UNIT – 2

SECONDARY METABOLITES

ALKALOIDS

1. VINCA
2. RAUWOLFIA
3. BELLADONNA
4. OPIUM

1.VINCA

- **Vinca (or sadabahar or periwinkle)** is commonly grown in india.
- It has its origin in madagaskar.
- Two varieties of vinca namely pink and the white coloured flower varieties are grown for their medicinal value.

Synonyms

Catharanthus,Periwinkle and sadabahar

Biological source

Vinca is the dried whole plant of ***Catharanthus roseus*** or ***vinca rosea***

Family

Apocynaceae

Geographical source

Vinca is native to madagaskar.it is grown as an ornamental plant in india, South Africa, USA, Europe, Australia and Carribbean islands.

Macroscopic characters

Vinca is an erect,pubescent herb.

Colour – violet,pink,white and carmine red colour flowers.

Odour – characteristic

Taste - bitter

Roots – branched tap root

Leaves – simple, petiolate, ovate or oblong, unicostate, reticulate, entire, brittle with acute apex and glossy appearance.

Flowers – bracteate,pedicillate,complete,2-3cm in cymose axillary clusters.

Fruits – follicles with several black seeds.

Microscopical characters

- Upper surface of vinca leaf has a single layer of rectangular celled epidermis with uni cellular covering trichomes.
- Palisade occurs as a single layer below the upper epidermis and has compact elongated cells.

- With inter cellular spaces spongy parenchyma of leaf is a 5 – 8 layered structure.
- Midrib has collenchyma just below the upper epidermis and above the lower epidermis.
- In the center xylem and phloem are present but calcium oxalate crystals are absent.
- On lower epidermis **cruciferous stomata** (Anisocytic) are abundantly present.

Chemical constituents

Vinca contains a large number of indole alkaloids of which around 20 dimeric indole dihydro indole alkaloids exhibit oncolytic activity.

- **Vincristine** and **vinblastine** being the most significant ones.
- **Vinblastine** contains **catharanthine** (an indole alkaloid part) and **vindoline** (a di hydro indole alkaloid part).
- **Ajmalicine**, **lochnerine**, **serpentine** and **tetra hydro alstonine** are the other alkaloids of vinca.
- For extracting 1gm of vincristine around 500 kg of crude drugs is required as vincristine is present in very low content (0.0002%).
- Hence **vinca alkaloids** are **very expensive.**
- The five ring dihydroindole system present in their ring is found in other natural drugs also.
- Thus,synthesis of four ring indole system is under process.

Chemical tests

Vincristine sulphate crystals are obtained from ethanol and are found to be un stable.

Uses

- Its leaves and stems are a source of alkaloids, which have antitumour and anti cancer properties.
- Its leaves are used for controlling diabetes and high blood pressure.
- Its alkaloids are sedative and tranquiliser.
- It relieves muscle pain and depression.
- It controls nose bleeds, bleeding gums, mouth ulcers and sore throats.

- It exhibits the property of detoxification and can counter the effect of poison thus is used in wasp stings.
- On internal administration, it is helpful in gastritis, cystitis, enteritis, diarrhoea, diabetes etc.
- It ensures brain health as the active ingredients improve blood supply to the brain and increase the oxygen level that brain can utilise.
- It also raises the serotonin levels and prevents abnormal blood coagulation.
- Vincamine alkaloid keeps the blood thin and acts as a memory enhancer, thus is used in preventing dementia.

Adulterants

Commercial samples of *Catharanthus roseus* are often found adulterated with certain solanaceous roots like ***solanum melongena*** (egg plant) and ***Lycopersicon esculentum***

(tomato) which adversely affect the quality as well as total alkaloidal yield of the drug.

2.RAUWOLFIA

- Rauwolfia is an evergreen plant.In india roots and rhizomes of this plant have been in use for hundreds of years.
- The plant is named after its discoverer a german doctor and traveller,**Leonhard Rauwolf**.
- Due to its immense therapeutic properties, it is used in Ayurvedic, Unani and Homeopathy.

Synonyms

Rauwolfia root, Sarpagandha,Indian snake root, Black snake root, Serpentina root, Chhotachand and devil pepper.

Biological source

Rauwolfia is the dried roots of the plant ***Rauwolfia serpentina***.

Family

Apocynaceae

Geographical source

- Various species of rauwolfia are found in the tropical regions of America, Africa and Asia. It is commercially cultivated in America, Thailand, Myanmar, Sri lanka and India.
- In india it is cultivated in Gujarath, Maharashtra, Karnataka, West Bengal, Tamilnadu, Orissa, Bihar and Uttar Pradesh.

Extra features

Due to longitudinal marking and wrinkled surface, the roots appear rough. Normally root lets are absent but some small circular root scars can be observed.

Macroscopic features

Colour – Root bark is greyish yellow to brown and wood is pale coloured.

Odour – Odourless

Taste – Bitter

Shape – Roots are sub cylindrical in shape and tortuous with slight tapered end.

Size – Diameter is around 1-3 cm and length is 10 – 18cm.

Fracture – Short and irregular. Transversely cut surface is white and dense with finely radiating xylem.

Microscopic features

Cork – it consists of stratified cells below which phelloderm of few rows of parenchyma is present.

Phloem – it is narrow and parenchymatous with small scaterred sieve tissues.In parenchyma starch grains and few latex cells with brown resinous matter are present. Calcium oxalate crystals are present in the secondary phloem.

Xylem – about 80% of diameter of root is xylem which includes vessels, tracheids, wood parenchyma and wood fibres. simple or bordered pits are present on xylem vessels. These vessels are elongated up to 350µ in length and 50µ in width.

- Stone cells or phloem fibers are absent.

Chemical constituents

- Rauwolfia contains about 0.7 – 2.4%of total alkaloidal bases of which **more than 80 alkaloids** have been isolated.
- The prominent alkaloids isolated from the drug are **reserpine**, **rescinnamine, rescidine, raubescine** and **deserpidine**.
- The other alkaloidal components are **ajmalicine** (8 – **yohimbine), ajmaline, ajmalinine, serpentine, serpentinine, tetra hydro reserpine, raubasine, reserpinine, iso ajmaline** and **yohambinine**.
- The other substances present are phytosterols, fatty acids, un saturated alcohols and sugars.

Chemical tests

1.On adding an acid or on exposing to light, most reserpine solutions give a distinct yellow colour and also a clear fluorescence on standing.

2.Violet red colour solution appears on treating reserpine with vannillin solution in acetic acid.

3.On crystallisation of reserpine crystals of reserpine hydro chloride hydrate are obtained that decomposes at 224C temperature.

4.On treating a freshly fractured surface with concentrated nitric acid a red colour is observed along the medullary ray.

Uses

- It is a **hypotensive drug** having a strong **sedative** property.
- It is a mild **tranquiliser** used for removing low level of anxiety.
- It is a rich source of indole alkaloids (such as reserpine, ajmaline, ajmalicine and serpentine) which are used in the treatment of circulatory disorders.
- Its roots are used **for lowering blood pressure** due to the presence of reserpine which dilates the blood vessels and also depresses the CNS activity by acting as **a hypnotic**.
- Deserpidine and rescinnamine are also used as hypotensive and tranquilliser.
- Its leaves are used in removing **opacities of cornea**.
- In Ayurveda it is best **for reducing fever**.

- It is also used as an **anti anxiety**, **anti psychotic** (neuroleptic) **hypnotic** and **sedative** drug. It induces sleep and relieves many mental disorders like aggression, anxiety and sleeplessness.
- Its root decoction is useful for the **treatment of snake poison**.
- In Ayurveda its roots and whole plant are used for treating **rheumatism, insanity** and **epilepsy**.
- It also **reduces the symptoms of hangover** occurring after heavy drinking.
- It is also useful for treating **dysentery** as it reduces the frequency of loose stools, checks bleeding and alleviates pain.

- It is used to treat **uterine pain due to miscarriage** as it contracts the uterus and eliminates the toxins from uterine cavity and further relaxes the uterine muscles.this stops bleeding and reduces pain.
- It **decreases pain during menstruation** by modulating blood flow which reduces cramps and throbbing pain.

Substitutes and adulterants

For **substitution** purpose,

- ***Rauwolfia tetraphylla***
- ***R.densiflora***
- ***R.vomitoria*** (African rauwolfia)

For adulteration

- Stem of the same plant is used.
- ***Ophiorrhiza mungos***
- White or red flowered species of ***Clerodendrum***
- ***Tabernaemontana divaricata***
- ***Rauwolfia beddomei***.
- ***Rauwolfia micrantha***.
- ***Rauwolfia verticillata***.

3.BELLADONNA

- Belladonna(or deadly night shade) is a perennial herbaceous plant.
- The foliage or berries contain tropane alkaloids and are very poisonous.
- Its toxicity is due to the presence of atropine, hyoscyamine and scopolamine causing hallucinations and bizarre delirium.
- Its pharmacological activity is anticholinergic.

Synonyms

Belladonna leaf, belladonna folium and deadly night shade leaf.

Biological source

Belladonna is the dried leaves and flowering tops of the plant ***Atropa belladonna***.

It should contain 0.30% or more of total alkaloids calculated as hyoscyamine.

Family

Solanaceae

Geographical source

Belladonna is native to Europe,north Africa and western Asia.In india belladonna is found in the western Himalayas from Shimla to Kashmir.

Macroscopic characters

Colour – **Leaves** – green to brownish green.
Flowers – purple to yellowish brown.
Fruits – green to brown.
Odour – slight and characteristic.
Taste – bitter and acrid.

Size – **Leaves** – 5-25cm long and 2.5 – 12cm wide.
Flowers – Corolla 2.5cm long and 1.5cm wide.
Fruits – About 10 cm in diameter.

Shape – **Leaves** – Ovate, lanceolate to broadly ovate with acuminate apex, decurrent lamina, entire margin, petiolate, brittle and transversely broken.

Flowers – Campanulate,5,small refluxed lobes of corolla.

Fruits – Berries, sub globular in shape with numerous flat seeds

Extra features

- The whole plant looks wrinkled and twisted, dropping flowers are present with many pairs of leaves.
- Flowers have five stamens a superior bilocular ovary having many seeds.

Microscopic characters

- A bifacial structure appears on the transverse section of ***A.belladonna*** leaf.
- The epidermal cells are arranged in wavy walls and have a striated cuticle.
- Stomata are mainly anisocytic type and some are anamocytic type present on both the upper and lower surface of leaves but are more commonly present on the lower side.
- In young leaves hairs are present abundantly.
- Uni cellular and multi cellular glandular trichomes are present.
- Calcium oxalate crystals are present in spongy mesophyll cells

Chemical constituents

- Around 0.3 – 0.60% alkaloids are extracted from *Atropa belladonna* in which **hyoscyamine** is the main component.
- Volatile bases like **pyridine** and **N- methyl pyrroline** are present in small quantities.
- Leaves of belladonna also have a fluorescence substance **β- methylaesculetin** (scopoletin) and calcium oxalate crystals.
- The leaves give 4% or less of acid insoluble ash and about 14% of total ash.
- About 0.28 – 0.32% of total alkaloids is present in finely powdered drug of a prepared belladonna herb.

Chemical test

Belladonna alkaloids give violet colour with fuming nitric acid and alcoholic KOH solution.

Uses

- It has **anticholinergic** and **parasympathetic** properties.
- In case of poisoning of opium and chloralhydrate, it is used as an **anti dote**.
- It is also used to **decrease the secretion of sweat, gastric juice** and **saliva**.
- It is used in **breathing abnormalities in infants**.
- It is used **for reducing sweat** and other secretions.

- It is effective **against tonsilitis, meningitis, scarlet fever, whooping cough** and **epilepsy.**
- Belladonna preparations are used against **vesico ureteral refluxes** (a condition in which urine flows back towards the kidney from the bladder).
- It is used as an **analgesic in pain due to kidney stones,sore throat etc.**
- It is useful in **liver** and **gall bladder disorders**.
- Powdered preparations are used **to treat asthma**.
- It can be used **to cure headaches** and **migraine**.
- Atropine is **used to dilate pupils**.it can reduce spasms in smooth muscles of digestive tract.

Adulterants

Phytolacca decandra (Family-phytolaccaceae)

- In this the lamina is denser and less decurrent than in belladonna.
- The epidermal cells have straight walls, stomata are of the **Anamocytic type**, and some of the mesophyll cells contain bundles of needle shaped crystals of calcium oxalate.

