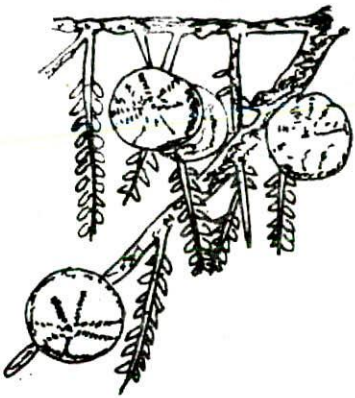


Fig. 14.13. Amla fruits

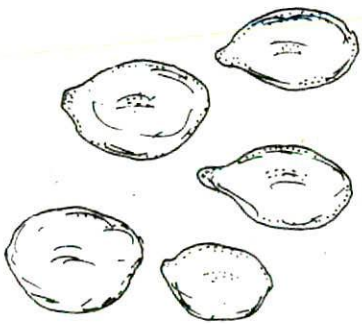
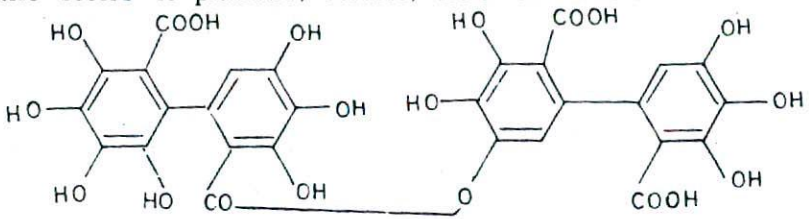


Fig. 14.14. Bahera fruits

Morphology : Fruits are globular drupe, 1.3-2.5 cm in diameter, obscurely 5-angled, ovoid, suddenly narrowing into a short stalk. Outer surface in velvety, irregularly wrinkled containing five well defined longitudinal ridges. The upper end is depressed and a prominent, sound scar of pedicel is present at one end of the fruit. Fruit is very hard and broken surface is yellow in colour. The fruit is odourless and taste is astringent.

Chemical Constituents : Bahera contains tannins (20-25%), phyllemblin, β-sitosterol, mannitol, glucose, fructose, rhamnose, fixed oil (30-40%) and hydrocarbons such as tetratriacontane, ditriacontane-2-ol, tritriacontan-9-one and n-tritriacontane. Tannin component is the mixture of gallic acid, ellagic acid, ethyl gallate, galloyl glucose and chebulaginic acid. A hexahydroxy-diphenic acid ester has been reported by the author which on hydrolysis yielded two moles of hexahydroxydiphenic acid. The fixed oil contains the esters of palmitic, stearic, oleic and linoleic acids.



Hexahydroxydiphenic acid ester

Uses : The fruit has bitter, astringent, tonic, laxative, antipyretic activity and is used in piles, dropsy, dysentery, diarrhoea, leprosy, biliousness, dyspepsia and headache. It is one of the ingredient of Ayurvedic purgative medicament 'Triphala'.

MYROBALAN

Synonyms : Harar (Hindi), Haritaki (Bengali and Sanskrit), Hirdo (Gujarati); Hirda (Marathi).

Biological Source : Myrobalan consists of dried mature fruits, known as Harde, or small fruits, known as Himaj, of the tree *Terminalia chebula* Retz.

Family : Combretaceae.

Habitat : The plant is found abundantly in north India from Kangra and Kumaon to Bengal and southern region in Madhya Pradesh, Maharastra, Gujarat and Travancore as well as in higher forests of the Bombay Ghats, Satpuras, Belgaum and Kanara.

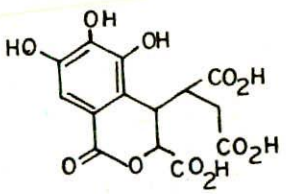
The fruits ripen from November to March, depending upon the locality, and fall soon after ripening. They are dried and the seeds stored for one year. The germination capacity of the seeds is low due to the presence of hard cover and the seeds require pre-treatment.

Characters : The fruit is a drupe, ellipsoidal, ovoid; yellow to orange brown in colour; 2 - 3.5 cm long, 1.3 - 2.5 cm wide, longitudinally wrinkled; carpel, 5-6 ribbed longitudinally; hard and strong; seeds are light yellow, 1.5 - 2.5 cm long and rough. Odour is slight and taste is astringent and bitter.

Chemical Constituents : Myrobalan contains hydrolysable tannins (30-40%), purgative compounds like anthraquinones, fixed oil containing esters of palmitic, oleic and linoleic acids, astringent compound chebulinic acid; ellagic acid, gallic acid and resin.

The tannins in Myrobalan belong to the pyrogallol type. They are very complex. The hydrolysable tannins, chebulagic acid, chebulinic acid, and corilagin are the major tannin constituents. On hydrolysis they form chebulic acid, 3, 6-digalloylglucose, ellagic acid, gallic acid, and β-glucogallin. The carbohydrates present in Myrobalan are : glucose, sorbitol, fructose, sucrose and gentiobiose. Eighteen typical amino acids are also present in addition to phosphoric, succinic, quinic, shikimic, dihydroshikimic and dehydroshikimic acids. During maturation of the fruits, the amount of tannin decreases whereas the acidity increases.

Uses : Myrobalan is astringent, laxative, and alterative; used externally as a local application to chronic ulcers and wounds and as a gargle in stomatitis. Finely powdered drug is used as a dentifrice and considered useful in carious teeth, bleeding and ulcerations of the gums. Myrobalan in combination with Amla *(Emblica officinalis)* and Bahera *(T. belerica)* forms the well known Ayurvedic preparation 'Triphala', which is used as laxative and stomach disorders.



Chebulic acid



Fig. 14.15. Myrobalan fruit

JATAMANSI

Synonyms : Indian Spike Nard; Nard.

Biological Source : Jatamansi consists of the dried rhizome of *Nardostachys jatamansi* DC.

Family : Valerianaceae.

Geographical Source : The plant is found in the alpine Himalayas, 4,000 - 5,000 meters, extending eastwards and Kumaon to Sikkim and Bhutan.

Characters : Jatamansi is a perennial herb containing a cylindrical rhizome covered with brown to deep greyish fibres, length is 2.5 - 7 cm, diameter 0.5 - 3 cm. Fibres are produced by an accumulation of skeletons of the leaf bases. Removal of the leaf bases, aerial parts and adventitious roots show the presence of rough surface with transverse rings. The rings indicate the scars of nodes, leaf bases and the adventitious roots. Internal colour is reddish brown. Fracture is easy and splintery. Adventitious roots are thin, branched and red to brown in colour. Odour is slight and aromatic and taste is acrid, slightly bitter and aromatic.

Chemical Constituents : Volatile oil of Jatamansi possesses an alcohol and its isovaleric ester, a saturated bicyclic sesquiterpene ketone, named jatamansone, and jatamansic acid.

