



आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

E-Content

IFTM University, Moradabad

Pharmacognosy and Phytochemistry-II (504T)

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UNIT-II

General introduction, composition, chemistry & chemical classes, biosources, therapeutic uses and commercial applications of following secondary metabolites:

Alkaloids: Vinca, Rauwolfia, Belladonna, Opium

Phenylpropanoids and Flavonoids: Lignans, Tea, Ruta

Steroids, Cardiac Glycosides & Triterpenoids: Liquorice, Dioscorea, Digitalis

Volatile oils: Mentha, Clove, Cinnamon, Fennel, Coriander

Tannins: Catechu, Pterocarpus

Resins: Benzoin, Guggul, Ginger, Asafoetida, Myrrh, Colophony

Glycosides: Senna, Aloes, Bitter Almond

Iridoids, Other terpenoids & Naphthaquinones: Gentian, Artemisia, Taxus,
Carotenoids

Alkaloids

- ❖ Alkaloids are a class of basic, naturally occurring organic compounds that contain at least one nitrogen atom. This group also includes some related compounds with neutral and even weakly acidic properties. They are very potent in nature and found generally in plants. The first alkaloid was isolated by Derosen known as Narcotine in 1803.
- ❖ Alkaloids, which mean alkali-like substances, are basic nitrogenous compounds of plant or animal origin and generally possessing a marked physiological action on man or animal. The nitrogen is usually contained in a heterocyclic ring system.

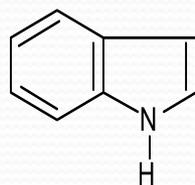
Properties of Alkaloids

- ❖ Alkaloids are colourless, crystalline, non-volatile, solids; a few such as coniine and nicotine are liquids and a few even coloured, viz. berberine is yellow.
- ❖ The free bases alkaloids are insoluble in water but soluble in most of the organic solvents.
- ❖ They are bitter in taste.

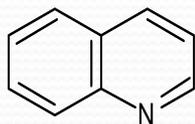
Classification of Alkaloids

❖ Alkaloids are classified according to their molecular skeleton, e.g., the two largest groups are the indole alkaloids and isoquinoline alkaloids. Other important groups are tropane alkaloids, steroidal alkaloids, and pyridine and pyrrolizidine alkaloids.

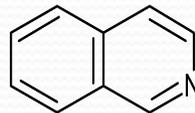
1. Indole alkaloids (physostigmine, strychnine, ergot).



2. Quinoline (quinine) and Isoquinoline alkaloids (opium).

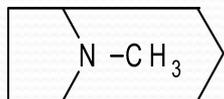


Quinoline

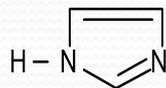


Isoquinoline

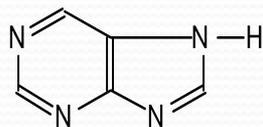
3. Tropane alkaloids (atropine, hyosciamine, cocaine).



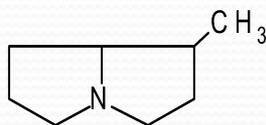
4. Imidazole alkaloids (pilocarpine).



5. Purine alkaloids (caffeine, theobromine, theophylline).



6. Pyrrolizidine alkaloids (platiphylline).



Identification test for Alkaloids

- 1. Dragendorff reagent** (Potassium-bismuth-iodide solution) gives reddish-brown precipitate.
- 2. Mayer reagent** (Potassium-mercuric-iodide solution) gives cream colour precipitate.
- 3. Wagner reagent** (iodine-potassium-iodide solution) gives Brown colour precipitate.
- 4. Hager reagent** (Saturated solution of picric acid) gives yellow colour precipitate.
- 5. Tannic acid** gives buff colour precipitate.
- 6. Murexide test** (Potassium chlorate, HCL, NH₃) gives purple colour.

VINCA

Synonyms: Sadabahar, Catharanthus, Periwinkle.

Biological Source: Vinca is the dried entire plant of *Catharanthus rosea*.