Ailanthus glandulosa (Family – Simarubiaceae)

- In this the leaves are triangular – ovate with straight walled epidermal cells.
- Cuticle is strongly striated , cluster of calcium oxalate crystals are present. and white, lignified and uni cellular clothing hairs are present on both the surfaces.

4.OPIUM

- Opium is the dried latex extracted from the seedpods of the plant opium poppy **(*Papaver somniferum*)**.
- The un ripened pods are slit open for the sap to seep out which is then dried on the outer surface of the pod.
- The resulting latex is scrapped off the pod which is yellow brown in colour and bitter in taste.
- Different types of alkaloids **morphine, codeine**, **thebaine** and **papaverine** are present in this latex.

Synonyms

Raw opium, Gum opium and Afeem.

Biological source

Opium is the dried latex extracted from the un ripe capsules of the plant opium poppy or ***Papaver somniferum***

Family

Papaveraceae

Geographical source

- Opium is commercially cultivated in Afghanistan, Yugoslavia , Bulgaria, Pakistan, Turkey, Persia (Iran) and India.
- It is mostly grown in Madhya Pradesh.

Macroscopical characters

Colour and shape

Indian opium: Dark brown in colour and is found in the form of cubical pieces enclosed in a tissue paper.

Persian opium: Dark brown in colour and is found in the form of brick shaped masses.

Natural Turkish or European opium: Brown or dark brown in colour and is found in conical or rounded and somewhat flattened masses.

Manipulated Turkish opium: Chocolate brown or dark brown.

Manipulated European opium: Dark brown in colour internally and covered with broken leaves.

Odour – strong characteristic

Taste – bitter

Microscopic characters

- Powdered opium is dried latex and brown coloured, amorphous masses of irregular shape.
- The vegetable debris consists of fragments of outer epidermis of the capsule.
- It consists of un lignified poly gonal tubular cells with thick walls.
- In the outer wall anamocytic stomata is present.
- Starch grains may be present in the capsule wall.

Chemical constituents

The alkaloids present in the latex are derived from amino acids, phenyl alanine and tyrosine. Different alkaloids derived from the opium are grouped in to two categories;

1.benzylisoquinoline: Narcotine (noscapine) narceine and papaverine.

2.phenanthrene: Morphine, codeine (methyl morphine) and thebaine.

- Narcotine is a weak, mono acidic base and optically laevo rotatory. Its salts are dextro rotatory.
- Narcotine is in soluble in water,alcohol and ether,Soluble in acetone, benzene and chloroform.

- **Papaverine** is an optically inactive and weak monoacidic base.It is insoluble in water and slightly soluble in organic solvents.
- **Morphine** is a laevo rotatory, phenolic and monoacidic alkaloid.
- Morphine is soluble in alkali hydroxides (except ammonium hydroxide) due to the presence of phenolic hydroxyl group.
- **Heroin** is a diacetyl derivative of morphine.
- **Codeine** is a laevo rotatory,mono acidic base.which is soluble in water and organic solvents(benzene,ether etc)

- The opium alkaloids are present as salts of meconic acid.
- Few alkaloids are present in minute concentration eg.,protopine and hydrocotarnine.
- Opium also contains sugar,wax,mucilage and salts of calcium,potassium and magnesium.
- Opium does not contain tannins,starch and calcium oxalate.
- Minute off white coloured seeds are present in large number within the poppy fruits.
- These seeds contain 30 – 35%of fixed oil.

Chemical tests

General test for opium alkaloids

- Opium is identified by testing the presence of meconic acid because opium alkaloids are present as a salt of meconic acid.
- **Opium** is dissolved in water and ferric chloride solution is added.it gives deep reddish purple colour which remains even on addition of hydrochloric acid.
- Orange red colour is obtained on sprinkling **morphine** on nitric acid.codeine gives negative result for this test.
- On reacting HCl acid solution of **papaverine** with ferric cyanide solution lemon yellow colour is obtained.

- On treating morphine solution with potassium ferric cyanide and ferric chloride solutions,bluish green colour is obtained.
- Codeine gives negative result for this test.

Uses

Hypnotic, sedative and analgesic properties:

- These properties of opium are due to morphine.
- Due to bi phasic action on CNS it shows sedative effects on cerebrum and medulla.
- It sedates emetic centre,respiratory centre and cough reflex.
- Morphine has central narcotic effects and causes addiction.
- Hence it can be used in case of severe pain.

Stimulation of chemo receptor zone:

- It stimulates the chemo receptor zone in medulla which causes nausea and vomiting (a side effect).

Anti tussive properties:

- Codeine relieves local irritation in the bronchial tract, thus used in many cough medicines as an anti tussive agent.
- Narcotine has a specific depressant action on cough reflex, hence it is used in the formulation of cough syrups.

Muscle relaxant properties:

- Papaverine has relaxant effects on intestinal and bronchial tract smooth muscles and also on blood vessels.

Substitutes

Papaver argemone, *P.dubium, P.orientale, P.bracteatum, P.strigosum, P.intermedia, P.paeoniflorum* hybrid of *P.somniferum* and *P.orientale, P.pseudo orientale* and plants from genera *Argemone* and *Eschscholzia* (both belonging to family papaveraceae).

Adulterants

At present time no adulterants are found in opium but previously many substances like flour, lead shot, powdered poppy capsule, gum, roasted bread crumb, pounded dates etc were used for adulteration.

Phenylpropanoids and flavonoids

1. Lignans
2. Tea
3. Ruta

1.Lignans

- Lignans are low molecular weight polymers formed by the coupling of two phenyl propane units in their C_3 side chains and between the aromatic ring and the C_3 chain are known as lignans.
- Cinnamyl alcohol (a common precursor of lignans) compounds like podophyllotoxin ,α and β peltatin (from ***Podophyllum peltatum*** and ***Podophyllum hexandrum*** of Beriberidaceae family)

Biosources – lignans widely occurs in plant compounds and are obtained from roots, heart wood, foliage, fruits and resinous exudates of plants.

Preparation

Lignans are formed by the reduction of ferulic acid to coniferyl alcohol and then through oxidative dimerisation of the coniferyl alcohol units and establishment of linkage in β – carbon atom of the C_3 side chain.

Characteristic features

- Lignans are found as single enantiomeric forms.
- They also occur as racemic products in di – forms.
- It has been found with respect to their oxidation levels, degree of substitution and structural complexity, lignans differ to a large extent.

2.Tea

- Tea is an evergreen shrub having several alternate branches.
- Tea leaves are pointed, lanceolate or elliptically oblong having short petiolate.
- Tea leaves have smooth surface on both sides with a shiny green appearance a prominent midrib and pinnately veined on one side.

Synonym

Folia thea

Biological source

Tea is the leaf buds and leaves of the plant ***Thea sinensis***.

Geographical source

It is often found in china and northern part of Burma.

Macroscopic features

- In the young stage leaves are covered with silky hair which disappear as they get mature. The surface becomes glabrous after the silky hair shed completely.
- The length of a fully matured leaf is about 5 – 10cm.
- The upper surface of the leaf is glossy and dark green coloured
- The outer lining is elliptical or lanceolate, the apex is acuminate or blunt and the base are tapering having short stalk.
- Margins are short and serrate.

Microscopic features

- The transverse section of the midrib shows dis continuous palisade cells.
- Phloem is present just below the xylem and covered by the band of pericyclic fibres. These fibers are slightly lignified.
- The epidermis is made up of polygonal cells having slightly wavy anticlinal walls.
- The lower surface of the leaves have numerous stomata and thick walled trichomes.
- Palisade cells are present in 2 rows in the mesophyll.
- Large lignified sclereids present in mesophyll and calcium oxalate crystals are scattered in parenchyma.

Chemical constituents

- The major constituent is **Caffeine** (tri methyl xanthine) 1 – 5% and **Tannins** (10-24%).
- Water decomposes the combination complex resulting in the liberation of caffeine.
- Adenine, Theophylline, Theo bromine (di methyl xanthine) and its isomer, Xanthine and volatile oil are present in trace amounts.
- The percentage of free caffeine increases during the fermentation process.

Chemical test

Murexide test : This test gives a positive result for tea as it is a purine alkaloid. Drug extract is taken in a petridish and potassium chlorate is added along with hydrochloric acid. The mixture is heated to dryness. The residue is exposed to dilute ammonia vapours resulting in a purple colour that disappears on addition of a fixed alkali.

Uses

- Caffeine stimulates heart and nervous system.It produce diuretic effect.
- Caffeine mixed with polyphenols (epigallocatechin-3-gallate)

  Shows strong anti oxidant properties.

- By inhibiting iron absorption by tannates and other ligands caffeine helps in treating genetic haemochromatosis.
- It also helps in treating diabetes induced blindness.
- It also plays a vital role in lowering the risk of heart disease

Adulterants

Foreign leaves and exhausted tea leaves are rolled and dried to be used as adulterants of tea.

3.RUTA

Synonym

Rue

Biological source

Ruta is obtained from the fresh and dried leaves of the plant ***Ruta graveolens***.it is a medicinal and ornamental herb.

Family

Rutaceae

Geographical source

It is native to the Mediterranean area and distributed all around the world.The genus Ruta has 14 approved species.

Macroscopic features

It is a perennial, scented and glabrous herb or a sub shrub.

Stem – Slim, smooth, pale green up to 1m in height.

Leaves – Compound and 2-3 pinnate. Green to greyish green colour. Thin, papery and have minute dots of glands every where.

Leaflets – Linear, oval or oblong.

Flowers – Dark yellow coloured.

Petals – Greenish yellow colour with toothed margin.

Fruits – Dry, hard and round. They are 4 or 5 lobed and have blunted tips.

Microscopic features

- The T.S of stem appears almost pentagonal in outline.
- Single layered outer epidermis followed by the hypodermis single layered.
- Cortex consists of few layers of chlorenchyma and inner parenchyma.
- Chlorenchyma is loosely arranged as aerenchyma with numerous air spaces. starch grains are present.
- The parenchyma is normal and has intercellular spaces. starch grains are present.
- The pericycle shows lignified fibers.
- The pith is large, parenchymatous.

Chemical constituents

- The commonly known phyto chemical compounds are acridone alkaloids, coumarins, volatile substances, terpenoids, flavonoids and fluoroquinolones.
- Saponin, tannins and glycosides are also found to be present.
- The main flavonoids are **Rutin** and **quercetin**.
- Rutin was first isolated from the leaves of *Ruta graveolens*.
- Aliphatic acids, alcohols and ketones are also present in high content in *R.graveolens* volatile oil.
- Rutacridone, rutacridone epoxide and gravacridondiol (acridone alkaloids) are obtained from the roots of *R.graveolens*.
- Graveoline (an alkaloid) is obtained from its leaves.

USES

- It is used as an emmenagogue, haemostat, intestinal antispasmodic, sedative, uterine stimulant, vermifuge, rheumatism and in cold and fever in Chinese medicine.
- It is used as an aphrodisiac and choleretic in Poland.
- It is used as a bitter, an aromatic stimulant, ecobolic and for suppressing menses.

Steroids

Cardiac glycosides and Tri terpenoids

1. Liquorice
2. Dioscorea
3. Digitalis

Steroids

- Plant steroids are a diverse group of natural products.
- They are bio synthetically derived from S – squalene- 2,3-epoxide through acetate mevalonate pathway.
- **Phytosterols** are universal steroids in the plant kingdom and have been reported to show hypocholesterolemic activity.
- Withanolides are large steroidal lactones group having many biological activities.
- A small group of plant steroids brassinosteroids exhibit plant growth hormonal activity.
- Steroidal alkaloids are nitrogen containing plant steroids possessing various biological activities.

- In some plants, minute amounts of cholesterol and mammalion steroidal hormones including progesterone have been detected.
- Plant steroid analysis is done by chromatographic methods like thin layer chromatography (TLC),high performance liquid chromatography(HPLC),ultra high performance liquid chromatography(UHPLC), and gas liquid chromatography (GLC).
- An flouresence(FL) detectors and mass spectrometry (MS) are used for the detection, quantification and identification of plant steroids.
- Immuno assays and biological assays are a few less common techniques used in the analysis of plant steroids.

Chemical classes

Steroids are chemically classified in to the followings:

1. **Anabolic steroids:** They interact with androgen receptor, increase muscle mass/athlete's performance and male sex hormones.
2. **Glucocorticoids:** They regulate metabolism and immune function and exhibit anti inflammatory activity.
3. **Mineralocorticoids:** They maintain blood volume and renal excretion.
4. **Progestins:** They are involved in the development of female sex organs and characteristics.