Uses : Jatamansi has aromatic, bitter, tonic, stimulant, spasmolytic, and antiseptic properties. It is employed for the treatment of epilepsy, hysteria, convulsive affections, in intestinal colic, palpitation of heart, high blood pressure, cardiac arrhythmias and substituted for Valerian.

Adulterant : It is adulterated with rhizome of *Selinum vaginatum* (Umbelliferae), which contains a volatile oil.



Fig. 14.16. Jatamansi

BANAFSHA

Biological Source : Banafsha consists of dried flowers or

aerial parts with or without flowers of *Viola odorata* Linn.

Family : Violaceae.

Geographical Distribution : The plant is a herb, 30 cm in height found in Kashmir up to 1,700 - 2,000 meters height. It is planted in many hill stations.

It arises from a rootstock. The plant is very variable, and several single and double-flowered types are grown for ornament. It can easily be cultivated in the hilly areas of North India; in the plains, the plants do not flower freely and are grown only in winter. The plant grows well in a cool and moist climate, but exposure to heavy rain is fatal to blooming. Propagation is by division, cuttings or seeds. The plants are repotted once or twice a year. The old plants are removed once in 4-5 years.

The drug, Banafshah, is available in commerce in three forms : (1) the dried aerial parts of the herb, viz. the stems, leaves and flowers *(Kashmiri Banafshah)*, (ii) only the dried flowers *(Gul-i-Banafshah)* and (iii) the aerial parts without flowers *(Berg-Banafshah)*.

Morphology : Herb is glabrous or pubescent; leaves tufted, broadly ovate-cordate, crenate, stalked, stipulses persistent. Flowers irregular, 2-sexual, noding, on axillary stalk, usually solitary, deep violet with a white base, sweet scented. Capsules ovoid, opening horizontally by 3 boat-shaped valves, often purple.

Chemical Constituents : Flowers contain a volatile oil, rutin, cyanin, glycoside of methyl salicylate and an emetic principle, called violin, which is acrid and bitter. The main components of the essential oil are α- and β-irones and α- and β-ionones. The ketones are responsible for the typical odour of the flower. Leaves possess a delightful volatile oil, an alkaloid, colouring matter, friedelin, β-sitosterol and a straight chain alcohol.

The presence of methyl salicylate, alkaloid violine, a glycoside violaquercitrin and a saponin has been reported in the roots.

The stem-violatile oil (4-12%) consists of 2, 6-nonadien-1-al as the major component (30-50%), 2, 6-nonadien-1-ol, n-hexanol, n-hexenol, n-heptenol, n-octenol, eugenol, benzyl alcohol, acids like propionic, enanthic (heptanoic), palmitic, salicylic, octanoic and octenoic acids.

Adulteration : Banafsha is adulterated with other *Viola* species, viz. *V. biflora, V. canescens, V. cinerea, V. pilosa* and *V. sylvestris.*

Uses : Banafsha is valued as an expectorant, diaphoretic, febrifuge, antipyretic and diuretic and as a laxative in bilious affections. The flowers are credited with emollient and demulcent properties and are used to treat coughs, sore throat, hoarseness, and ailments of infants. Petals are made into a syrup and used as a remedy for infantile disorders. The herb is used in homoeopathy to treat diseases of skin and eyes and for relief from pain in the ear. In folk medicine, it is used as a blood-purifier.

TULSI

Biological Source : Tulsi is the dried leaves of *Ocimum sanctum* Linn.

Family : Labiatae.

Geographical Distribution : The plant is cultivated throughout India especially in Hindu houses and temples for worship.

Macroscopy : Tulsi is an annual herb, 30-60 cm high, with much branched stems. The branches are generally purplish, sub-quadrangular and covered with soft hairs.



Fig. 14.17. Banafsha : *Viola odorata*

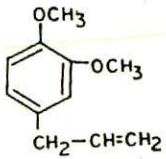


Fig. 14.18. Tulsi : *Ocimum sanctum*

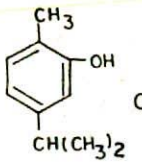
Leaves are simple, elliptical, oblong obtuse or acute, 2-5 cm long 1.5-3.2 cm wide, margin entire or serrate, base obtuse or acute; petiole slender, 1.3-2.5 cm long, hairy surface, pubscent on both sides. Flowers are verticillate, in racemes, 15-20 cm long in close whorls. Odour and taste are aromatic and sharp.

Chemical Constituents : Leaves contain 0.7% of volatile oil. The prominent constituents of the essential oil are eugenol (71%), methyleugenol (20%), carvacrol (3%), and caryophyllene (1.7%). The oil of species grown in Phillipines contains methyl chavicol, cineole and linalool.

Uses : Leaves have expectorant, diaphoretic, antiperiodic, anticatarrhal, antiseptic and spasmolytic properties and are used in catarrh, bronchitis, cold, cough, fever and gastric disorders. The leaves have been employed as aromatic, carminative, stimulant and flavouring agent. Infusion of leaves is used as stomachic in gastric disorders of children and in hepatic affections. Dried powdered leaves are taken as snuff in ozena. Seeds are demulcent and given in disorders of the genito-urinary system. The plant is also used in snake-bite and scorpion-sting.



Methyl eugenol



Carvacrol

NEEM

Synonyms : Nim; Nimba (Sans.); Limba (Marathi, Gujarati); Vepa (Telgu).

Botanical Source : Neem is the fresh or dry leaves and seed oil of *Azadirachta indica* J. Juss. (syn. *Melia indica* Bran. or *M. azadirachta* Linn).

Family : Meliaceae.

Habitat : Neem tree is habitated in south-east Asia, India, Andamans, Pakistan, Sri Lanka, Burma, Malaya, Indonesia, Japan, tropical regions of Australia and Africa.

Characters : Neem is a large glabrous tree, 10-20 m high with a straight trunk and long spreading branches. Leaves are imparipinnate, alternate, existipulate, 3-6 cm long on long slender petioles; leaflets 7-17; alternate or opposite, very

shortly stalked, 1-1.5 cm long, ovate-lanceolate, attenuate at the apex, unequal at the base, the upper half much longer than the lower and the leaflet in consequence more or less falcate, coarsely and bluntly serrate, smooth and dark green. Odour is typical and taste is bitter.

The fruit is an ovoid, bluntly pointed, smooth drupe, green when young and unripe, yellow to brown when mature and ripe, with a very scanty pulp and a hard bony endocarp. The seed is solitary with a thick testa and embryo with foliaceous cotyledons in the axis of scanty endosperm.

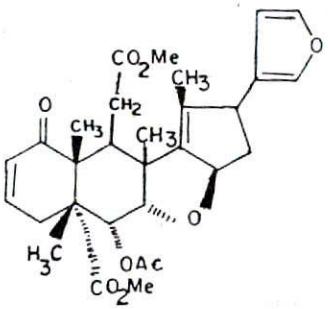
The seeds contain fixed acrid bitter oil (23-31%); deep greenish-yellow to brown in colour, extracted from the seeds by pressure; sp. gr. 0.91; soluble in ether, chloroform; practically insoluble in alcohol and water, odour of garlic, bitter taste.