Family: Apocynaceae.

Geographical Source: It is indigenous to Madagascar. This plant is cultivated as an ornamental plant and found in tropical regions like Africa, Australia, Eastern Europe, South Florida, India, Taiwan and Thailand.

Macroscopic characters:

Colour: Flowers 2 to 3 in cymes, axillary and terminal clusters. Bases on flower colour, three varieties are known namely alba: white, ocillata: white with pink or carmine red eyes and roseus with rose coloured flowers.

Odour: Slight

Taste: Bitter

Shape: Leaves are Ovate, oblong.

Size: 0.5 to 1 meter length.

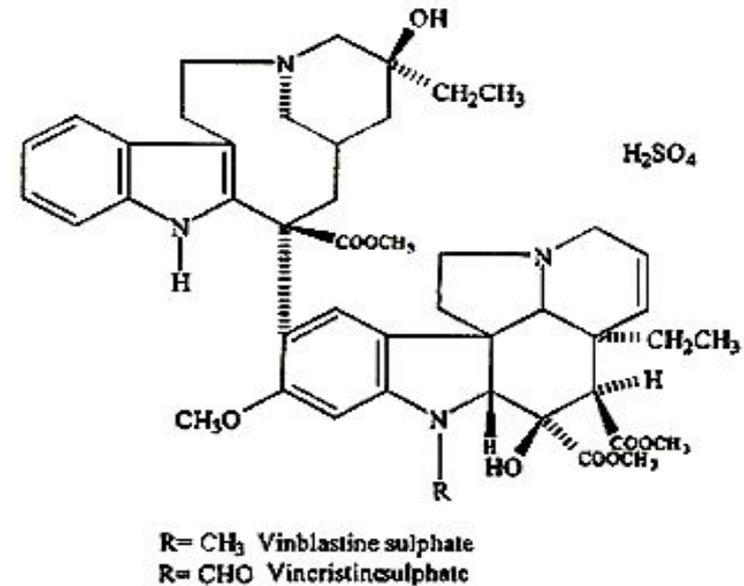
Chemical constituents:

Indole and indoline alkaloids:

Ajmalicine
Lochnerine
Serpentine

Tetrahydroalstonine:

Dimeric Indole bases of monoterpene type
Vinblastin
Vincristin



Therapeutic Uses:

- Antineoplastic (antimitotic= Cytostatic = anticancer antitumour).
- In the treatment of Hodgkin's disease.
- In the treatment of leukemia in children.
- Vinca is also used in hypertension.

RAUWOLFIA

Synonyms: Indian snakeroot, Devil pepper, Serpentine wood, Sarpagandha and Chotachand.

Biological Source: Rauwolfia consists of the dried roots and rhizomes of *Rauwolfia serpentina*. It contains not less than 0.15% of reserpin.

Family: Apocynaceae.

Geographical Source: It is widely distributed in West land and in shady forests in Punjab eastward to Nepal, Sikkim, and Assam in India; Bhutan, Pakistan, Java and Thailand etc.

Macroscopic characters:

Colour: Outer surface is greyish yellow, pale brown or brown.

Odour: Odourless.

Taste: Bitter.

Shape: Pieces are cylindrical, slightly tapering and tortuous.

Size: Drug consists of mostly small pieces, which are 2 to 15 cm long and 3 to 22 mm diameter.

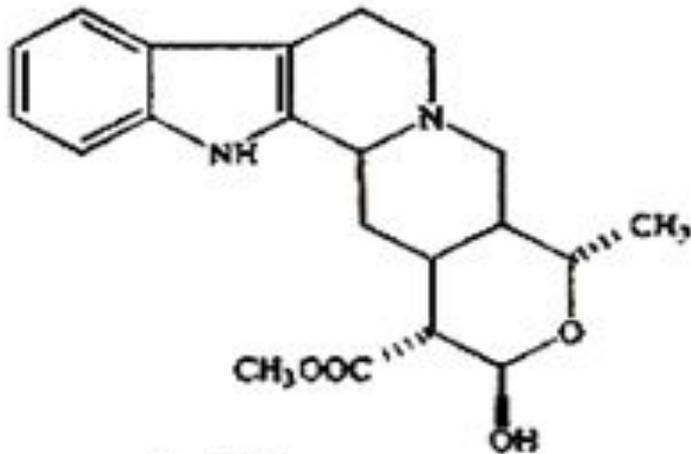
Chemical constituents:

Alkaloids- Indole alkaloids (1.5 or 3%) present.