5.Phytosteroids: They are plant steroids.

6.Ergosteroids: They are the steroids of fungi, and are vitamin D related.

Bio sources

Steroidal alkaloids found in the plants of Solanaceae and Melanthiaceae family (specially the genus ***veratrum***) cardiac glycosides, phyto sterols and brassino steroids (which include many plant hormones) are the sources of plant steroids.

Therapeutic uses: Steroids are used in different forms,

1.Tablets,syrups and liquids eg – prednisolone

2.Inhalers and nasal sprays eg –beclomethasone and fluticasone.

3.Creams,lotions and gels, eg,.hydrocortisone.

Steroids are used in following conditions:

1. Asthma and chronic obstructive pulmonary disease(COPD)
2. Hay fever
3. Hives and eczema
4. Painful joints or muscles such as arthritis, tennis elbow and frozen shoulder
5. Pain caused by an irritated or trapped nerve such as sciatica
6. Inflammatory bowel disease such as crohn’s disease
7. Multiple sclerosis(MS)

Commercial Applications

- The converted form of diosgenin i.e.

16 – dehydro pregnenolon acetate is an active ingredient in many steroidal drug preparations like sex hormones and oral contraceptives pills.

- For washing silk, wool and hair, saponins of ***Dioscorea*** are used.
- They are also used as fish poison and for killing lice.
- Solasodine and hecogenin are used in the production of sex hormones and oral contraceptive pills.

1.Liquorice

- Liquorice is a perinnial herb cultivated in the Mediterranean region and central and South West Asia for its sweet taproot (thus, also termed **sweet root**).
- The plant gives purple with white coloured flowers and its roots grow to a depth of 4 feet (1.2 m).

Synonyms

Radix glycyrrhizae and sweet liquorice.

Biological source

Liquorice is dried peeled or un peeled roots and stolon of different varieties of ***Glycyrrhiza glabra.***

Family

Leguminosae

Geographical source

- On a large scale, it is cultivated in Spain, Sicily and Yorkshire(England).
- Other species of liquorice like ***G.glabra var violaceae*** is found in iran.
- ***G.glabra var glandulifera*** is cultivated in Russia and is named the **Russian Lliquorice**.
- In Asian continent, it is cultivated in india (sub - Himalayan tracts) and Baluchistan.

Macroscopic Features

Size – several feet in length, varies in thickness from ¼ to about 1 inch and longitudinally wrinkled.

Shape – Liquorice root is long, straight, nearly cylindrical and occurs as unpeeled pieces.

Colour – Externally greyish brown to dark brown.

Taste – Sweet and very slightly acrid.

Odour – Weak and somewhat aromatic.

Fruit – Legume.

Microscopic features

The T.S of the stolon shows the following characteristics:

Outer surface – Around 10 rows of narrow cork cells are present.

Cork cells – These are thin walled cells, poly gonal in nature, beneath this may be a few parenchyma rows forming the cortex.

Parenchymatous Pericycle – It has small groups of fibers at intervals.

Phloem fibers – These are thick walled, lignified cells with sieve tissue. Sieve tubes are clear near the cambium.

Xylem – It consists of strongly lignified xylem fibers and vessels with little xylem parenchyma.

Medullary rays – These are composed of cellulosic parenchyma having rectangular and radially elongated cells.

- Parenchymatous cells contain a solitary prism of calcium oxalate.
- All the parenchyma cells contain either calcium oxalate crystals or starch.

Pith – it is parenchymatous.

Chemical constituents

- The main constituent of liquorice is **glycyrrhizin** (6-8%) in the form of sweet (50 times sweeter than sucrose).
- White crystalline powder consisting of calcium and potassium salt of **glycyrrhizic acid**.
- Glycyrrhizic acid on hydrolysis yields **glycyrrhetic** or **glycyrrhetinic acid**.
- It also contains two flavonoids **liquiritin** and **iso liquiritin.**
- The flavonoids are responsible for its anti gastric effect and are used in peptic ulcer treatment.

Chemical tests

- On addition of 80% sulphuric acid to a section or powder of the drug, orange yellow colour is produced due to the transformation of liquiritin (flavone glycoside) to isoliquiritin (chalcone glycoside).
- Powdered drug on reacting with water in the presence of KOH gives a red colour.

Uses

- It is used as a sweetening agent and in bronchial problems (flu and coughs).
- It is used as an expectorant and demulcent.

- It is used in **peptic ulcer** and as an antispasmodic.
- It is used as a **flavouring agent** for chewing tobacco and snuff tobacco.
- Its prolonged use raises the blood pressure and causes water retention.
- Its prolonged use raises the blood pressure and causes water retention.
- Its root is used externally in the treatment of herpes and eczema.

Substitutes and Adulterants

- **Manchurian liquorice** is obtained from ***Glycyrrhiza uralensis***.
- It is pale chocolate brown in colour with exfoliated cork and wavy medullary rays.
- It is free from sugar,but contains glycyrrhizin.
- **Russian liquorice** may be peeled and obtained from ***Glycyrrhiza glabra*** **variety** ***glandulifera***.
- The drug is purplish in colour with numerous long roots, but no stolons.

2.Dioscorea

- In the family Dioscoreaceae, around 600 species of flowering plants are classified under the genus Dioscorea.
- The genus is named after the ancient Greek physician and botanist, Dioscorides.

Synonyms

Yam, kins and singli – mingli.

Biological source

Dioscorea is the dried rhizome of several species of Dioscorea like ***Dioscorea deltoidea***,***D.composita*** and other species of Dioscorea.

Family

Dioscoreaceae

Geographical source

- It is cultivated in North Japan, china,Mexico,india and Nepal.
- In india it grows widely in western Himalayas.
- Karnataka,jammu and Kashmir,Maharashtra,tamil nadu,west Bengal etc

Macroscopic Features

Colour – Slightly brown

Odour – Odourless

Taste – Bitter

Size – Varies depending upon age of rhizomes.

Macroscopic Features

- Epidermis is normally absent in the transverse section of the drug.
- The cork consists of only a few layers,followed by thin walled cortical parenchymatous tissue.
- Stele forms the major part of the drug and consists of several close colleteral fibro vascular bundles.

Chemical constituents

- It mainly contains **diosgenin** (a steroidaL sapogenin) epimilagenin (its glycoside) and **yamogenin**(a β-isomer).
- it also contains sapogenase, phenolic compounds and starch.

Chemical tests

When diosgenin (a steroidal sapogenin) is treated with acetic anhydride in the presence of sulphuric acid,it gives a bluish green colour.

Uses

- It is a major source of diosgenin which is used for the manufacture of progesterone and other steroidal drugs.
- These are used as contraceptive and in diseases like asthma and arthritis.

Substitutes and Adulterants

- ***Dioscorea floribunda*** is cultivated in Central America and india (Karnataka state). It contains 3 – 5% of diosgenin.
- ***D.Villosa*** is a perennial herb with yellow flowers and triangular capsules. ***D.villosa*** contains more diosgenin.
- ***Sikkimensis prain*** contains 2 – 2.8% of diosgenin.
- ***Costus speciosus*** is an alternative potential source for diosgenin (1.5%) and can be used as a substitute for the genunine drug.

Digitalis

The genus Digitalis has around 20 species of herbaceous, perennial shrubs. The digitalis plant is also known as **foxgloves**.

Synonyms

Digitalis leaves and Foxglove leaves.

Biological source

- Digitalis is the dried leaves of ***Digitalis purpurea*** dried at a temperature below 60C immediately after collection.
- The leaves should not contain more than 5% of moisture.

Family

Scrophulariaceae

Geographical source

- It is cultivated in Europeon countries like England, France, Germany, North America and India.
- In India, it is grown in Kashmir and Nilgiri hills.

Macroscopic features

Colour – Dorsal surface is deep green and greyish, but ventral surface is pale green and more greyish.

Odour – Slight, characteristic.

Taste - Bitter

Size – Length 10-40cm and width 4-20cm

Shape – Ovate (egg shaped), lanceolate (widest in the middle and tapering). Apex is pointed. Margin of the leaf is serrated or crenate (broad rounded teeth).Tips are obtuse (rounded with narrow spaces).Petiole is small and winged.

Microscopic Features

- Digitalis is a dorsiventral leaf. It has **anomocytic stomata** on both surfaces and water pores at the apex of most of the marginal teeth.
- The **trichomes** are uni seriate, multi cellular (3 to 5 cells) and bluntly pointed. Glandular trichomes are also present with uni cellular stalk and uni cellular head.

- Collapsed celled covering trichome is an important characteristic of digitalis.
- Digitalis is free of calcium oxalate crystals and sclerenchyma
- Starch grains are present in the endodermis.
- There is collenchyma at 3 different places at the upper epidermis,lower epidermis and pericyclic part.

Chemical constituents

- Digitalis contains 0.2 – 0.45% mixtures of both primary and secondary cardiac glycosides (cardenolides).
- Purpurea glycosides A and B and glucogitaloxin are primary glycosides possessing at C-3 of the aglycone.

- Digitalis also contains several other glycosides such as odoroside H, gitaloxin, verodoxin and glucoverodoxin.
- It also contains 2 saponin glycosides digitonin and gitonin.
- The total number of glycosides reported in the drug is about 30.
- Apart from the glycosides, leaves also contain hydrolytic enzymes.

Chemical tests

1.Keller-Killani Test for Digitoxose: About 1gm of the digitalis powder is boiled with 10ml of 70% alcohol for 2-3 minutes.

- This extract is filtered and the filtrate is added to 5ml water and 0.5ml strong solution of lead acetate.

- This mixture is shaken well and the filtrate is separated.
- The clear filtrate is treated with an equal volume of chloroform and evaporated to form extract.
- The extract is dissolved in glacial acetic acid and after cooling, 2 drops of ferric chloride solution is added.
- These contents are transferred to a test tube containing 2ml of concentrated sulphuric acid.
- A reddish brown layer acquiring bluish green colour after standing is observed due to the presence of digitoxose.

2. Legal Test: The extract is dissolved in pyridine,sodium nitroprusside solution is added to it and made alkaline. A pink or red colour is produced.

3. Baljet Test: To a section of digitalis, sodium picrate solution is added. It shows yellow to orange colour.

4. Keddes Reagent: Cardenolides react with this reagent to give blue or violet colour.

5. Raymonds Test: Digitalis is dissolved in 1ml of 50% ethanol and 0.1ml of 1%solution of dinitrobenzene in ethanol or methanol is added. 2-3 drops of 20%NaOH are added to the mixture. A violet colour is produced which changes to blue.

6. Tollens Test: On dissolving the glycoside in a mixture of pyridine and ammonical silver nitrate solution, a precipitate of silver is obtained.

Uses

- Digitalis increases the force and velocity of contraction of the normal and failing heart.
- In congestive heart failure digitalis increases the activity of cardiac muscles.

Substitutes

1.Adonidin:The active principle of ***Adonis vernalis***

(Ranunculaceae) is a glucoside. Adonidin acts more quickly and powerfully than digitalis, and has more curative power.

2.Foxglove

Adulterants

1.Common Mullein Leaves: The leaves of ***Verbascum thapsus*** (Scrophulariaceae) are mixed with the genuine drug. This has large wooly branched candelabra trichomes.

2.Primrose Leaves: The leaves of ***Primula vulgaris*** (Primulaceae) are added to digitalis. They have uni seriate covering trichomes which are 8-9 celled long. The lateral veins of the leaves of primrose are straight.

3.Comfrey Leaves: These are the leaves of ***Symphytum officinale*** (Boraginaceae) and can be detected by the presence of multicellular trichomes forming hook at the top.

VOLATILE OILS

1. Mentha
2. Clove
3. Cinnamon
4. Fennel
5. Coriander

1.Mentha

- Mentha is the oldest known species of medicinal plant.
- It is used as a flavouring agent.it is also used in cosmetics and other pharmaceutical products.

Synonyms

Oleum mentha piperita,Colpermin and Mentha oil.

Biological source

The oil is obtained by the steam distillation of fresh flowering tops of the plant ***Mentha piperata***. The oil is rectified. Mentha oil should contain not less than 50% of total menthol.

Family

Labiatae

Geographical source

It grows wildly in Europe, France, Italy, USA, Bulgaria and USSR. It is cultivated in Jammu and in Tarai region of Uttar Pradesh in india.