Chemical Constituents : The leaves contain nimbin, nimbinene, 6-desacetylnimbinene, nimbandiol, nimbolide, quercetin, β-sitosterol, ascorbic acid, n-hexacosanol, nonacosane and amino acids.

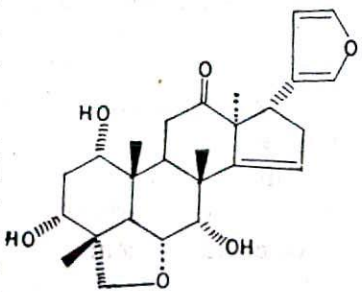
The fruits contain gedunin, 7-deacetoxy-7α-hydroxygedunin, azadiradione, azadirone, 17β-hydroxyazadiradione, 17-epiazadiradione and nimbiol.

The seeds contain six tetranortriterpenoids, viz 1-methoxy-1, 2-dihydroepoxyazadirone, 1, 2-diepoxyazadiradione, 7-acetylneotrichilenone, 7-desacetyl-7-benzoylazadiradione, 7-desacetyl-7-benzoylepoxyazadiradione and 7-desacetyl-7-benzoylgedunin. They also contain azadirachtin.

Kernels yield a greenish yellow to brown, acrid, bitter fixed oil (23.5%) having a strong, disagreeable odour resembling garlic. The fatty acid composition of the oil is as : myristic (0.2%), palmitic (16.2), stearic (14.6), arachidic



Nimbin



Nimbidinin

(3.4), oleic (56.6) and linoleic (9%). The component glycerides are : palmitodistearin, oleopalmitostearin, oleodistearin, palmito-oleolinolein, palmitodiolein, stearo-oleolinolein, stearodiolein and linoleodiolein. The oil also contains 2% bitter principles which include nimbidin, nimbidinin, nimbin, nimbinin and nimbidol.

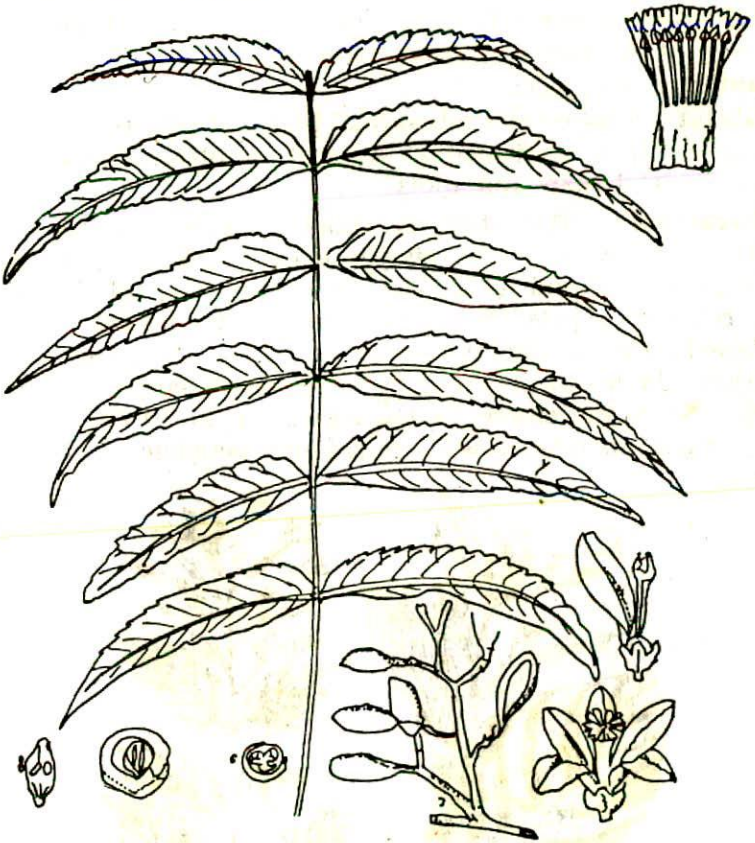


Fig. 14.19. Neem : *Azadirachta indica.*

Uses : Neem oil is stimulant, antiseptic, alterative and used in rheumatism and skin diseases. Leaves as poultice are applied to boils. Neem oil is also used in the manufacture of oleic and stearic acids. Leaf juice is given in worms, jaundice and in skin diseases. Paste of the leaves is used externally in cases of small-pox.

The tender leaves along with *Piper nigrum* are used in intestinal helminthiasis. The paste of leaves is useful in ulceration of cow-pox. Fresh, mature leaves along with the

seeds of *Psoralea corylifolia* and *Cicer arietinum* are used to prepare an effective medicine for leueoderma. The leaves are used as insect-repellent, anti-viral and antifungal.

TOBACCO

Synonyms : Leaf Tobacco: Tamaku (Hindi).

Biological Source : Tobacco consists of the cured and dried leaves of *Nicotiana tabacum* Linn.

Family : Solanaceae.

Habitat : Tobacco is a tall annual herb indigenous to tropical America. It is cultivated in tropical countries especially in Brazil, Sri Lanka and India.

Characters : The stem is simple, giving rise to large, pubescent, ovate, entire, simple, decurrent leaves; the veins are prominent and hairy. The flowers are long tubular, pink or reddish, sepals (5), united, persistent, funnel or cup-shaped, lobes valvate or twisted, occur in terminal spreading cymes. The leaves are hung in barns, slowly cured and dried. They are ovate, elliptic or lanceolate, up to 10 cm or more in length, usually sessile, sometimes petiolate.

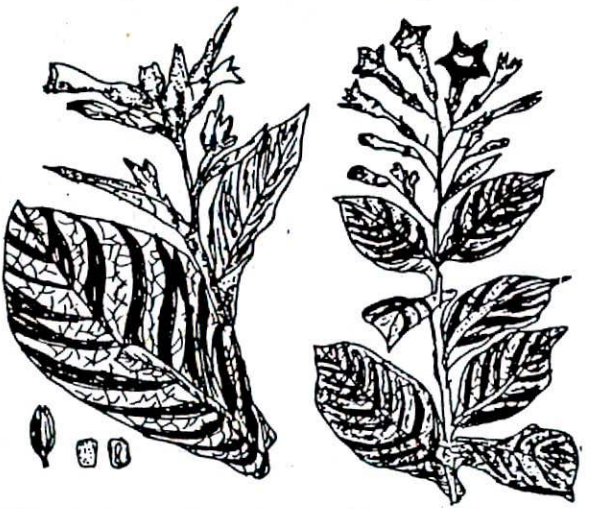


Fig. 12.20. *Nicotiana tabacum* flowering branches.

Cultivation : Tobacco, introduced into India by Portuguese in 17th century, is propagated by seeds raised in nursery beds. Transplanting to the fields is done by hand on a rainy day or after irrigating the field. Tobacco is sensitive to the physical and chemical properties of the soil. The best soil is open, well drained and aerated. It requires 100-120 frost-

free days with an average temperature of 27° to mature. Nitrogen is required for the development of leaves. Phosphate appliication improves the size of leaf and promotes uniform ripening. Plants are topped when they are 90-100 cm high or 5-6 weeks old. Tobacco is cured in the sun.