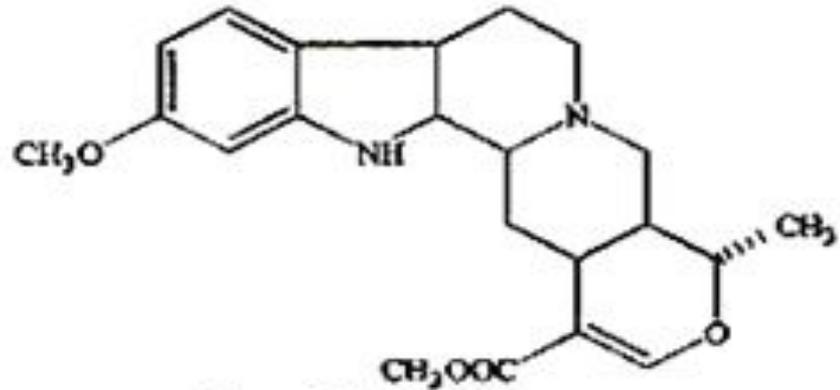
Reserpine group-Reserpine, Rescinnamine, deserpidine.

Tertiary indoline alkaloids-Ajmaline group- Ajmaline and Ajmalicine.

Serpentine group -Serpentine, Serpentinine and Alsotonine.



Ajmalicine



Reserpine

▪ **Therapeutic Uses:**

Rauwolfia is used as hypotensive and tranquillizer.

Reserpine being the main alkaloid is responsible for the activity and is used in anxiety condition and other neuropsychiatric diseases.

Sedative -calm down activities and excitement (reserpine group).

Stimulates the central of peripheral nervous systems (Ajmaline group).

The decoction of root is used to increase uterine contraction in difficult cases.

The extract is used for intestinal disorders and as anthelmintic bitter tonic and febrifuge.

BELLADONNA

Synonyms: Deadly-nightshade, Belladonna leaf and Sag-angur Patti (Hindi).

Biological Source: It consists of dried leaves and flowering tops of *Atropa belladonna*.

Family: Solanaceae.

Geographical Source: Plant is a native of Central and Southern Europe. It is cultivated in England, Germany, America and India.

Macroscopic characters:

Colour: yellowish-green.

Odour: Odourless.

Taste: Bitter.

Shape: Broadly ovate.

Size: 5-25 cm length, 5-12 cm broad.

Chemical constituents:

Tropane alkaloids (0.2-0.5%)

L-hyoscyamine (90%)

D, L- hyoscyamine (Atropine)

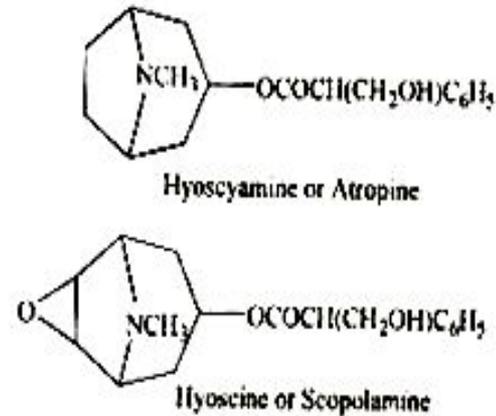
Scopolamine (10%)

Apoatropine

Belladonnine

Therapeutic Uses:

- Mydriatic (dilation of the pupil).
- Antispasmodic (a drug that counteracts a sudden, violent, involuntary muscular contraction).
- Antimuscarinic effect (acts peripherally to produce parasympathetic inhibition).
- Antisialagogue (a drug that arrest the flow of excess of saliva).
- Cerebral sedative (reduce excitement).