Preparation of oil

- Mentha plants are dried to 1/4th of their weight to reduce the bulk. Drying in direct sunlight causes loss of volatile oil.
- While drying the herb, it should not undergo fermentation, or else the quality and quantity of oil will be severely affected.
- The material dried in air is charged in to galvanized iron or mild steel still having a false perforated bottom.

- Steam under pressure is generated with a boiler, and passed through the drug, which takes around 3 to 4 hours for distillation.
- During the first half of distillation, more than 80% of the oil is distilled off.
- Distillation should be carefully finished because menthol obtained in the final stage of distillation is medicinally and commercially important.
- The condenser should be aluminium or stainless steel. Collection of mentha oil is done in separating can.
- Mentha oil floats in the separating can and insoluble in water. This oil is decanted and filtered.

Macroscopic Features

Colour – Colourless to yellow

Odour – Characteristic and pleasant

Taste – Pungent followed by cooling sensation

Solublity – Soluble in 70% alcohol,ether and chloroform.in soluble in water.

Microscopic Features

- **Upper epidermis** with a few glandular trichomes, palisade parenchyma, cells with abundant chloroplasts.4 – 6 layers of parenchyma.no stomata.
- **Lower epidermis** epidermal cells with numerous diacytic stomata. non glandular and glandular trichomes are present. Calcium oxalate crystals are not present.

Chemical constituents

- The chief constituent of mentha oil is **L-menthol** which contains 70% of menthol, American variety contains 80% of menthol and the Japanese variety contains 70 – 90% of menthol.
- Menthone, **menthofuran, jasmine, menthyl iso valerate**, **menthyl acetate** and many other terpene derivatives are other important constituents of mentha oil.
- Other terpenes includes L-limonene, isopelugol, cineole, pinene, camphene etc.
- The pleasant flavour of mentha oil is because of **jasmone** and esters, and its dirty smell is due to resinification caused by **menthofuran**.

Chemical test

- A few drops of peppermint oil are mixed with 5ml of nitric acid solution (prepared by mixing 1ml of nitric acid with 300ml of glacial acetic acid).
- The resultant mixture is heated on waterbath.
- A blue colour appears within 5 minutes of heating.
- On further heating,the blue colour darkens to copper colour fluorescence,which becomes golden yellow after some time to give a clear and transparent liquid.

Uses

- It is used as a carminative, stimulant and flavouring agent.
- It shows mild antiseptic properties.
- It is used in toothpastes, tooth powders,shaving creams and in various pharmaceutical dosage forms.
- It is also used for preparing chewing gums, candies, jellies, perfumes and essences.
- It possesses calcium channel blocking activity which produces spasmolytic and smooth muscle relaxant effects. so,it is used in irritable bowel syndrome.
- It stimulates the bile flow thus exhibits digestant activity.

- Due to its muscle relaxant activity mentha oil is used to relieve spasm during endoscopy of colon.
- Azulene present in the leaves shows anti inflammatory and anti ulcer activity.
- It is considered by U.S.F.D.A as generally regarded as safe nasal decongestant.
- It is used for inhalation in steam, and in topical products and lozenges for its antitussive properties.

Substitutes and Adulterants

- Many species of mentha contain oil, and sometimes these oils are de – mentholised and used as drug adulterants.
- Mentha oil is generally adulterated with **cornmint** (difficult to detect even at 85%) and is the most adulterated oil.

2.Clove

Synonyms

Caryophyllum, clove flower and clove buds.

Biological source

Clove is the dried flower buds of the plant ***Eugenia caryophyllus*** and should contain 15%(v/w) or more of clove oil.

Family

Myrtaceae

The un opened pink coloured buds of cloves are found in evergreen clove trees. They are available through out the year.

Geographical source

- They are cultivated in Zanzibar, pemba penang, Madagascar, carribbean islands, Sri lanka and India.
- Nilgiri, Tenkasi hills and in Kanyakumari district of Tamilnadu state are the regions in India where cloves are grown.
- Kottayam and Quilon districts of Kerala are also famous for their cultivation.

Macroscopic Features

Colour – crimson to dark brown.

Odour – slightly aromatic.

Taste – pungent and aromatic followed by numbness.

Size – About 10-17.5 mm in length,4mm in width and 2mm thick.

Shape – Hypanthium is surrounded with 4 thick acute divergent sepals, these sepals are covered by dome shaped corolla which consists of un expanded membranous petals, several stamens and a single stiff prominent style.

Density – Cloves are heavier than water.

- The clove oil is Colourless to pale yellow in colour.
- During storage it becomes thick and darker in colour.

Microscopic Features

- The epidermis of clove has a thick cuticle covering and is composed of a large **anomocytic stomata** and straight walled cells.
- Schizolysigenous and ovoid shaped oil glands are present in almost all portions of the drug.
- The isolated **phloem fibers** are rarely found in the spongy tissue.
- **Calcium oxalate crystals** with small number of stone cells are also found in clove.
- Starch grains are absent.

Chemical constituents

- Clove contains about 15 – 20% of **volatile oil** and 10 – 13% of **tannin** in the form of **gallotannic acid, resin, chromone** and **eugenin.**
- About 70 – 90% of **eugenol, eugenol acetate, caryophyllenes** and trace amounts of esters, ketones and alcohols are present in the volatile oil of clove.

Chemical test

On treating the transverse section of clove with strong potassium hydroxide solution, it shows needle shaped crystals of potassium eugenate.

uses

Clove is used as

- Dental analgesic,
- Carminative,
- Stimulant,
- Flavouring agent,
- Aromatic and antiseptic.
- It is also used for preparing cigarettes.
- Clove oil is used in perfumery and in the production of vanillin.

Adulterants

1.Mother clove: These are ovate ripened fruits of clove tree appearing dark brown in colour.

- These cloves are slightly aromatic. starch grains and minimum quantity of volatile oil are present in them.

2.Blown clove: These are lengthened flowers of the clove tree with separated stamens.

- These cloves include volatile oil (in content less than that of the authentic drug) and their colour is similar to that of cloves.

3.Clove stalks: These adulterate the powdered cloves and get easily mixed with cloves as they are similar in colour, odour and taste.

- The presence of isodiametric sclereids and calcium oxalate prisms helps in their detection.
- They possess high content of ash value and crude fibers.

4.Exhausted cloves: These cloves are darker in appearance and are more shrunken.

- When exhausted cloves pressed with finger nails, oil does not exude out as it has been removed by distillation.
- These cloves float on water.

3.Cinnamon

Cinnamon obtained from the inner bark of the trees of genus ***Cinnamomum*** is majorly used in sweet and savoury foods.

Synonyms

Cinnamon bark, kalmi – Dalchini and Ceylon cinnamon.

Biological source

Cinnamon is the dried inner bark of the shoots of coppiced trees of ***Cinnamomum zeylanicum*** (syn.***Cinnamomum verum***) and should contain 1.0% or more of volatile oil.

Family

Lauraceae.

Geographical source

Cinnamon was found near srilanka and Malabar coast of india. Jamaica and brazil are also the sites of cinnamon, but mostly it is found in srilanka,so it is called as **sri lanka cinnamon**.

Macroscopic Features

Colour – yellowish brown

Odour – fragrant

Taste – aromatic and sweet followed by warm sensation

Fracture – splintery

Size – about 1mm in length,icm in diameter, 0.5mm thickness

Shape – found in the form of compound quills.

Microscopic Features

- Since cinnamon is the inner bark it lacks cork and primary cortex.
- Patches of **primary cortex** may be observed in rare cases.
- **Sclerenchymatous pericycle** is present
- The stelar portion of cork contains phloem,phloem fibers,biseriate medullary rays and secretory cavities with volatile oil and mucilage.
- In **cortical parenchyma** and **medullary rays**, starch grains are found.
- In the cells of parenchyma,**calcium oxalate crystals** are present.

Chemical constituents

- The crude drugs contains many essential constituents such as volatile oil (0.5 – 1.0%) and phlobatannins(1.2%).
- Mucilage, calcium oxalate, starch grains and mannitol are also present.
- Among these ,volatile oil is considered to be the active constituent which on distillation appears light yellow in colour.
- It changes its colour during storage and becomes red.
- Cinnamon oil (yellow to red colour) contains **cinnamaldehyde** (60-70%) **eugenol** (5-10%) **benzaldehyde, cuminaldehyde** and terpenes (phellandrene, pinene, cymene, caryophyllene etc.)

Chemical test

1.When a drop of ferric chloride solution is added to a drop of volatile oil, a pale green colour appears. This colour is achieved as cinnamic aldehyde on reacting with ferric chloride gives brown colour and eugenol yields blue colour.The pale green colour is the combination of brown and blue colours.

2.It yields brown colour with oil of cassia due to the presence of cinnamic aldehyde.

Uses

- Carminative, stomachic and mild astringent properties.
- Anti inflammatory , anti diabetic, anti ulcer ,anti microbial it inhibits the growth of yeast, bacteria, fungi etc
- It helps in reducing the LDL Levels and increasing HDL levels thus lowers cholesterol levels.
- Flavouring agent, stimulant, an aromatic and an antiseptic.
- Its anti oxidant properties protect from the damaging effects of free radicals.
- Used as a spice and condiment. Used in gastric disorders and dysmennorrhea.
- The oil is used in candies, dentifrices and perfume preparations.

Adulterants and substitutes

1.Jungle cinnamon: The main source of this cinnamon bark is wild trees.it is dark coloured. less aromatic than the cultivated trees, and slightly bitter in taste.

2.Cinnamon chips: These pieces are obtained from untrimmed bark.they arte different from the authentic drug as they show the presence of large number of cork cells.

3.Saigon cinnamon: It is the bark of ***Cinnamomum loureirii*** belonging to the family **Lauraceae** and is exported from Saigon.

4.Java cinnamon: It is obtained from ***Cinnamomum burmannii*** belonging to the family **Lauraceae**. This is a peeled,double quilled bark, less aromatic in nature. Contains 75%cinnamaldehyde.

4.Fennel

All the parts of fennel are eatable (roots,stalks and leaves,with the spice obtained from dried seeds).Fennel is native of Mediterranean. It is an ancient plant known to the ancient greeks and spread through out Europe.

Synonyms

Large fennel, Sweet fennel, Fructus foeniculi, Fennel fruit.

Biological source

Fennel is the dried ripe fruits of the plant ***Foeniculum vulgare***.

Family

Umbelliferae

Geographical source

Fennel is native of Mediterranean countries and asia.it is mainly grown in France,Japan,Russia and Persia.In india it is cultivated throughout the country and often grows wild.

Macroscopic Features

Fennel herb is 2m in height, glabrous and aromatic, having pinnately decompound leaves. The drug consists of partly Cremocarps and partly Mericarps.

Colour – Greenish brown **Odour –** Aromatic,

Taste – Sweet and aromatic **Size-** 0.5 -1.0cm long,2-4mm broad

Shape- Slightly curved and oval

Surface – Glabrous,5 prominent primary ridges, bifid stylopod at the apex.

Microscopic Features

- The epidermis of fennel contains pericarp with **anomocytic stomata**, and the mesocarp contains lignified and reticulate parenchyma.
- Parquetry arrangement of cells on the inner epidermis of pericarp (common in all umbelliferous fruits)
- **Vittae** (secretory canals)are brown in colour and contain volatile oil.
- Endosperm contains thick walled cells containing fixed oils, aleurone grains and small rosette crystals of calcium oxalate.
- Starch grains and trichomes are absent.

Chemical constituents

- Fennel contains 2 - 6.5%**volatile oil** and 12%**fixed oil**.
- The volatile oil contains 50 – 60% **phenolic ether** and 18 – 20% **fenchone** as its major constituents, which imparts a distinct odour and taste to the fruits.
- Methyl chavicol, anisic aldehyde,anisic acid,α – pinene,di terpene,limonene and phellandrene are the other volatile oil constituents.

Chemical tests

1. A thin section of fennel with alcoholic solution of sudan red III if globules becomes red indicates the presence of volatile oil ,if no colour volatile oil is absent.

2. A thin section of fennel with phloroglucinol and Conc.HCL (1:1) if pink patches appear lignified parenchyma and vascular bundles are present ,if not it is absent.

3. A thin section of fennel with alcoholic picric acid if it gives yellow colour confirms the presence of aleurone grains.