Chemical Composition : Tobacco contains several pyridine alkaloids (4-6%) of which nicotine (0.6-9%) is the most important. The other basic components are nicotyrine, nicotimine, l-nornicotine, d-nornicotine, piperidine, pyrrolidine, anabasine, anatabine, etc. Tobacco contains 25-50% carbohydrates, mainly sucrose, starch, pectins, cellulose, and lignin. Dextrin, maltose, stachyose, raffinose, rhamnose, ribose, inositol and sorbitol have been identified. Tobacco contains a high percentage of organic acids (~20%), mainly malic, citric acid and oxalic acids. Other acids identified are maleic, fumaric, lactic, malonic, terephthalic, succinic, acetic, methylvaleric, glyceric, crotonic, propionic, methyl ethyl acetic, benzoic and 2-furoic acids. Palmitic, oleic, linoleic and linolenic acids are also reported. Polyphenolic compounds like rutin, chlorogenic acid, quinic acid, shikimic acid, quercitrin, iso-quercitrin and its 7-glucoside, scopolin, aesculetin and its 7-glucoside, and kaempferol glycosides are present. The phenolic compounds reported are caffeic acid, melilotic acid, phenol, guaiacol, eugenol, iso-eugenol, p-allylcatechol, m-cresol and o-hydroxyacetophenone. Nearly sixty phenolic compounds have been distinguished in the extract of flue cured leaf. In addition to these, Tobacco contains resins, paraffins, amino acids, enzymes mineral contents, vitamins, sterols and some other compounds.

Uses : Tobacco is sedative, narcotic, emetic, antiseptic, used in rheumatic swelling, skin diseases and for insect poisoning. It is widely used for smoking and as agricultural insecticide. Tobacco snuff is useful in nasal polypi, nasal catarrh, headache, chronic giddiness and fainting. Its excessive use produces dispepsia, chronic inflammation of bronchial mucous membrane, nervous depression, diseases of liver, sleeplessness, general anaemia, loss of vision or blindness, weakness, cancer, throat troubles, mental fatigue and cardiac diseases.

GUGGAL

Synonyms : Indian bdellium, Salai-gogil.

Biological Source : Guggal is a gum-resin obtained by incision of the bark of *Commiphora mukul* (H. & S.) Engl. (syn. *Balsamodendron mukul* Hook. ex Stocks).

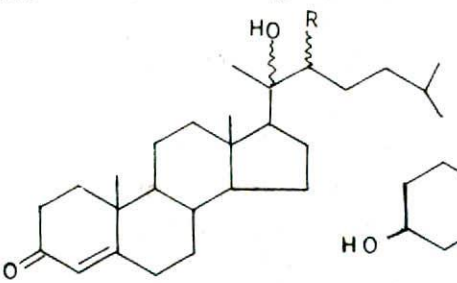
Family : Burseraceae.

Geographical Source : The tree grows in Sind, Rajasthan, Bengal, South India, Maysore and Baluchistan.

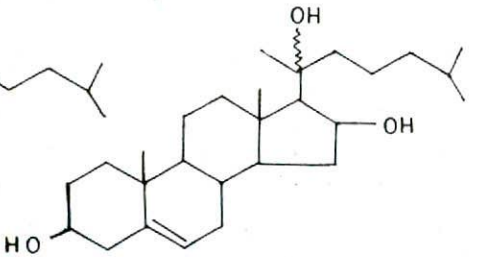
Collection : Guggal tree is small, 1.2-1.8 m high, branches slightly ascending. It is sometimes planted in hedges. The ash coloured bark comes off in rough flakes exposing the underbark. Each plant yields about one kilogram of the product which is collected in cold season.

Characters : Guggal occurs as yellowish viscid, brown tears; or in fragment pieces, mixed with hairy stem, pieces of bark; colour brownish dark to golden yellow. It hardens very slowly. With water it forms a milky emulsion with terebinthinate odour, but fainter. Taste is bitter aromatic.

Chemical Constituents : Oleo-gum resin of guggal contains gum (32%) and essential oil (1.45%). The drug also contains sterols (guggulsterols I, II and III, guggulsterone), sugars (sucrose, fructose), amino acids, camphorene, cembrene, allylcembrol, and flavonoids (viz. quercetrin and its glycosides) and ellagic acid.

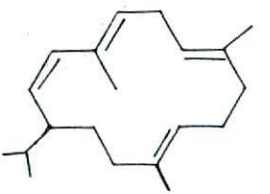


Guggulsterol I (R = OH)
Guggulsterol III (R = H)



Guggulsterol II

Uses : The gum resin in astringent, antirheumatic, antiseptic, expectorant, aphrodisiac, enriches the blood, demulcent, aperient, and emmenagogue. It is used in the form of a lotion for indolent, as a gargle in teeth diseases, chronic tonsilitis and ulcerated throat; as a stomachic, intestinal disinfectant in chronic



Guggulsterol II

catarrh of the diarrhoea. It is believed to stimulate the appetite, improves the general condition, reduces fever and secretion from diseased surfaces. It is a valuable aphrodisiac and has marked antisuppurative properties. Like all oleoresin it causes an increase of leucocytes in the blood and stimulates phagocytosis. It acts as a diaphoretic, expectorant, diuretic and a uterine stimulant. The resin is usd in the form of a lotion for indolent ulcers and as a gargle in caries of the teeth, weak and spongy gums, pyorrhoea alveolaris, chronic tonsiltis and pharyngitis and ulcerated throat.

PTEROCARPUS

Synonyms : Malabar kino tree; Bijasal.

Biological Source : Pterocarpus consists of an aqueous extract of the wood and other parts of *Pterocarpus marsupium* Roxb.

Family : Leguminosae, Papilionaceae.

Habitat : The tree is found commonly in hilly regions throughout the Deccan Peninsula, and extending to Gujarat, Madhya Pradesh, Utter Pradesh, Bihar and Orissa.

Characters : It is a moderate-sized to large deciduous tree, up to 30 m high and a girth of 2.5 m with a straight clean bole. Bark grey, rough, longitudinally fissured and scaly: blaze pink and whitish markings, older tree exuding a blood red gum-resin, leaves imparipinnate, leaflets usually 5-7, oblong; flowers in large panicles, yellowish fragrant, pods orbicular, flat, winged, up to 5 cm in diameter, seeds 1-2, convex and bony.

The tree is found in deciduous forests both on undulating and flat ground and grows on a variety of formations, provided the drainage is good. It prefers a soil with a fair proportion of sand, though it is often found on red loam with a certain amount of clay. The normal rainfall in its natural habitat ranges from 75 to 200 cm. It produces root suckers sparingly. It is planted as a shade tree in coffee estates in South India.