OPIUM

Synonyms: Raw opium and Afim (Hindi).

Biological Source:

Opium is dried latex obtained from the seed capsules of the opium poppy *Papaver somniferum*.

Family: Papavaeraceae.

Geographical Source: It is native of Western Asia but it is cultivated at the present time not only in the original area of distribution but also in India, Iran, Turkey and Europe.

Macroscopic characters:

Colour: Light, medium, dark-brown and black.

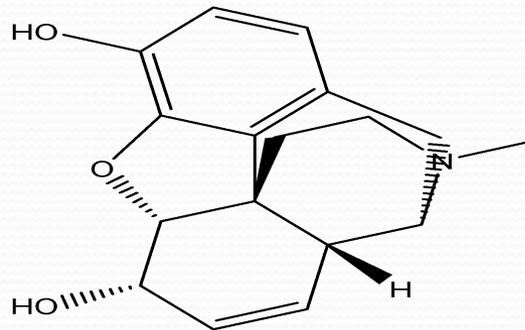
Odour: Strong and characteristic.

Taste: Bitter

Shape: Lumps, powder, sticks and moulded cakes .

Chemical constituents:

Papaver somniferum, is the type of poppy from which opium and all refined opiates chemical constituents such as morphine (up to 20%), thebaine (5%), codeine (1%), papaverine (1%), and narcotine (5-8%) are naturally present and extracted from the poppy.



Morphine

Therapeutic Uses:

- Euphoria, Relaxation, Analgesia, Slower breathing, Lower heart rate, Impaired reflexes, Temporary constipation and Loss of appetite.

Phenylpropanoids and Flavonoids

The phenylpropanoids are a diverse family of organic compounds that are synthesized by plants from the amino acids phenylalanine and tyrosine. It also known as cinnamic acids which are relatively simple secondary metabolites that are derived from the shikimic acid pathway via phenylalanine and tyrosine in some plants.

- Flavonoids are polyphenolic molecules containing 15 carbon atoms and are soluble in water. They consist of two benzene rings connected by a short three carbon chain.
- Flavonoids, a group of natural substances with variable phenolic structures, are found in fruits, vegetables, grains, bark, roots, stems, flowers, tea and wine.
- The flavonoids can be divided into six major subtypes, which include chalcones, flavones, isoflavonoids, flavanones, anthoxanthins and anthocyanins.

LIGNANS

Lignans are a subgroup of non flavonoids polyphenols that was first introduced by Haworth (1948). Lignans are phenolic compounds found frequently in fiber-rich plants. Flaxseeds are the richest dietary source of lignan precursors. Plant lignans are polyphenolic substances derived from phenylalanine.

Lignans are present in a wide variety of plant foods, including seeds (flax, pumpkin, sunflower, poppy, sesame), whole grains (rye, oats, barley), bran (wheat, oat, rye), beans, fruit (particularly berries), and vegetables . Secoisolariciresinol and matairesinol were the first plant lignans identified in foods. Pinoresinol and laricresinol, two recently identified plant lignans, contribute substantially to total dietary lignan intakes.

Uses of lignans:

Antioxidant, Oestrogenic ,Hormone metabolism and Enzyme activity.

TEA

Synonyms: Camellia thea

Biological Source: Tea consist of the prepared leaves and leaf buds of *Thea sinensis* .

Family: Theaceae.

Geographical Source: It is mainly cultivated in India (Assam), China, Srilanka, Japan and Indonesia.

Macroscopic characters:

Colour: Dark green.

Odour: Agreeable.

Taste: Bitter.

Shape: Lanceolate, Serrate margin

Size: 4-10cm length,.