Uses

- Stimulant, aromatic, stomachic, carminative, emmenagogue and expectorant.
- It is a common ingredient for cough and stomach mixtures.
- It is used in disease related to chest, spleen and kidney.
- Anethole is added in mouth and dental preparations.

Substitutes

Some varieties of fennel are,

1.Saxony Fennel – 4mm in size,aromatic taste,4.76% volatile oil and 22%fenchone is present.

2.Russia or Romanian variety – 4 – 6mm in size, camphoraceous, 4.50%volatile oil,18%fenchone is present.

3.French sweet or Roman – 7-8mm in size,sweet and aromatic taste,2.1%volatile oil and fenchone is not present.

4.Indian Variety - 4-7mm in size,camphoraceous,0.720% volatile oil ,6.70% fenchone is present.

5.Japanese Variety – 3-4mm in size,very sweet, 2.70%volatile oil and 10.20% fenchone is present.

Adulterants

1. **Exhausted fennel** is generally used to adulterate fennel.
   - The alcohol exhausted fennel appears as fresh fennel and has 1-2% volatile oil.
   - The steam exhausted fennel appears dark, contain small amount of volatile oil and are heavier than water.
2. Un developed or mould attack fruits
3. Bitter fennel, synthetic *trans*-anethole, fenchone, methyl chavicol and limonene.

5.Coriander

Coriander herb is grown once in a year. It is also well known by the names of **cilantro** or **Chinese parsley**. All its parts are edible but fresh leaves and dried seeds are mostly used for cooking purpose.

Synonyms

Coriander fruits, Chinese parsley and Indian parsley.

Biological source

Coriander is the fully dried ripe fruits of the plant ***Coriandrum sativum.***

Family

Umbelliferae

Macroscopic Features

Colour – Yellowish brown to brown

Odour – Aromatic

Taste – Spicy and characteristic

Size – Fruits are 2 – 4mm in diameter and 4-30mm in length.

Shape – Sub globular cremocarpous fruit.

Extra features – 10 wavy primary ridges and 8 straight secondary ridges are present on the outer surface.it is further described as an **endospermic** and a **coelospermic** fruit.

Microscopic Features

- The **epidermis** part of the pericarp is formed of polygonal tubular cells **with stomata**.
- Inner epidermis of pericarp consists of **parquetry cells**.
- **Calcium oxalate** prisms are found in epidermal cells.
- In mesocarp inner and outer layer of parenchyma is present along with a layer of **sclerenchyma**.
- In **endosperm**, fixed oil globules are found and volatile oil is present in the **vittae**.
- The polygonal thick walled cellulose parenchyma of endosperm contains **aleurone grains.**

Chemical constituents

Coriander is chemically constituted with;

- Volatile oil (0.3-1%)
- Fixed oil(13%)
- Proteins(20%)
- **The volatile oil contains**,90% of D-linalool (coriandrol)
- Coriandryl acetate, L-borneol, geraniol and pinene(in trace amounts)
- Coriander leaves contain rich content of vitamin A. Coriander fruits yield 5-7% of ash. The composition of volatile oil varies during the storage of crude drug.

Chemical tests

Prick test: 2-5mg of powdered coriander is applied on the skin with a drop of saline solution, and then pricked in to the skin. The reactions occurring are observed after 15 minutes. Reactions with a diameter of atleast 3mm larger than the negative control (saline solution) are regarded positive.

Uses

Aromatic, carminative, stimulant and flavouring agents. The oil is used along with purgatives to prevent gripping.It is an ingredient in orange spirit and cascara elixir.

Substitute

Ellipsoidal **Bombay coriander fruits** having less volatile oil.

TANNINS

1. Pale catechu
2. Black catechu
3. Pterocarpus

1.Pale catechu

Synonyms

Gambier, Pale catechu, Terra japonica and Catechu

Biological source

Pale catechu is an extract prepared from the leaves and young shoots of plant ***Uncaria gambier*** roxburg.

Family

Rubiaceae

Geographical source

Largely cultivated in Singapore and Sumatra.

Macroscopic Features

Form – Regular cubes,2-3cm on each side, or irregular broken pieces.

Colour – Dark reddish brown to brown colour

Odour – Odourless

Taste – First bitter and astringent, then sweetish

Surface – Dull

Fracture - Brittle

Microscopic features

- A little of the powdered drug mounted in lactophenol and examined under microscope exhibits numerous minute **acicular crystals of catechin**.
- The residue left after extraction with alcohol may be examined for starch which should be absent.
- The residue insoluble in water consists mainly pieces of **epidermis, trichomes, cork cells, pollen grains** and other vegetable debris of the young leafy twigs used in its preparations.

Chemical constituents

- Pale catechu contains about 7.33% (+)catechin and 22-50% catechu tannic acid. These two substances in varying proportions constitute together over 60% of the drug.
- Catechu tannic acid gives a green colour with ferric chloride solution,indicating a phlobatannin.
- Brown substance,rubeanic and japonica acids of unknown chemical nature are also present.
- Other constituents of the drug are catechu-red, quercetin and gambier fluorescein (a fluorescent substance).

Chemical Tests

1.Gambier fluorescent Test

A little powdered drug is boiled with alcohol,filtered and sodium hydroxide solution is added to the filtrate stirred and a few ml of light petroleum is added. Petroleum layer shows green fluorescence. Due to the presence of fluorescence constituent.

2.Chlorophyll Test

The powdered drug is boiled with 5ml chloroform on a waterbath, filtered in a white porcelain dish and evaporated in a waterbath. a greenish yellow residue forms due to the presence of chlorophyll. Chlorophyll is absent in black catechu thus this test gives negative result.

3.Match stick Test

- A match stick is dipped in decoction of pale catechu, dried in air, dipped in concentrated hydrochloric acid and warmed near the burner. Magentha or purple colour is produced.
- By the action of HCL on catechins or catechol tannins, Phloroglucinol is produced which with lignin of the matchstick gives positive result.

4.Vannilin hydrochloric acid Test

- The drug treated with vannilin hydrochloric acid reagent which is a mixture of vannilin (1gm) and conc.HCL(10ML).
- Pink or red colour forms due to the formation of phloroglucinol.

Uses

- All parts of the plant have astringent properties
- In india, gambier is used as skin lotions and applied to treat **burns.**
- In paste form it is used to treat **scurf.**
- To treat **diarrhoea** and **dysentery** and as a gargle for **sore throat.**
- In the treatment of **sciatica** and **lumbago**.
- Gambier catechu yields a colour known as **cutch brown** which is used **for dyeing** and **tanning** cotton,wool and silk. Also used in leather such as calf and kip skins produce khaki colour.

Adulterants

- The adulteration of gambier has been done with mineral matter (clay,ferric hydroxide etc) starch and astringent extracts.
- Few dutch east indies gambier come in last blocks,have about 25% of moisture,and leaves around 30 – 45% of water.

2.Black catechu

Synonyms

Catechu, catechu nigrum, cutch khadir (Sanskrit), katha (hindi) cashoo, peru catechu and cachou.

Biological source

Black catechu is dried aqueous extract obtained from the heart wood of plant ***Acacia catechu***.

Family

Leguminosae

Geographical source

The tree is native of india and also found in Myanmar.

Macroscopic Features

Form – Irregular mass, outer surface is rough and dull and rarely glossy.

Colour – Black

Odour – Odourless

Taste – Bitter in the beginning and astringent afterwards

Fracture – Hard and brittle, and the broken surface is dark brown with a dull gloss and porous.

Surface – Rough, dull or slightly glossy and porous

Solublity – Partially soluble in cold water and alcohol, completely soluble in hot water.

Microscopic Features

- A transverse section of acacia catechu shows numerous uniseriate and biseriate **medullary rays** with vessels occurring isolated or in small groups of two or four.
- **Xylem fibers** with narrow lumen occupy major portion of wood and **xylem parenchyma** .
- Wood consists of crystal fibers having **prismatic crystals of calcium oxalate.**
- A few **tracheids** with scalariform thickening and some cells including vessels are also present.

Chemical constituents

- Black catechu contains **tannic acid**(7.5 – 35%) **catechin**(10-15%) **acacatechin** (2-12%) **phlobatannin** (25-35%) **gum** (20-30%) and **quercitin**.
- Minor constituents are quercetin, catechu red and moisture.
- **Acacatechin** contains (-)epi catechin which is the *trans* - form of acacatechin.
- During the extraction of heartwood chips with boiled water, epi catechin undergoes epimerization and racemization to dl-acacatechin.

Chemical Tests

1.Gambier fluorescent Test

A little powdered drug is boiled with 2 ml of ethyl alcohol, and 2ml of sodium hydroxide solution. Followed by a few ml of light petroleum ether. Petroleum layer does not shows green fluorescence. Black catechu is present.

2.Chlorophyll Test

The powdered drug is boiled with 5ml chloroform on a waterbath, filtered in a white porcelain dish and evaporated in a waterbath. No greenish residue forms. black catechu is present.

3.Match stick Test

- A match stick is dipped in decoction of tannin, dried in air, dipped in concentrated hydrochloric acid and warmed near the burner. Magentha or purple colour is produced.
- By the action of HCL on catechins or catechol tannins, Phloroglucinol is produced which with lignin of the matchstick gives positive result for tannins.

4.Vannilin hydrochloric acid Test

- The drug treated with vannilin hydrochloric acid reagent which is a mixture of vannilin (1gm) and conc.HCL(10ML).
- Pink or red colour forms due to the formation of phloroglucinol.indicates the presence of tannins.

5.Lime Water Test

Few drops of fresh aqueous extract of the drug are added to 10ml lime water. A brown colour is produced and on standing for 3 minutes a precipitate is formed. Black catechu is present.

6.Ferric Ammonium Sulphate Test

To an aqueous solution of drug (2%) solution of ferric ammonium sulphate is added, after formation of green colour sodium hydroxide is added. Green colour changes to purple colour.Black catechu is present.

Uses

Internal uses

- It has cooling and digestive properties, hence used in GIT disturbance.
- It is used in relaxed conditions of throat, mouth and gums.
- It is also used in cough and diarrhoea.

External uses

- Astringent, ulcers, boils and skin eruptions.

Industrial uses

- It is an ingredient in betal leaf (paan) and paan masala, so it is largely used in katha industry.

3.Pterocarpus

Synonyms

Bijasal,Indian kino tree and Malabar kino.

Biological source

Pterocarpus is the dried juice of ***Pterocarpus marsupium*** linn. The juice is obtained from the stem and bark by making vertical incisions. The exuding juice is collected and dried.

Family

Leguminosae

Geographical source

It is widely distributed in the hilly regions of gujarath,Madhya Pradesh, uttar Pradesh, bihar and orissa.it is also cultivated in the forest of karnal, kerala, west Bengal and assam.

Macroscopic Features

Colour – Ruby red

Odour – Odourless

Taste – Astringent

Size – 3-10mm granules

Shape – Angular grains

Solublity – Partially soluble in water, fully soluble in alcohol.

Microscopic Features

- Transverse shows alternating bands of larger and smaller polygonal cells comprising of **tracheids**, **fiber trachieds**, **xylem parenchyma** and transversely arranged **xylem rays**, **xylem vessels** are distributed all over.
- **Tyloses** filled with tannins are present.
- Tracheids are long,thick walled having tapering ends and simple pits.
- Xylem parenchyma comprises of rectangular cells with simple pits and xylem rays are uni – to – biseriate.
- Calcium oxalate crystals are present and starch is absent.

Chemical constituents

- Kino is having around 70 – 80% of **kino tannic acid, kino red, k-pyrocatechin (**catechol**) resin** and **gallic acid.**
- Kino tannic acid is glucosidal tannin and kino red is a kinoin an hydride.
- Kinoin is an insoluble phlobaphene, which is produced when acted upon by the oxidase enzyme, its colour is darker than kino tannic acid.

Chemical tests

- On treating the solution of pterocarpus with ferrous sulphate a green colouration develops.
- On treating the solution of pterocarpus with alkali(potassium hydroxide) a violet colouration develops.
- On treating the solution of pterocarpus with mineral acid a precipitate develops.

Uses

- Powerful astringent, in diarrhoea, dysentery, and passive haemorrhage toothache.
- The aqueous infusion of the wood is used in diabetes.it also shows hypoglycaemic action.

Resins

1. Benzoin
2. Guggul
3. Ginger
4. Asafoetida
5. Myrrh
6. Colophony

1.Benzoin

Benzoin has 4 varieties **Sumatra, Palembang, Penang** and **Siam benzoin**. They are easily identified by their specific look. Sumatra, penang and siam benzoin are three derivatives which are derived from 3 different plants.