Natural reproduction is through seeds. The early development of seedlings is favoured by shelter from the sun and a loose soil clear of weeds. Seedlings may show little stem development or may die back annually for several years but ultimately shoot up after they have developed a long

stout tap root. Whole pods are sown and germination can be hastened by cutting across their ends and then soaking them in water for a few days prior to sowing. Stump planting of one-year old plants raised in nursery gives good results. Seedlings may also be raised in bamboo baskets for planting out. The tree is attacked by a number of insects, mostly defoliators, and some fungi which cause rotting of the wood.

The tree yields a gum kino which exudes when an incision is made through the bark up to the cambium. The exudate is collected and dried in the sun or shade to give 340 g dried gum per tree. Kino occurs in small (3-5 mm), angular, glistering, brittle fragments, appearing almost black in colour. The edges looked ruby-red and transparent when viewed by transmitted light. It is odourless and bitter with astringent taste and colours saliva pink when masticated.

Chemical Constituents : The bark contains l-epicatechin and a reddish brown colouring matter. The heartwood yields liquirigenin, isoliquiritigenin, a neutral unidentified compound (mp 160), alkaloid (0.017%) and resin (0.9%). The wood also contains a yellow colouring matter, an essential oil and a semidrying fixed oil (0.52%). Kino contains a non-glucosidal tannin kinotannic acid (25-80%), kinoin and kino-red in addition to small quantities of catechol (pyrocatechin), protocatechuic acid, resin, pectin and gallic acid. Kino-red is the anhydride of kinoin, which is a phlobaphene produced from kinotannic acid by the action of an oxidase enzyme present in the kino.

Uses : An aqueous infusion of the wood is used in diabetes. The bark is used as an astringent and in toothache. The flowers are antipyretic. The leaves are employed as an external application for boils, sores and skin diseases. Kino is a powerful astringent and used in the treatment of diarrhoea and dysentery. It is locally applied in leucorrhoea and in passive haemorrhage and in toothache. Kino finds application in dying, tanning and printing and is of potential use for the paper industry.

GYMNEMA SYLVESTRE

Synonym : Gur-mar (Hindi).

Biological Source : The drug consists of leaves of *Gymnema sylvestre* R.Br. (Fam. Asclepidaceae).

It is a large, more or less pubescent, woody climber found in southern India, occassionally cultivated as a medicinal plant. The leaves are opposite, usually elliptic or ovate; flowers small, yellow, in umbellate cymes; follicles terete, lanceolate, up to 7-8 cm in length.

The leaves contain albumin, organic acids, pararabin, hentriacontane, pentatriacontane, α- and β-chlorophylls, phytin, resins, tartaric acid, formic acid, butyric acid, anthraquinone derivatives, inositol, d-quercitol and "gymnemic acid" which is an impure complex mixture. The leaves give positive tests for alkaloids.

The plant is stomachic, stimulant, laxative and diuretic. It is used in cough, biliousness and sore eyes. The leaves have been, sometimes used as a remedy for diabetes. However, the alcoholic extract or leaf powder does not show any effect on the concentration of sugar in the blood or in the urine of patients suffering from diabetes. But they cause hypoglycaemia in experimental animals when administered. This effect is not due to any direct influence on the carbohydrate metabolism but to indirect stimulation of insulin secretion by pancreas.

The leaf powder is tasteless with faint pleasant aromatic odour. It stimulates the heart and the circulatory system, increases the secretion of urine and activates the uterus. The laxative property is attributed to the presence of anthraquinone derivatives. The drug is used as an errhine and for parageusia and furunculosis.

VIDANG

Synonyms : Embelia; Black Vidang; Baberang (Hindi).

Biological Source : Vidang consists of dried ripe fruits of *Embelia ribes* Burm. f. containing 2 per cent of embelin.

Family : Myrsinaceae.

Geographical Distribution : Vidang is common in the mixed deciduous forests of India ascending to 1500 m in Sri Lanka, Burma and South China. It is often cultivated in gardens and homeyards.

Characters : The plant is a large scandent shrub with slender branches and elliptic-lanceolate, gland-dotted leaves. Vidang is a globular brownish-black fruit, 2-4 mm in diameter, warty

with beak like projection at the apex, about 1.2 mm long pedicel may be present in some fruits. A presistent calyx with 3-5 sepals is present. When pedicel is not present a circular scar is observed at its place. Each fruit contains a single seed covered with thin membrane. The seed is covered with a small yellow spots of crystalline embelin. Vidang contains an aromatic odour and hot astringent taste.

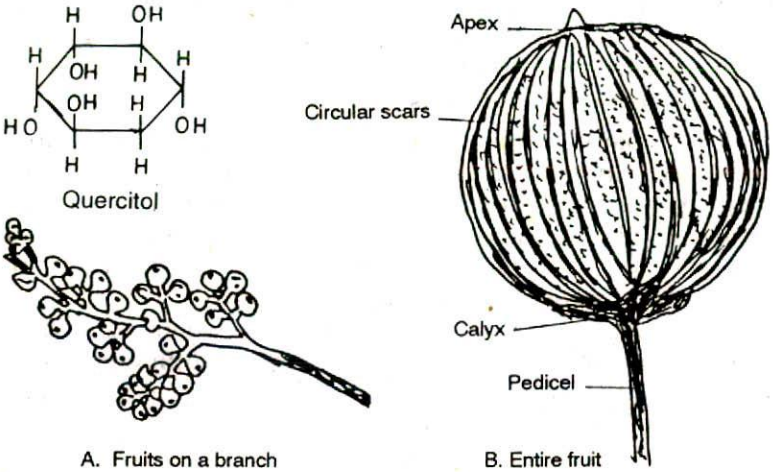


Fig. 14.21. Vidang

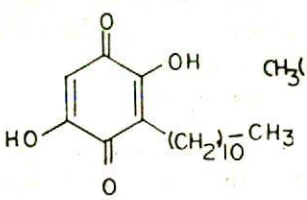
Chemical Constituents : Vidang contains 2-3% hydroquinone embelin (2, 5-dihydroxy-3-lauryl-p-benzoquinone), a dimer of embelin known as vilangin, an alkaloid christembine, tannins, quercitol, and minute amount of volatile oil. Embelin occurs in golden yellow needles, is insoluble in water but soluble in alcohol, chloroform and benzene. Fatty ingredients are also present in the fruits.

Tests for Identification

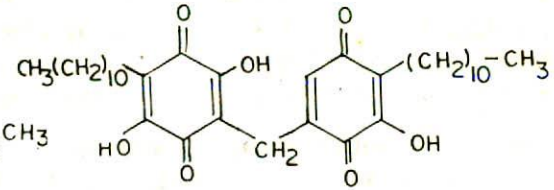
1. A mixture of ethereal extract of Vidang powder and aqueous sodium hydroxide gives deep violet colour in aqueous layer. With dilute ammonia solution a bluish violet precipitate is formed (Test for embelin).
2. Alcoholic extract (10 ml) of powdered drug (2 g) with lead acetate solution produces green precipitate.
3. Alcoholic extract of the drug gives reddish brown precipitate with ferric chloride.