Chemical constituents:

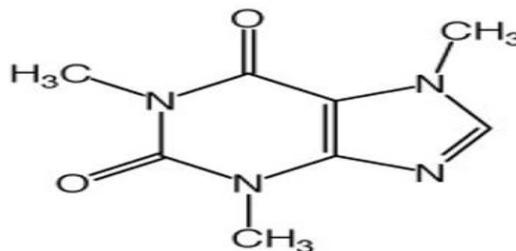
Purine alkaloids

Caffeine

Theobromine

Theophylline

Gallotannic acid



Caffeine

Therapeutic Uses:

CNS stimulant and Diuretic

RUTA

Synonyms: Rue, Sadab

Biological Source: Ruta consist of fresh dried leaves of *Ruta graveolens* .

Family: Rutaceae

Geographical Source: Ruta grown as an ornamental plant and herb. It is native to the Balkan Peninsula. It is now grown throughout the world in gardens.

Macroscopic characters:

Colour: Blue-green.

Odour: Odourless.

Taste: Characteristic.

Shape: Ovel-Oblong

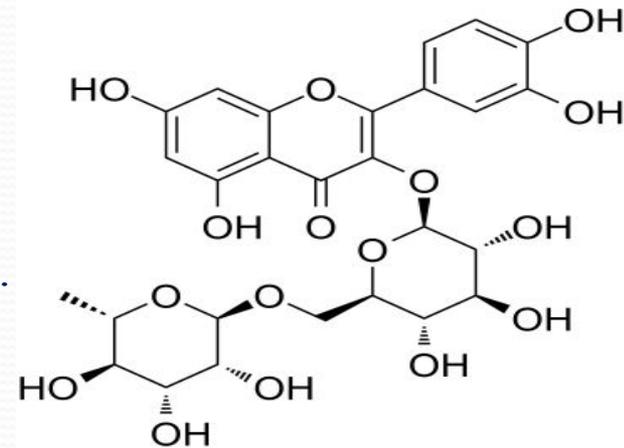
Chemical constituents:

Glycoside (Flavonoid rutin).

Alkaloids (Coquisagenin, Graveoline and xantotoxine).

Essential oils(Methyl nonyl ketone).

Furocoumarins(Psoralens).



Rutin

Therapeutic Uses:

Used to treat eyestrain, insect repellent, Antispasmodic, Treatment for menstrual problems and Rheumatism.

Steroids

Steroids are a biologically active organic compound with four rings arranged in a specific molecular configuration. Steroids have two principal biological functions: as important components of cell membranes which alter membrane fluidity and as signaling molecules. Hundreds of steroids are found in plants, animals, and fungi. All steroids are manufactured in cells from the sterols lanosterol (opisthokonts) or cycloartenol (plants). Steroids are an important class of hormones. Hormones are chemical compounds produced by specialized cells in the body and released into the circulatory proteins. Examples of steroids include the lipid cholesterol and the sex hormones testosterone.

Cardiac Glycosides

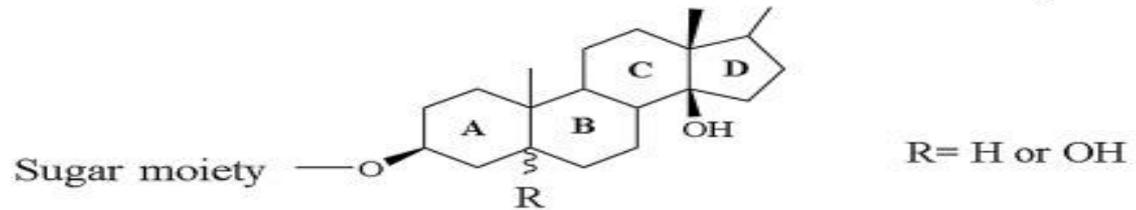
Cardiac glycosides are also called as steroid glycosides. The aglycone part of cardiac glycosides is a steroidal moiety. They have a cyclopentanophenanthrene nucleus with an unsaturated lactone ring at C₁₇. These glycosides are classified on the basis of the nature of the lactone ring such as:

Cardenolides: They are C₂₃ glycosides and have a five-membered lactone ring e.g. Digitalis and Stropanthus.