Synonyms

Sumatra benzoin and loban.

Biological source

- The balsamic resin derived from ***styrax benzoin*** or ***styrax parallelloneurus*** known as **Sumatra benzoin**.
- The balsamic resin obtained from ***styrax tonkinensis*** is **siam benzoin**.

Family - Styraceae

Geographical source

Sumatra benzoin is obtained from the trees grown in south eastern Asia. while siam benzoin is obtained from the trees grown in Thailand and Vietnam.

Macroscopic Features (Sumatra benzoin)

Colour – Greyish-brown or grey

Odour – Aromatic and characteristic

Taste – Sweetish and slightly acrid

Shape – Lumps of varying sizes or tears

Surface – Un even

Nature – On heating it produces fumes of benzoic and cinnamic acids.

Macroscopic Features (Siam benzoin)

Colour – Yellowish brown to rusty brown

Odour – Agreeable and vanilla like

Taste – Sweetish and slightly acrid

Shape – Hard and brittle masses

Extra features – On heating, it softens in to paste

Chemical constituents

Benzoin contains free balsamic acids and esters of balsamic acids.

- **Sumatra benzoin** has benzoic acid (18% or more) and cinnamic acid(20%).
- Cinnamic acid is partially free and partially combined with benzoresinol and sumaresinotannol.
- It also has vanillin(1%),styrol, styracin, phenyl –propyl cinnamate and benzaldehyde. with the combination of these constituents Sumatra benzoin get its specific odour.
- **Siam benzoin** has benzoic acid(38%) is the main component.
- It is partially free and partially combined with benzoresinol and siaresinotannol.
- It also consists of vanillin and an oily aromatic liquid.
- In its pure form it is completely soluble in alcohol.

Chemical tests

- On treating benzoin alcoholic solution with water a milky white solution develops.
- A small quantity of benzoin is heated in a test tube mouth is covered with a glass plate. The contents of the tube are cooled and on viewing under microscope, cinnamic acid crystals should be observed.
- 2.5gm benzoin is shaken with 10ml ether,2-3ml of this extract is poured in porcelain dish and added with 2-3 drops of sulphuric acid. A deep brown colour develops for Sumatra benzoin and purplish red colour for siam benzoin.
- Igm of benzoin warmed with 4ml of potassium permanganate. Odour of benzaldehyde produced in Sumatra benzoin.

Uses

- It acts as an irritating expectorant, a carminative, and diuretic.
- It is used externally as an antiseptic.
- It is used in the form of compound tincture of benzoin, and as an inhalation for treating upper respiratory tract infection.
- It is used to delay the rancidity of fats and oil in the preparation of benzoate lard.

Adulterants

- ***L ,styraciflua*** (or sweet gum) is the American variety obtained by exudation is called liquidamber, liquid storax or copalm balsam.
- ***L ,storesin*** in eastern market is an aromatic resin are obtained from ***L.formosana*** in china and from ***L.altingea*** (*Altingia excelsa*) in java and burma.where the storax like substances are white to red in colour.
- ***Styrea reticulata*** and other species in brazil secrete a fragrant substance (similar to benzoin) which is used in churches as frankincense.
- The most common adulterants are **sawdust** and **turpentine**.

2.Guggul

Guggul is obtained from the sap (gum resin) which exudes from the Indian tree ***Commiphora wightii***. In ayurveda,the uses of guggul are mentioned before 600BC,Ancient reveals the use of guggul in treatment of atherosclerosis.

Synonyms

Guggal,palankasha and Devadhupa.

Biological source

Guggul is an oleo gum resin(oleo resin) that exudes as a result of injury from the bark of the plant ***commiphora wightii***.

Family

Burseraceae

Geographical source

The guggul plant may be found from northern Africa to central Asia, but is most commonly found in northern india.

Macroscopic Features

Plant – Branched,thorny,dimorphic and bisexual

Leaves – Serrate,obovate,1-5cm long,0.5-2.5cm broad,neem like.

Flowers –Red or sometimes pink in colour.

Fruits – Pulpy and ovate in shape

Juice – Thick, aromatous, inflammable and melts in sun. when it is immersed in warm water, it attains milky white colour.

Colour – Brown to pale yellow or dull green.

Odour – Agreeable, aromatic and balsamic.

Taste – Bitter and characteristic.

Chemical constituents

Guggul comprises of steroids, diterpenoids, aliphatic esters, amino acids etc in a complex mixture. some phyto chemicals like **guggulsterone I,II,III,IV,V,Z – guggulsterone, E-guggulsterone** and **16 – β – hydroxy progesterone** are also characterized. **Mukulol** (a type of alcohol) is also reported to be present in guggul.

Chemical test

An extract of guggul is prepared using ethyl acetate,to this extract acetic an hydride is added and boiled.on cooling the resultant solution 2ml of H_2SO_4 is added which results in the formation of green colour at the junction of liquid due to the presence of sterols.

Uses

- As per the Ayurveda,oleo gum resin obtained from guggul is used in various disorders like obesity, arthritis and rheumatism.
- It is also used as anti inflammatory and hypo-cholesteremic drug.

Recent scientific researchers have confirmed the anti-hyperlipidemic activity of guggul in semi purified form which is patented in the name of **Gugulip** and is marketed by cipla.

Adulterants

Guggul can be adulterated with various species of commiphora such as, ***C.abyssinica***, ***C.roxburghii***, ***C.molmol*** and also with ***Boswellia serrata*** that contains lesser amount and inferior quality of phytochemicals.

3.Ginger

Synonyms

Zingiber and zingiberis

Biological source

Ginger is rhizomes of ***Zingiber officinale***. Its outer skin is removed by scraping,after which it is dried in the sun. Its market name is Jamaica ginger.

Family

Zingiberaceae

Geographical source

More than 35%of worlds ginger is produced in india.it is also cultivated in Africa, Australia, Jamaica, Taiwan and India.

Macroscopic Features

Colour – Externally buff coloured

Odour – Agreeble and aromatic

Taste – Agreeble and pungent

Size – Rhizomes are 5 to 15 cm

Shape – Rhizomes are laterally compressed, flat, ovate and oblique branches on the upper side, with bud at the apex.

Fracture – Short and fibrous

Surface – Longitudinally striated with projecting fibers

Extra Features – T.S shows well marked endodermis and stele.

Microscopic Features

Cork: It comprises of irregularly arranged cells, followed by cortex

Cortex: It comprises of thin walled parenchymatous tissue.It is distinguished from stele by a well marked endodermis. Many closed collateral fibro vascular bundles are enclosed within the cortical tissue.

Vascular bundles: They are present just inside the endodermis and are free of fibers

Endodermis: It is free from starch, and oleo resinous cells and starch grains are found all over the ground tissue.

Chemical constituents

- Ginger contains 1-4% of **volatile oil**,40-60% of **starch**,10% of **fat**,5% of **fiber**,6% of **inorganic material,**10% of **residual moisture** and 5-8% of **acrid resinous matter.**
- Ginger oil contains **monoterpene hydro carbons**, **sesqui terpene hydrocarbons**, oxygenated mono and sesquiterpenes and phenyl proponoids.
- Ginger oil also contains **α-zingiberene, β-bisabolene, α-farnesene, β-sesquiphellandrene** and **α – curcumene**.

- The main character of ginger are aroma and flavour. The aroma is due to the presence of fragrant principles of volatile oil and Pungency due to phenolic ketones of oleo resin.
- Volatile oil components such as isometric terpenic aldehydes like geraniol and citral, produces mild and lemony aroma.
- Few sesquiterpene oil hydrocarbons produce the spicy flavour.
- Phenolic ketones of oleo resin include **gingerols** such as shogaols, zingerone, paradols, gingediols hexa hydro curcumin and their o-methyl ethers.

Chemical tests

To 1gm of pulverized ginger,5ml of dilute acetic acid(prepared by diluting 1 part of glacial acetic acid with 1 part of water) is added and shaken for 15 minutes. The resultant mixture is filtered. A few drops of ammonium oxalate is added to the filtrate, which gives rise to a slight turbidity.

Uses

- It is used as an anti emetic, and its aromatic, carminative and absorbent properties improve the effects of motion sickness directly in the GIT.
- It is also used for lowering cholesterol levels by inhibiting cholesterol biosynthesis.

- It also shows anti tussive, anti pyretic and analgesic properties
- Its rhizomes show fungicidal, anti bacterial and anthelmintic properties.
- Sesquiterpene hydro carbons are the reason for its anti ulcer activity.

Adulterants

Spent ginger – in this ginger the essence has been extracted due to which it produces lower than official standards for extracts.

- For increasing pungency sometimes adulterated with **capsicum** or **grains of paradise**.

4.Asafoetida

The name Asafoetida has been derived from the latin word **foetid** which means smelly. Asafoedita is a genus of perinnial herbs.it has a very distinct, pungent odour.It is a spice used as a digestive aid, in food as a condiment, and making pickles.

Synonyms

Gum asafoetida and Devils dung.

Biological source

It is a oleo gum resin obtained by incision from the rhizomes and roots of ***Ferula foetida***.

Family

Umbelliferae

Geographical source

Asafoetida is found to be distributed from Mediterranean region to central Asia, especially in Iran and Afghanistan. Three species of Ferula are found in india. ***Ferula narthex*** occurs in Kashmir.

Macroscopic Features

Colour – Yellowish white changing to reddish brown.

Odour – Intense, persistent, penetrating, and alliaceous.

Taste – Bitter, alliaceous and acidic.

Size – Tears are 0.5 – 3cm in diameter.

Shape – Occurs in 2 different forms tears and masses. Tears are rounded or flattened.

Chemical constituents

- Asafoetida contains **resin** (40-65%),**gum** (20-25%) and **volatile oil** (4-20%).
- The chief resin of asafoetida is **asaresinotannol** present either in free form or is combined with **ferulic acid.**
- Asafoetida oil obtained by steam distillation of the oleo gum resin.
- The oil contains **secondary butyl propenyl disulphide** as its chief constituent. Di and tri sulphides, pinene and other terpenes are also present in the oil.

Chemical tests

- On treating with sulphuric acid, a red or reddish brown colour appears.
- On treating with 50%nitric acid, it yields a green colour.
- On triturating with water it forms a yellowish orange emulsion.

Combined umbelliferone test

- If the drug is in tear form, it is triturated with sand. About 0.5gm of the drug is boiled with 3ml of HCL acid and 3ml of water for 5-10 minutes. The resultant mixture is filtered, and an equal volume of alcohol and excess of strong solution of ammonia are added to the filtrate. A blue fluorescence appears due to the presence of combined umbelliferone.

Uses

- Sometimes it is used as an antispasmodic, carminative, expectorant and laxative.
- It is also a powerful nerving stimulant, used in nervous disorders related to hysteria.
- It is also used as intestinal flatulence.
- Its 2% (w/v) suspension is used as a repellant against dogs, cats, deer, rabbits etc

Adulterant

- Asafoetida is adulterated with **gum Arabic, rosin, gypsum, red clay, chalk and barley** or **wheat flour.**

5.Myrrh

Myrrh is a sap like resin which is obtained by making incisions in the bark of trees that belongs to the members of the **Commiphora** species.

Synonyms

Gum, Bol and Myrrha.

Biological source

Myrrh is an oleo- gum- resin obtained from ***Commiphora molmol*** from other Commiphora species.

Family

Burseraceae

Geographical source

Myrrh is widely distributed in North East Africa and Southern Arabia.

Macroscopic Features

Colour – Reddish - brown externally and brown internally.

Odour and Taste – Aromatic and agreeble.

Size – 3m in height and 1.5 – 3.0 cm in diameter.

Shape – Occurs as round or irregular tears.

Extra features – Fractured surface is slightly granular, fragile and has a translucent surface, whitish spots are present on the broken pieces.

Microscopic Features

The bark of commiphora species consists of,

- Outer sclerenchymatous cells. Beneath the sclerenchyma cells, thin walled parenchyma cells are present.
- Towards the internal surface of the bark, **schizolysigenous ducts** are present which consists of resinous secretions.
- These ducts are present among the **phloem parenchyma.**
- **Medullary** or **vascular rays** (made partly of xylem and partly of phloem) are also present in the interior of the bark. These medullary rays are biseriate and extend towards the **pith** (parenchymatous cells with intercellular spaces).