Uses : Vidang is anthelmintic especially against tapeworm. The fruit has astringent, carminative, stimulant, alternative

and tonic properties. It is used to cure fevers, coughs and diarrhoea. Children suffering from tape-worms are treated by giving milk boiled with the drug. It has no activity against roundworms or threadworms.



Embelin



Vilangin

Substituents - Red Vidang : In commercial supply of Vidang sometimes Red Vidang is mixed which is dried ripe fruits of *Embelia robusta* Roxb. (syn. *E. tsjeriam-cottam* DC.) (Fam. Myrsinaceae). The plant occurs on the Malabar coasts of India,. Sri Lanka and Sylhet. The fruits are relatively larger in size (4-5 mm in diameter) and possess distinctly reddish wrinkled surface. The persistent calyx is more prominent with 5 distinct sepals. It contains embelin (1.5%) and minute amount of volatile oil.

ACHYRANTHES

Achyranthes consists of the entire plant of *Achyranthes aspera* Linn. (Family Amaranthaceae).

The plant is an erect or procumbent, annual or perennial herb, 1-2 m in height, often with a woody base, commonly found as a weed of waysides and waste places throughout India up to an altitude of 2,100 m. Stems are angular, ribbed, simple or branched from the base, often tinged with reddish purple colour, leaves thick, ovate-elliptic or obovate-rounded, but variable in shape and size, flowers greenish white, numerous in axilary or terminal spikes, up to 75 cm long, seeds sub-cylindric, turncate at the apex, rounded at the base, reddish brown.

The plant is very variable, and a few varieties have been recorded. The plant thrives best in the community of *Cassia tora* and is commonly found in shady places as a weed. It also grows in drier situations but does not tolerate waterlogging.

The seeds contain saponins, pentatriacontane, 6-pentatriacontanone; hexatriacontane and triacontane.

The presence of hentriacontane and ecdysterone is also reported. The whole plant contains the alkaloids, achyranthine and betain. Achyranthine, a water-soluble alkaloid, dilates the blood vessels, lowers the blood-pressure, depresses the heart, and increases the rate and amphitude of respiration. Ecdysterone is also present in stem and leaves.

Uses : The plant is pungent, astringent, pectoral and diuretic. It is used as an emmenagogue, and in piles and skin eruptions. A decoction of the plant is useful in pneumonia and renal dropsy. The juice of the plant is used in ophthalmia, toothache and dysentery. The benzene extract of stem bark showed significant abortifacient activity.

The leaves are used as a cure for gonorrhoea, and excessive perspiration. Their extracts showed antibiotic action. The roots are astringent; their paste is applied to clear opacity of cornea, and to wounds as an haemostatic. A decoction of the roots is used for stomach troubles, and an aqueous extract for stones in bladder. The flowers are used for menorrhagia and to treat rabies. Seeds are emetic and given for biliousness. A medicated oil is dropped into the ear in deafness and noise in the ears.

QUESTIONS

1. Give the botanical sources, chemical constituents and uses of the following drugs : (a) Brahmi (b) Punarnava (c) Chirata (d) Aswagandha (Jamia Hamdard, 1994).
2. Discuss the biological source, active constituents and uses of the following : (a) Shankhpushpi (b) Amla (c) Brahmi (d) Satavari.
3. Write short notes on any four of the following drugs: (a) Gokhru (b) Brahmi (c) Pipal (d) Vaj (e) Tulsi
4. Discuss the source, chemical constituents, authentication and clinical uses of (a) *Tylophora indica* (b) *Centella asiatica* (c) *Achyranthes aspera* (d) *Convolvoulus microphyllus*.

15

PHARMACEUTICAL AIDS AND TECHNICAL PRODUCTS

A number of natural products find use in various fields in addition to medicine and pharmacy. These products are called as technical products which are used in beverages, condiments, flavouring agents, spices, paints, varnishes, confectionaries, textiles and cosmetics.

Pharmaceutical Aids

For the production of drugs various techniques such as purification, filtration, adsorption, solubilization, absorption, suspension, emulsification, etc. are employed. A number of natural products are used in these techniques. Flavouring, colouring, coating and perfuming agents are used in drug industries. These agents possess little or no therapeutic value, but they are used in the preparation of many pharmaceutical products. These agents are called as pharmaceutical aids which may be of plant, animal, mineral or synthetic origin.

In pharmaceutical industry Starch and Guar gum are used as a disintegrating agent. Sodium alginate acts as stabilizing, thickening, emulsifying, defloculating, gelling and filming agent. Glucose and sucrose are sweetening and coating products. Agar is used as emulsifying agent and for cultural media. Acacia and Tragacanth are employed as binding, suspending and emulsifying agents. Mucilages like Ispaghol and Linseed act as demulcent and soothing agents.

Quillaia contains saponins and is used in coal tar emulsion. Most of the volatile oils are flavouring products. Fixed oils like Olive, Seasame, Cottonseed, Almond and Castor oils act as emollients and vehicles for drugs. Beeswax, Spermaceti, Wool fat, Lanolin and Lard are the ointment bases. Chlorophyll, Cochineal and Saffron are the natural dyes used as colouring agents. Gelatin is a suspending agent and used for making capsules. Pyrethrum, Derris, Lonchocarpus, Cevadilla seed and Ryania are the natural insecticides. Absorbent Cotton, Jute, Hemp, Flax, Wool, Silk, Viscose, Alginate, etc. are used to prepare fibres for filtering and surgical dressings. Shellac is used for coating confections and medicinal tablets. Kaolin is employed externally as dusting powder, filtering and cleaning agent.

Technical Products

In perfumery the natural substances Lavender, Sandalwood, Citronella, Balsam of Peru, Balsam of Tolu and Storax are used as technical products. Soaps are prepared from fatty acids of Castor oil, Cottonseed oil, and Peanut oil. Myrrh and Quillaia are used in incense and shampoos, respectively. Wool fat, Spermaceti and White wax are the ingredients of creams. Coconut oil, Castor oil and Henna find use in hair dressings. Benzoin is added in lotions.

In food industry Acacia, Agar, Alginates, Starches and Sterculia gum are used in confection and bakery products. Citrus fruits and Ginger are employed in soft drinks (beverages). The vegetable oils used as food are Coconut, Seasame, Cottonseed, Peanut and Mustard. The fruits and other parts of Capsicum, Nutmeg, Cardamom, Clove, Coriander, Caraway and Dill are used as spices and condiments.

In Tobacco industry Glycyrrhiza and Vanilla are used in cigarettes, cigars, snuffs and other products. Hops, Yeast and Malt find use in the manufacture of bear. From Linseed oil, Castor oil, Copaiba and Colophony, paints and varnishes are manufactured. Black Catechu is applied on chewing betel leaf. In textile industry Acacia, Agar, Alginates, Catechu, Cotton, Gambir, Rosin, Starch and Sterculia gum are employed.