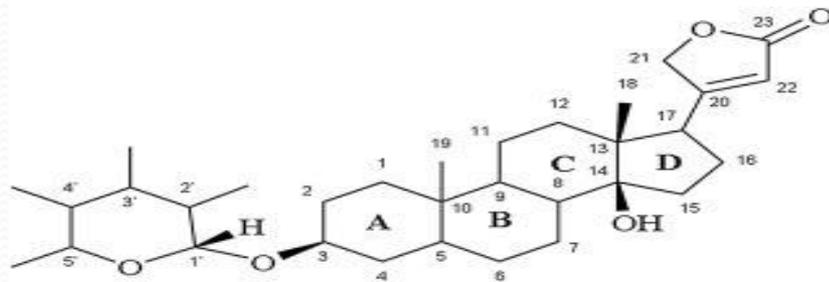
Bufadienolides: They are C₂₄ glycosides and have a six-membered lactone ring e.g. Scilla.

Steroid nucleus

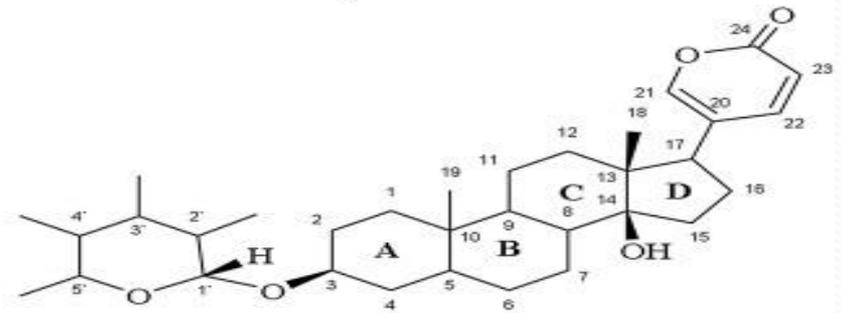
Lactone moiety



Cardiac glycosides



Cardenolides



Bufadienolides

□ The sugars present in cardiac glycosides are glucose, rhamnose, cymarose, thevatoxose and digitoxose. The cardiac glycosides exert a powerful action on the cardiac muscle when administered in small quantity where as large doses may cause death .They also increase diuretic action.

Triterpenoids

They are also known as triterpenes or C-30 compounds having general molecular formula $C_{30}H_{48}$. They are found in plant and animals both.e.g.

S.NO.	Constituents	Drugs
1	Squalene	Arachis,Olive
2	Sterol	Wool fat, Yeast
3	Quinovic acid	Cinchona bark
4	Arjunolic acid	Arjuna
5	Asiatic acid and Brahmic acid	Brahmi

LIQUORICE

Synonyms: Mulethi, Glycyrrhiza and Liquorice root.

Biological source: Liquorice consists of dried unpeeled roots and stolons of *Glycyrrhizic glabra* linn, belonging to family **leguminosae**.

Geographical Source: The liquorice plant is a herbaceous perennial legume native to the Western Asia and southern Europe, Iran Greece and India.

Macroscopic Characters:

Colour: Unpeeled-yellowish-brown or dark brown externally, and yellowish internally, while the peeled liquorice is pale yellow in colour.

Odour: Faint and Characteristic.

Taste: Sweet.

Size: Length 20 to 50 cm and 2cm in diameter.

Shape: Cylindrical pieces which are straight may be peeled or unpeeled. Peeled liquorice is angular.

Chemical constituents:

Triterpenoid saponins known as glycyrrhizin

Glycyrrhizinic acid

Carbenoxolone

Asparagin, fat, resin and glucose.