Chemical constituents

- Myrrh contains **yellowish thick volatile oil** (10%) **gum**(60%),**resin**(25-40%) and **bitter principle** (3-4%).
- It has many impurities which are about (5%).
- **Ether soluble resin acids**(α and β commiphora acids) are found in the resin portion of myrrh which are insoluble in ether.
- Terpenes, cuminic aldehyde, eugenol etc are found in the volatile oil of myrrh.
- The gum is associated with oxidase enzyme.

Chemical tests

- 0.1gm of the drug and 0.5 gm of the sand are triturated with solvent ether. The resultant is filtered and evaporated to attain a thin film, which on being treated with bromine vapours produces violet colour.
- On triturating the drug with water, a yellowish brown emulsion is formed.

Uses

- It is used as a stimulant and antiseptic.As a protective agent.
- It is astringent to the mucous membrane so it is used in mouthwashes and gargles.

ADULTERANTS

It is adulterated with

- **Arabian myrrh**
- **Yemen myrrh** etc. species.
- Both these species are less fragrant and less aromatic.
- Myrrh in india is adulterated with ***Balsamo dendron mukul*** called as Indian bdellium.

6.Colophony

Colophony is a translucent, hard substance and is produced from pine oleo resin. It is used particularly in inks and varnishes, and it is also used on the bows of stringed instruments.

Synonym

Rosin, Gandha bihrojaa (hindi and urdu)

Biological source

- Colophony is a yellow resin and **abietic anhydride**.
- It is the residue that remains after distilling the volatile oil from the oleo resin, which is obtained from ***Pinus palustris*** and various other species of ***P*inus**.

- Generally,it is obtained as wood rosin from southern pine stumps, gum rosin collected as the exudate from incisions in the living tree ***P.Palustris*** and ***P.Caribaea*** and finally from tall oil rosin.

Family

Pinaceae

Geographical source

- The genus Pinus is distributed in United States, France, Italy, Portugal, Spain, Greece, New Zealand, India, China and Pakistan.
- The Chief producer of colophony is United States, contributing 80% of world supply of colophony.

Macroscopic Features

Colour – Pale yellow to amber coloured fragments.

Odour – Turpentine like odour and taste

Nature – It produces a smoky flame when burned.

Shape – Translucent, hard, shiny, sharp fragments.

It easily melts on heating.

Solublity – It is insoluble in water, and readily soluble in alcohol, benzene, ether, glacial acetic acid, oil, carbondisulphide and alkali solutions.

Microscopic Features

Translucent, pale yellow to brownish yellow coloured, angular, irregularly shaped, brittle and glassy pieces of different sizes of conchoidal markings appear on its surface when viewed under a microscope.

Chemical constituents

- Colophony contains about 90% of resin acids, fatty oil esters and resenes.
- **About 90%** of the resin acids are isomeric **(α, β-abietic acids)** and the remaining 10% is a mixture of dehydroabietic acid and dehydroabietic acid.

Chemical tests

- A solution of 0.1gm powdered resin in 10ml acetic acid is taken in a dry test tube and added with a drop of conc.sulphuric acid. A purple colour appears, which readily changes to violet.
- The petroleum ether solution of powdered colophony is shaken with twice its volume of dilute solution of copper acetate, the colour of petroleum ether layer changes emerald green due to the formation of copper salt of abietic acid.
- The alcoholic solution of colophony is added with water turns milky white due to the precipitation of chemical compounds.
- The alcoholic solution of colophony turns blue litmus to red due to the presence of diterpenic acids.

Uses

- It is used as a hardening agent in ointments, adhesives, plasters and cerates.
- It is used as a diuretic in veterinary medicines.
- It is commercially used in manufacturing varnishes, printing inks, cements, soap, sealing wax, floor coverings, papers, wood polishes, plastics, fire works, tree wax, rosin oil and for cardboard water proofing.
- Abietic acids of colophony exhibit antimicrobial, anti ulcer and cardio vascular activity.
- Some of them have filmogenic, surfactant anti feedant properties.

Glycosides

1. Senna
2. Aloes
3. Bitter almond

1.Senna

Senna is a herb used as a laxative.it is also known as wild senna. *Cassia marilandica* or locust plant.in the ancient times arabian physicians used senna as cathartics.

Synonyms

Cassia senna,Folia senna and Tinnelvelly senna

Biological source

Senna is the dried leaflets of cassia angustifolia

Family

leguminosae

Geographical source

Cassia senna is found to be grown in tropical Africa and sudan while *Cassia angustifolia* is native to Arabia, Somalia, Sind and Punjab.

Macroscopic features

Colour - Yellowish green

Odour – Slight

Taste – Mucilaginous, bitter and characteristic

Size – 7-8 mm in width and 25 – 60 mm in length

Shape – Leaves are lanceolate, entire apex is acute with spine at the top. Base of the leaflets are asymmetrical with transverse lines, more prominent on lower surface.

Microscopic features

- Senna represents the typical histological characters of **isobilateral leaf** in which the epidermis shows the presence of unicellular, conical, thick walled **warty trichomes**. Trichomes are slightly curved at their bases and are present on both the surface.
- **Rubiaceous or Paracytic stomata** are present on epidermal surfaces. Palisade tissue is present on both the sides, consisting of rectangular cells, with **cluster crystals of calcium oxalate.**
- A patch of sclerenchyma towards the upper epidermis and above xylem(also known as pericyclic fibers are present).
- **Cluster sheath** and **collenchyma** are characteristics of senna.

Chemical constituents

- Senna contains mainly 2 anthraquinone glycosides sennoside A and sennoside B (not less than 2.5%) which is responsible for its purgative property.
- **Tutin in 1913 isolated rhein** and **aloe emodin**. **Stoll** and his colleagues **in 1941** reported isolation of crystalline sennosides A and B.
- Sennosides A and B are sterio isomers of each other.
- Senna also contains Sennosides C and D, rhein-8-glucoside, rhein-8-diglucoside, aloe emodin, anthrone diglucoside, kaempferol and isorhamnetin. phyto sterol, mucilage, resin, myricyl alcohol, calcium oxalate are also present.

Chemical test

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

2.Little amount of senna leaves is extracted with water by boilng and then filtered.The filtrate is treated with 5N NaOH and sodium hyposulphate.On heating the mixture red colour develops.

Uses

It is mainly used as a purgative.

It is used as a stimulant cathartic.

It is also used in manufacturing sennosides.

Substitutes

1.Senna pods:These are fruits of cassia acutifolia,occasionally found mixed with the senna,and imported as a separate flat legumes.

2.Cassia obovata (Dog senna):Cultivated in Italy and termed Italian senna,leaves are broadly obovated,apex abruptly tapering,pinnate venation.Constituents are similar to senna.

The following are the **other varieties of senna** imported:

1. *Cassia Holosericea*
2. *Cassia Montana*
3. *Tephrosia Apollinea*
4. *Colutea Arborescens*
5. *Globularia Alypum*
6. *Coriaria Myrtifolia*

Adulterants

1. *Cassia brevipes*
2. *Cassia pubescens*
3. *Solenostemma argel*

2.Aloes

- Aloe vera is a plant species of the aloe genus.
- It grows wildly in tropical climates and is also cultivated due to its agricultural and medicinal values.
- Aloe vera is one of the most familiar of all the medicinal herbs. Out of more than 300 species of aloe, only 4 are believed to have medicinal properties.
- The most potent medicinal effects are believed to come from Aloe barbadensis, which is frequently produced in gel form.

Synonyms

Mussabar, kumari and aloes.

Biological source

Aloe vera is the dried juice obtained from the leaves of various species of aloe like

1.***Aloe barbadensis*** or **Curacao Aloe**

2.***Aloe ferox*** or **Cape Aloe**

3.***Aloe perryi*** or **Socotrine Aloe**

4.***Aloe Africana*** and ***Aloe spicata*** or **Cape aloe**

Family

Liliaceae

Geographical source

1. **Curacao,Barbados, Aruba:** Curacao aloes or Barbados aloes and Bonaire (west Indian islands)
2. **Cape town (South Africa):** Cape aloes
3. **Socotrine and Zangibar islands:** Socotrine or zangibar aloes

It is also cultivated in Europe and the north west Himalayas region in india.

Preparation

1.Cape aloes are prepared from wild plants of *A.ferox* and its hybrids.

- The leaves are cut transversely near the base and about 200 of them are arranged around a shallow hole in the ground which is lined with plastic sheeting or a goat skin.
- After 6 hours when all the juice has been collected.it is transferred to a drum or paraffin tin and boiled for 4 hours on an open fire.
- The product is poured while still hot in to tins each holding 25kg where it solidifies.

2.Barbados(curacao) aloes are prepared from cultivated plants of *A.barbadensis*.

- The cut leaves are kept in v shaped troughs,arranged on a slope so that the juice flows from a hole at one end of the trough in to a collecting vessel and evaporated in a copper vessel.
- The product is semi transparent and known as capey Barbados.

3.Aloe juice obtained from socotrine aloes is Collected in goat or sheep skin and allowed to evaporate for about a month till a viscous pasty mass is obtained.

Macroscopic Features

1.Curacao Aloes

Colour – Brownish black opaque mass

Odour – Strong odour and resembles iodoform

Taste – Intensely bitter

Texture – Waxy and resinous

2.Cape Aloes

Colour – Dark brown or greenish brown

Odour – Sour and distinct odour

Taste – Nauseating

Texture – Breaks with a glassy fractions

3.Socotrine Aloes

Colour – Brownish yellow opaque mass

Odour – Un pleasant

Taste – Externally bitter and nauseous

Texture – Fractured surface

4.Zanzibar Aloes

Colour – Liver brown

Odour – Characteristic but agreeble

Taste – Bitter

Texture – Dull, waxy, smooth and even fracture

Microscopic Features

- T.S of the leaf exhibits outermost cuticle followed by epidermis, palisade tissue and mucilaginous parenchymatous mesophyll.
- Mesophyll contains vascular bundles which are covered with periycle.
- These cells contain highly viscous, yellow juice (aloe jel).
- The leaves are sessile and when they are cut from the base, the juice flows down which is to be collected.
- A few calcium oxalate crystals are present in the parenchyma.

Powder Characters

1.Curacao Aloes: It shows fragments consisting of a large number of very small needles or slender prisms.

2.Cape Aloes: This variety appears as transparent,brown,angular or irregular fragments.

3.Socotrine Aloes: It is characterized by fragments of quite large prisms either present in group or in dispersed form.

Commercially, aloes are available as both crystalline and amorphous substance.

Chemical constituents

- Aloe is made up of 30% of aloin which is a mixture of barbaloin, β barbaloin and iso barbaloin isomers.
- Barbaloin is a crystalline glycoside which is present in all the four varieties of aloe.
- It is slightly yellow coloured, bitter in taste and water soluble.
- Barbaloin is a c – glycoside compared to common o – glycosides.

- β barbaloin is amorphous in nature and is present in cape aloe.
- It can be obtained by heating barbaloin.
- Iso barbaloin exists in crystalline form and is present in curacao and cape aloe in trace amounts, but absent in socotrine and zangibar aloe.
- It is a mixture of barbaloin and polyphenols (responsible for its colour tests).

Chemical tests – Refer practical manual

Uses

- It is used as a purgative because of its intensely irritating effects on the delicate mucosal lining.
- It is one of the ingredients of compound benzoin tincture in which it is a pharmaceutical adjuant.
- It causes gripping and therefore is administered with carminatives.
- Ointment of aloe gel is used in the treatment of skin irritations, burns caused by sun, heat or radiation.

Substitutes and Adulterants

- ***A.candelabrum*** (natal aloes) is a dull greenish black to dull brown in colour and opaque.
- When scraped,it gives a pale greyish green or a yellow powder.
- It can be distinguished as it responds negatively to borax test and produces a deep blue colour.
- **Jafferabad aloes** and **Mocha aloes** are the other two types of aloe which are used as adulterants.

2.Bitter Almond

Bitter almonds are used as food flavouring agents or in oils. Trees of bitter almond are found in middle East and Asia.

Synonym

Amygdala amara

Biological source

Bitter almond is the dried ripe kernals of ***Prunus amygdalus***, ***Prunus communis*** and ***Amygdalis communis***.

Family

Rosaceae

Geographical Source

Bitter almond trees are native to Persia and Asia Minor.They are cultivated in cooler climate such as in Italy, Sicily, Portugal, Spain, Southern France and Moracco.In india they are produced in cooler areas of Punjab and Kashmir.