SPERMACETI

Synonyms : Cetaceum; Spermwax.

Biological Source : Spermaceti is a solid waxy substance obtained from the oil derived from the head and blubber of the sperm whale, *Physeter macrocephalus* (Fam. Physteridae).

Geographical Distribution : The whales are found in the Pacific, Indian and Atlantic oceans. They attend a length of 20 meters and up to 6-9 meters in circumference.

Collection and Preparation : The whales are killed with torpedo harpoons that explode upon striking the animal. In front of the cranium there is a large cavity which contains an oily fluid. The cranial cavity is opened and the oily liquid removed by buckets or by pumping. A single whale yields 10-12 barrels of oil. On cooling about 11% Spermaceti separates out. The crude material is pressed, melted and strained, and treated with boiling aqueous caustic soda to remove free acids in the form of soap. The purified Spermaceti is cooled to form cakes.

Characters : Spermaceti is white, somewhat transparent slightly unctuous masses with crystalline fracture and pearly luster.. It is almost odourless and tasteless but becomes yellow and rancid on long exposure to air; density 0.93 - 0.94; m.p. 42-50°; viscosity 1.433, saponification number 120 - 136, iodine number 3-4.4. It is insoluble in water and cold alcohol, soluble in chloroform, ether, carbon disulphide, oils, boiling alcohol; slightly soluble in petroleum ether.

Chemical Constituents : Spermaceti consists of chiefly cetyl palmitate ($C_{15}H_{31}$ OCO C_{16} H_{33}), cetyl myristate ($C_{15}H_{31}$ $OCOC_{13}H_{27}$), cetyl laurate, acetyl laurate and cetyl stearate; the total ester constituents are about 85%. Free cetyl alcohol is present in appreciable amounts. The esters of higher alcohols are also present. On saponification of esters with alcoholic potassium hydroxide, cetyl alcohol, (C_{16} H_{33} OH), m.p. 49.5°, is formed.

Uses : Spermaceti is used as a pharmaceutical aid for cold creams, as a base for ointments, cerates, etc. and as emulsion with egg yolk or expressed almond oil. It is also used in manufacture of candles, soaps, cosmetics, laundry wax; finishing and lustering linens. It possesses emollient properties.

KAOLINS

Synonyms : Bolus alba; China clay; Porcelain clay; White bole; Argilla.

Kaolins or China clays (white or high-cream burning) are derived from pegmatites or from hydrothermal alterations along fractures.They may also occur as blanket deposits in extensive areas of igneous of metamorphic rocks, bedded deposits derived from feelspathic, sandstones or as pockets in limestones.

Distribution

Kaolins are found in the Garo hills of Assam, banks of Dora river in Lakhimpur districts, Makkiari near Ranjiganj, Birbhum districts, Rajmahal hills in Bhagalpur (Bihar); Begaum, Ratnagiri, Kanera, Thana districts of Maharastra and in some parts of M.P., Delhi, Madras, Kerala and other states.

Chemical Constituents : Clays are made up of mineral grains, some of which may be of very small size. Kaolin group contains kaolinite, nacrite, dickite, annauxite and hallosysite, all. Al_2O_3 $2SiO_2$. $2H_2O$ and allophane, Al_2O_3. $nSiO_2$. H_2O. It contains traces of magnesium, calcium and iron.

Preparation

Kaolin is prepared when the rock in mined, excavated and the impurities are washed with water and then powdered. The rock is elutriated with water and large-sized particles are separated. On allowing the turbid liquid to settle, heavy Kaolin containing particles of large size and colloidal Kaolin containing particles of small size are separated and then dried.

Description

Kaolin, Al_2O_3. $2SiO_2$. $2H_2O$ (Al_2O_3 39.3%, SiO_2 46.8%, H_2O, 13.9%, sp. gr. 2.6), is an important member of the family of clay material. It is slightly plastic like and is normally white but is often tinged grey, yellow brown, blue or red by impurities. Its softness is very characteristic. It is unctuous and soapy to touch. On rubbing with a piece of bone, it takes a high polish. It is highly refractory. Its fusion point is in between 1700-1800°. When heated in a closed tube,

it gives out water. On heating on charcoal black with cobalt nitrate, it gives a blue mass due to the alumina present. It is not affected by dilute hydrochloric or nitric acid, but is decomposed by prolonged boiling or treatment with concentrated sulphuric acid. It becomes more resistant to acids if it is first heated to white heat.

The particles of heavy Kaolin are 20 μm in diameter, flat and irregularly arranged. With water plastic-like form is obtained which is less sticky. When the aqueous suspension is kept for some time, the whole Kaolin settles below leaving a clear supernatant liquid. Heavy Kaolin polarizes light brightly.

The particles of fine or colloidal Kaolin are small, less than 2 μ in diameter and have various shapes and sizes. They do not polarize light. A sticky mass is obtained with water. Its aqueous suspension remains turbid permanantly and only a small fraction is deposited.

Uses : Heavy Kaolin is used externally as a dusting powder, poultice, carrier of heat, filtering and cleaning agent. Fine Kaolin is used internally as an adsorbent and to coat irritated intestinal mucosa in case of diarrhoea, dysentery and intestinal fermentation. They are also used to manufacture porcelain, pottery, bricks, portlant cement, ultramarine, colour lakes, refractory mortar, plaster material, filler for paper, electric and heat insulators; clarifying liquids, drying and emollient agents.

COCHINEAL

Biological Source : It consists of the dried female insects *Coccus cacti (Dactylopius coccus)* containing eggs and larvae.

Habitat : Cochineal insects are indigenous to Central America. Commercially they are grown in Peru, Mexico, Canary Islands, Algiers, Honduras, East and West Indies, Spain, Florida and California.

Eggs from the previous crop are hatched on the Cacti or Nopal tree *(Nopalea cochenillifer,* Family Cactaceae). Both male and female insects emerge. The males are about 1 mm long and possess wings, while the females are about 2 mm long and without wings. After a time fecundation takes place and the females attach themselves to the Nopal tree by means of their probosces. The males then die. The female insects

grow faster and becomes to about twice their original size. The larvae mature in about 14 days.

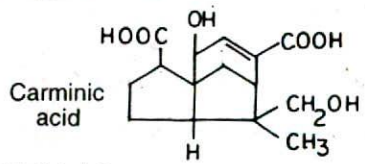
Collection and Preparation : The insects are separated from the tree, killed with hot water, stove heat or by exposure to the fumes of burning sulphur or charcoal. If heat is used, the colour of insects becomes purplish-black and they are called as *'black grain'*. The fumed-killed purplish-grey insects are known as *'silver grain'*. Small immature insects and larvae are separated by sieves and known as *'granilla'*. About 70,000 insects produce 450 g (1 lbs) of the Cochineal drug.