Therapeutic Uses:

Demulcent and expectorant

Tonic, Laxative, Diuretic and emollient property

Anti- inflammatory agent, Spasmolytic agent, Cough and peptic ulcer

DIOSCOREA

Synonyms: Yam, Rheumatism root and Pitalu (Hindi)

Biological source: It consist of the tubers of the drug tubers of *Dioscorea composita*.

Family: Dioscoreaceae.

Geographical Source: The plant are grown in Nepal, China and India. In India it is grown in Jammu and Kashmir, Punjab, Tamilnadu, Karnatka and West Bengal.

Macroscopic Characters:

Colour: Light brown

Odour: Odourless

Taste: Bitter

Size: Variable Size

Shape: Cylindrical or globose tubers

Chemical constituents:

Steroidal sapogenin

Smilagenin and isomer yammogenin

Diosgenin

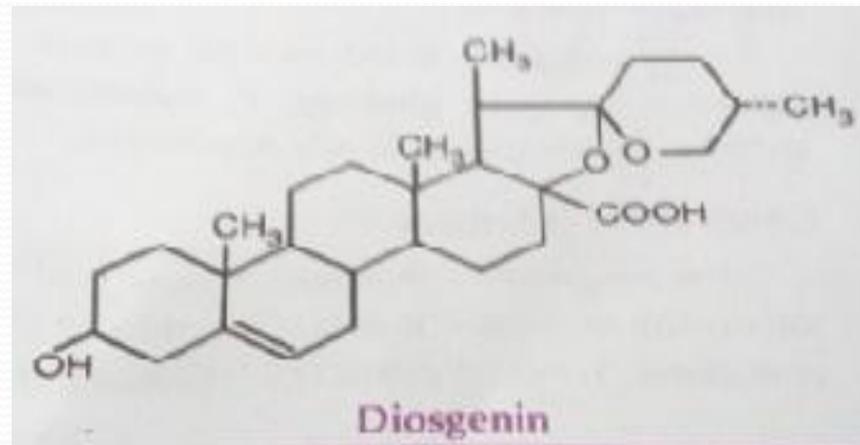
Sapogenase

Dioscin

Therapeutic Uses:

Used in rheumatic arthritis.

Diosgenin is used as precursor for the production of steroidal drugs like corticosteroids, oral contraceptive and sex hormones.



DIGITALIS

Synonyms: Foxglove leaves and Folia digitalis

Biological source: It consists of the dried leaves of *Digitalis lanata* belonging to the family *Scrophulariaceae* and contains 1 to 1.4 per cent of a mixture of cardiac glycosides.

Geographical Source: It is cultivated in England, Germany, France, USA and India. In India, it is grown in Jammu and Kashmir,

Macroscopic Characters:

Colour: Greyish green

Odour: Characteristic

Taste: Bitter

Size: 10 to 30 cm in length, 4 to 10 cm in width

Shape: Ovate-lanceolate,

Chemical constituents:

Purpurea glycosides A (Digitoxigenin and 3 digitoxose) and Purpurea glycosides B (Gitoxigenin and 3 digitoxose).

The primary glycosides are identified as lanatosides A, B, C, D and E. It should be noted that the glycone digitoxose and not aglycone, is acetylated. It is more potent than *Digitalis purpurea* and is used as a source for the manufacture of digoxin, lanatosides C and other cardiac glycosides such as digitoxin.

Therapeutic Uses:

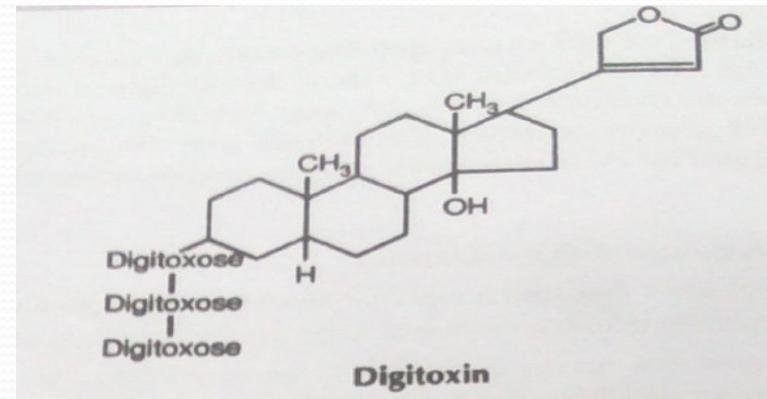
In the treatment of congestive heart failure