Macroscopic Features

Colour – Brown

Odour – Odourless

Taste – Bitter

Size – About 20mm in length,125mm in width and 10mm in thickness

Shape – Flattened, oblong, ovoid in shape with testa

Chemical Constituents

- Bitter almond oil contains 80% of benzaldehyde and about 2 to 6% of hydrocyanic acid.
- Bitter almonds have 40 – 50% of **bland fixed oil** and 20% **protein.**
- It also contains **emulsion enzyme** and 1-3%**amygdalin** (a colourless crystalline bitter glycoside).
- About 0.5% of volatile oil is also present in bitter almond.
- Amygdalin hydrolyses in presence of water and decomposes in to **benzaldehyde** (80%) and **hydrocyanic acid** (2-6).
- Bitter almond is highly poisonous due to hydrocyanic acid.

Chemical tests

1.Ferric ferrocyanide test:1gm of powdered drug is macerated with 5ml of alcoholic KOH (5% w/v) for 5 minutes.The resultant mixture is transferred to an aqueous solution containing FeCl3(1%w/v) and is maintained at 60 – 70 C temperature for 10 minutes.Then the contents are transferred to HCl(20%) and a distinct Prussian blue colour appears indicating the presence of HCN.

2.Precipitation of Hg from HgNO3: The aqueous mercurous nitrate solution (3%w/v) reduces to metallic Hg in the presence of HCN, forming a black metallic Hg in the cells.

Grignard Reaction Test: A strip of white filter paper is dipped in to picric acid solution (1% w/v in water) drained, again dipped in sodium carbonate solution

(10% w/v in water) and drained. The crushed and moistened drug material is taken in a small Erlenmeyer flask, the strip of prepared sodium picrate paper is suspended in the above material. The flask is kept in a warm place for an hour when the liberated HCN changes the colour of sodium picrate paper from yellow to brick red because of the formation of sodium isopurpurate (this is the Grignard’s reaction)

4.Cuprocyanate test: Filter paper pieces are saturated with freshly prepared solution of guaiac resin dissolved in absolute ethanol, and allowed to dry completely in air. Then a piece of his filter paper is moistened with a dilute solution of $CuSO_4$ and placed in contact with the freshly exposed surface of the drug. If HCN is produced, a distinct stain appears on the paper.

Uses

1.Due to the presence of hydrocyanic acid, it is used as a sedative.

2.Its oil is used in demulcent skin lotion.

3.It is also used in preparation of amygdalin. Bitter almond water, perfumes and liquors.

Terpenoids

1. Gentian
2. Artemisia
3. Taxus
4. Carotenoids

1.Gentian

The name of the genus **Gentian** is derived from the name of an ancient king of Illyria, **Gentius** who discovered the medicinal value of this plant. During the Middle Ages, this plant was majorly used as an antidote to poison.

Synonyms

Gentian root, Gentiana and Radix Gentianae

Biological source

Gentian is the dried and partially fermented rhizome and root of yellow gentian, *Gentiana lutea*

Family

Gentianaceae

Geographical source

Gentian is a perennial herbaceous tree which is native of the hilly zones in central and southern Europe.it is grown on vosges mountains,Yugoslavia and jura.

Macroscopic Features

Colour – Whitish roots

Odour – Odourless

Taste – Sweet which later becomes bitter

Shape – Simple or branched, rhizome is cylindrical

Size – 20cm long and 1-4cm in diameter, roots are 1cm long

Surface – Wrinkled, becomes tough by absorbing moisture

Microscopic Features

The transverse section of gentian root shows the;

1.Periderm: it consists of :

i.Cork: it consists of 4-5 layers,thin walled,rectangular and orange brown coloured cells.

ii.Phellogen and phelloderm: Present as a few layers of thick walled parenchyma cells below the cork.

2.Cortex: It is a thin zone of thick walled parenchyma cells,contains oil globules,few starch grains and minute acicular raphides.

3.Secondary phloem: Parenchyma cells with oil globules,few starch grains,acicular raphides.sieve elements are seen clearly.

4.Cambium:it is clearly visible as a yellow ring comprised of 3 – 5 layers of thin walled, and small rectangular cells.

5.Secondary xylem: This forms the bulk of the root and consists of parenchymatous cells, vessels and medullary rays.The vessels are present individually but mostly found in groups towards the cambium.

Chemical constituents

Gentian contains bitter glycosides, **gentiopicrin** (or **gentiopicroside**).It is a water soluble, crystalline compound whose bitter value is 12000. When fermented and dried, it gives gentiogenin and glucose. The drug also has amarogentin, amaroswerin, gentioside and gentinin (a mixture of gentiopicrin and gentisin).

Chemical test

An extract of gentian gives out light fluoresence under UV radiation.

Uses

1.It is used as a bitter tonic for stimulating gastric secretion and thus improving appetite.

2.It is also used as an anthelmintic, anti inflammatory, antiseptic, cholagogue, febrifuge, refrigerant and stomachic.

Substituents and adulterants

Gentiana purpurea, Gentian kurroa, Gentiana punctata, Gentiana pannonica and *Rumex alpinus.*

2.Artemisia

Artemisia, also known as mugwort, wormseed and sagebrush is a plant of the daisy family of Asteraceae.It belongs to a diverse variety of plants having around 200 – 400 species.

Synonyms

Santonica and worm seeds

Biological source

Artemisia is an unexpanded flower head obtained from the plant *Artemisia cina , Artemisia brevifolia, Artemisia maritima* and other species of Artemisia.

Family

Asteraceae

Geographical source

Artemisia plant is found in the kurran valley regions of Pakistan, Turkey and widespread from Kashmir to kumaon in Himalayas and in West Tibet. The plant is also cultivated in the states of Punjab,Uttar Pradesh and Haryana.

Macroscopic Features

Colour – Flowers are yellow in colour, while other parts are whitish grey.

Odour – Aromatic and sweet

Taste – Bitter and camphoraceous

It contains yellowish or brownish, oval shaped flower heads. The flowers are fertile in presence of tubular corolla.

Microscopic Features

The furrow membrane part of the pollen is smooth with a circular pore. The spines are small and widely and evenly arranged by using TEM the walls of the pollen can be clearly observed containing 3 main layers.

1.The outermost layer **tectem** (T) of thin branching columella

2.An inner layer of thick **columella** (C) and

3.A thick **foot layer** (F)

Chemical Test

1gm of finely powdered drug is mixed with 10ml alcohol and filtered.Sodium hydroxide is added to the filtrate and the mixture is heated.The colour of liquid appears red.

Chemical constituents

- Santonica possesses oil and 2 crystalline substances, **santonin** and **artemisin**.
- The essential oil content ranges from 1.0 – 2%.
- The oil contains many essential constituents like cineole, pinene and resin while the main constituent of the plant is santonin (a sesquiterpene lactone which is anhydride of santonic acid)
- The yield of santonin is not same throughout the year.
- In some conditions when the flower heads are unexpanded and can be dried quickly it yields 3.0%of santonin.

Uses

- Santonica is a strong anthelmintic acting against roundworm infections. It shows no effect on hook worms and tape worms.
- Today the crude drug is rarely used for therapeutic purpose and has been totally replaced by santonin.

Substitutes

The plant can be substituted by a tall aromatic shrub of ***Artemisia vulgaris*** (belonging to family compositae) distributed in all mountainous regions of india.

3.Taxus

The genus Taxus consists of small coniferous trees or shrubs in the yew family Taxaceae.The plant grows very slowly and is very long lived.The plant length is 1-40m(3.3-131.2ft) and the trunk thickness is 5m (16ft).

Synonyms

Yew,Talispatra and Himalayan yew

Biological source

Taxus is the dried leaf, stem,bark and roots of different species

1.Leaves of ***Taxus baccata*** (europeon or English yew)

2.Stem bark of ***Taxus brevifolia*** (pacific yew)

3.Leaves and roots of ***Taxus canadensis*** (Canadian or American yew)

4.Leaves of ***Taxus cuspidata*** (Japanese yew)

Family

Taxaceae

Geographical source

Taxus is relatively slow growing ever green gymnospermous tree. They are the natives of india. Canada and America.In india, it is found in temperate Himalayan regions at an altitude of 2000-3500 meters.

Macroscopic Features

Taxus baccata (yew) is a short evergreen tree of height 9-20cm with a huge Trunk. The parts of the plant are:

1.Stem: It is highly branched and is surrounded by a thin brown coloured bark.

2.Branches: The branches grow through out their life, forming a very dense canopy(covering).due to this reason this plant is a ever green tree.

3.Leaves: They are linear,small,2-3cm long,and spirally arranged

Upper surface is dark green and lower surface is pale red.

4.Root: Long,well developed, deep feeders and highly branched

5.Seed: Covered with a red aril and resembles a berry.

Odour – agreeble

Taste – bitter and acrid

Microscopic Features

- The stem shows an irregular structure and seems to appear as pinus.The plant is covered with a dense single layered epidermis. Below the epidermis,the parenchymatous cortex is present with tannin filled cells. Endodermis and sclerenchymatous pericycle are also present.
- The young stem of ***Taxus baccata*** contains a collateral,open vascular bundles with pith. In protoxylem spiral tracheid is found. Phloem part contains sieve cells,sieve plates and phloem parenchyma.

Chemical constituents

- Chief constituent is **taxol** found in all parts of the plant.
- Taxanes are typical cyclic diterpenoids,and 40 different varieties of taxanes have been reported till now.
- Taxol, cephalomannine and 10-deacetyl baccatin are the important substances.
- **Taxol is mainly derived from** the stem bark of ***Taxus brevifolia***
- Extraction of taxol is obtained from the 60 years old 3 , 4 trees to obtain 1gm of taxol.
- The leaves contain 10-deacetyl baccatin III which may get easily transferred to taxol.

Various species of the plant are used in the treatment of cancer the most potent constituents are as follows

1.Taxol(containing a rare oxetane ring and amide side chain)

2.Cephalomannine (about 0.031%)

3.Baccatin-III(about 0.084%) and

4.10 – de acetyl baccatin – III

Taxotere is a potent compound of taxol possessing better bioavailability and pharmacological properties and is considered as an anti cancer agent.

Uses

1. The plant grows as an ornamental plant
2. ***Taxus baccata*** and some other species is oily and heaviest making decorative flowers and posts.
3. The wood of the plant is used for making various decorative pieces.
4. All parts of the plant (leaves, shoots and seeds) are poisonous due to the presence of taxine (a toxic alkaloid)
5. In some countries the plant is used as a fish poison.
6. Traces of ephedrine present in leaves of plant used to treat asthma, bronchitis and epilepsy
7. The seeds are used to produce sedative effect.

4.Carotenoids

- Carotenoids are polyenes and mostly hydrocarbons.
- They can also be called as tetraterpenes because of the presence of polyisoprene structure in their carbon skeleton.
- Most of the naturally occurring carotenoids are trans – isomers but some are cis trans isomers and this has been proved by x-ray analysis.
- Carotenoids are lipid soluble C-40 tetraterpenoids.
- Majority of them are derived from a 40 – carbon polyene chain which is the backbone of the molecule.

According to the structure carotenoids are classified as:

1.Hydrocarbon carotenoids or carotenes

(example) β-carotene

2.Oxygenated carotenoids: These are derivatives of xanthophyll hydrocarbons.

(Examples) zeaxanthin and lutein(hydroxy) Spirilloxanthin (methoxy) echinenone (oxo) and antheraxanthin(epoxy).

Bio sources

- Carotenoid is present in large amount in all the parts of green plants.
- Their presence is confirmed by the colours like red, orange, green and yellow.

- These colours are imparted to foods (tomatoes, carrots and apricots) by the carotenoids.
- Thus they are present in any fruit or vegetable having red, orange, green and yellow colour.
- They are also found in high concentration in dark leafy green vegetables like spinach, broccoli and kale.

Uses

- Vision protection, support to the cardio vascular system.
- It has anti oxidant property which protects the health of sperm and male reproductive system.

- Lycopene is the red pigment in tomatoes.It helps in the prevention of prostate and breast cancer and arterial ageing.
- It also keeps the liver, colon and lungs healthy.
- Carotene and cryptoxanthin protect the skin, tissues and cells from environmental toxins and disease.
- Non – provitamin A carotenoids

  (Example) – lutein, zeaxanthin and astaxanthin are good for skin.