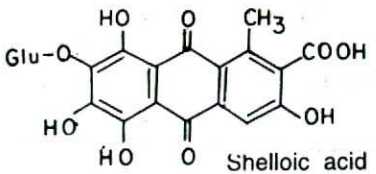
Characters : Cochineal insects are about 4 mm long and oval in shape. The convex dorsal surface shows from 9 to 11 segments without constrictions between head, thorax and abdomen. The insect has a pair of antennae with 7-joints and three pairs of very incospicuous legs. The surface contains tubular glands which secrete wax.

Chemical Constituents : Cochineal contains a water soluble glycosidic colouring matter known as carminic acid or carmine red (10%) which is a C-glycoside of anthraquinone. The insect also contains fat (10%) and a wax known as co cerin (2%). Carmine is an alkaline preparation of Cochineal containing about 50 per cent of carminic acid.

Uses : Cochineal is used as a colouring agent for food products, drugs and toilet preparations. Carmine and carminic acid are used for manufacture of red and pink inks and lakes. Several grades of cochineal are available such as Silver grain, Black grain, Grannilla, Rosy-black and Red foxy.

Adulteration : The weight of cochineal is increased by adding inorganic matter.





Shelloic acid

SHELLAC

Synonyms : Lacca; Lac.

Biological Source : Shellac is a resinous substance prepared from the excretion of scale insects, *Laccifer lacca* (Family Coccidae).

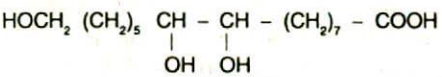
Habitat : Shellac is produced in Burma, Assam and India. Most Shellac is produced in Madhya Pradesh, Uttar Pradesh, Bihar and Orissa states of India.

Preparation : The insects live on the juices of various trees such as *Acacia* species, *Butea frondosa* (Leguminosae), *Aleurites laccifera* (Euphorbiaceae), *Ficus* species (Moraceae), *Cajanus indicus*, *Shorea talura* (Dipterocarpaceae), *Schleichera trijuga* (Sapindaceae), and *Zizyphus jujuba* (Rhamnaceae).

The insects suck the juice of the tree and excrete "stick-lac" almost continuously. Whitest Shellac is produced when the Kusum tree *(Schleichera trijuga)* is the host. The structure and life history of the scale insect are identical to those of Cochineal.

Preparation : Shellac is found most abundantly on the smaller branches and twigs. These are broken off and the excretion is scraped from the twigs with the help of curved knives. It is ground and the colouring matter exctracted with water or dilute alkali solution. The exhausted Shellac in dried form is known as *Seed lac*. The alkaline extract on dryness gives *Lac dye*. The *seed lac* is melted in a long sausage-shaped bag suspended over a charcoal fire and the lac is squeezed out. It is cooled and then stretched into a large sheet. It is broken up to give flake Shellac of commerce. Sometimes the Shellac is poured into circular moulds and, on cooling, stamped with the maker's name. This form of Shellac is known as *Button lac*. When the Shellac is dissolved in hot alkaline solution, bleached with chlorine or sulphurous acid, precipitated with acid, collected by filtration and pulled under water into sticks, it is known as *Bleached Shellac*. When the Shellac is kept under water, it is soluble in alcohol, but the solubility decreases on exposure.

Characters : Shellac occurs in thin, very brittle, yellowish, translucent sheets or powder; m.p. 115-120, saponification no. 185-210°, iodine no. 10-18. It is soluble in alcohol, ether, benzene and petroleum ether; sparingly soluble in oil of terpentine and insoluble in water.



Aleuritic acid

It is soluble in aqueous solutions of ethanolamines, alkalies and borax with slightly purple colour.

Various grades and colours are used for particular purposes. Shellac containing brownish-yellow colour is known as *orange Shellac* and the reddish-brown varieties are called *ruby* or *garnet Shellac*.

Chemical Constituents : Shellac contains wax (6%), red colouring matter (6.5%), laccaic acid, resin (70-85%) and few insect remains and vegetable debris. Hydrolysis of the resin gives a complex mixture of aliphatic and alicyclic hydroxy acids and their polyesters. The composition of the hydrolysate depends on the Shellac source and the time of collection. The major component of the aliphatic fraction is aleuritic acid.

Uses : Shellac is used for coating confections and medicinal tablets; finishing leather, in lacquers and varnishes, to manufacture buttons, grinding wheels, sealing wax, cements, inks, phonographs, records, paper; for stiffening hats; in electrical machines; and in polishes.

LARD

Biological Source : Lard is the purified internal fat obtained from the abdomen of the hog, *Sus scofa*, var. *domesticus* (Family Suidae).

The abdominal fat, known as *flare*, is obtained by treatment with hot water at a temperature not exceeding 57°C.

Characters : Lard is a soft, white fat, m.p. 34-41°, iodine value 52-66, saponification value 192-198. It has non-rancid odour. It is insoluble in water, very slightly soluble in alcohol and freely soluble in benzene, chloroform, solvent and petroleum ethers and in carbon disulphide. It should be free from moisture, alkalies and chlorides. It is adulterated with beef-fat, Seasame oil and Cottonseed oil.

Lard oil is colourless, pale yellow liquid, density 0.90 - 0.91, viscosity 1.47. It solidifies in between –2 to +4° C.

Chemical Constituents : Lard contains solid glycerides (40%) such as myristin, stearin and palmitin; and mixed liquid glycerides (60%) such as olein. The fractions are separated by pressure at O° C into solid fat 'stearin' and liquid 'lard oil'. Hydrolysis of Lard yields oleic acid (48%), palmitic acid (28%), octadecadienic acid (11%), stearic acid (9%) and myristic acid (3%).

Uses : Lard is an emollient and used as a base for ointments and cerates. It has a tendency to become rancid; this can be retarded by combining lard with 1% Siam Benzoin or Sumatra Benzoin to prepare Benzoinated Lard. Lard oil is

used as an antifoaming agent in the fermantations and as a tablet lubricant, illuminant, oiling wool and to manufacture soap.

DIATOMITE (KIESELGUHR)

It occurs as large deposits in California, Germany, North Africa and Virginia.

The material is dried, powdered, ignited to remove organic matter, boiled with dilute hydrochloric acid to remove iron and other impurities, washed with water and dried. Purified form occurs as fine, white, odourless powder. The diatoms consist of two halves or valves fitted together. The valves vary in shape. Many diatoms contain a median cleft in the valves, called as the raphe. The valves also show dots, lines and minute cavities in the walls. It is insoluble in all acids except hydrofluoric acid. After fusion with alkalies, it is soluble in acids.

The crude product contains silica (68-87%), organic matter, clay, iron oxide and water (5-15%). Diatomite is used for the filtration of oils, fats, syrups, for sterilization; as an inactive support in column, gas and thin layer chromatography; in face powders, pills, polishing powders, soaps and to absorb nitroglycerine in the manufacture of dynamite.

QUESTIONS

1. What are pharmaceutical aids and technical products? Write biological sources, preparation, characters, chemical constituents and uses of any two such products studied by you.
2. Write notes on :
   (a) Spermaceti,
   (b) Kaolins,
   (c) Cochineal,
   (d) Shellac.