Increases the activity of cardiac muscles

Atrial fibrillation

Diuretic effect

Used to control cardiac arrhythmia



Volatile oils

Introduction:

Volatile oils are mixture of hydrocarbon terpenes, sesquiterpenes and polyterpenes and their oxygenated derivatives obtained from various parts of the plant. Volatile oils evaporate on exposure to air at ordinary temperature and are the odorous constituents. As volatile oil oils are responsible for the essence or odour of the plant they are also known as essential oils.

Properties:

Volatile oils, when fresh, are colourless liquids. A few are crystalline or amorphous solid. On long standing, they become darker in colour, especially when exposed to air and direct sunlight. Volatile oil should, therefore, be stored in tightly closed amber-coloured bottles in a cool, dry place. Volatile oils are slightly soluble in water but are readily soluble in ether, alcohol and most of organic solvents.

The various parts of the plant which contain volatile oil are as follows:

VOLATILE OIL MAY PRESENT IN PLANT PARTS:

Glandular hair	:	Mint stems and leaves (Labiatae)
Mesophyll	:	Eucalyptus leaves
Modified	:	Piperaceae, Parenchyma
Vittae	:	Anise (Umbelliferae)
Lysigenous or	:	Gossypium species
Schizogenous gland	:	Pinaceae, Rutaceae
All tissues	:	Conifers
Petals	:	Rose
Bark	:	Cinnamon
Rind	:	Orange
Heart wood	:	Sandal wood

MENTHA

Synonyms: Mint, Peppermint oil

Biological Source: Mentha oil is obtained by steam distillation of aerial parts of the plant *Mentha piperita*.

Family: Labiate

Geographical Source: It is mainly cultivated in Britain, France, Germany, North Africa and India. In India, it is found in Jammu and Kashmir and Uttar Pradesh.

Macroscopic characters:

Colour: Colourless to yellowish liquid.

Odour: Characteristic, Pleasant.

Taste: Pungent followed by cooling sensation.

Chemical constituents:

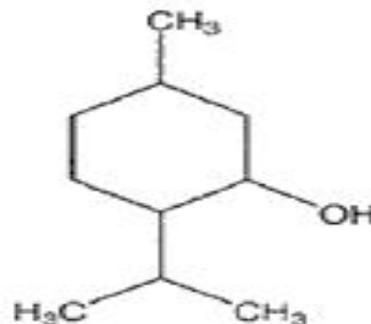
Menthol (50-60%)

Menthone

Menthofuran

Limonene, Cineole

Pinene and camphene



Menthol

Uses:

Flavouring agent, Carminative, Aromatic and stimulant, Food and cosmetic industries
Antiseptic, In toothpaste and chewing gum and perfume.

CLOVE

Synonyms: Laung, Caryophyllum, Clove bud.

Biological Source: It consists of the dried flower buds of *Eugenia caryophyllus*.

Family: Myrtaceae

Geographical Source: Clove tree is indigenous to Molucca island. It is cultivated in Penang Zanzibar, Madagascar, Sumatra, Caribbean island, Srilanka and india. In india, it is found in Tamilnadu And Kerala.

Macroscopic characters:

Colour: Dark brown or dusky red

Odour: Strongly aromatic.

Taste: Pungent and aromatic.

Shape: Cylindrical

Size: 10 to 17.5mm in length and 4 mm width

Chemical constituents:

Eugenol (80-95%)

Gallotannic acid

Oleanolic acid

Acetyl Eugenol

Caryophyllene

Therapeutic Uses:

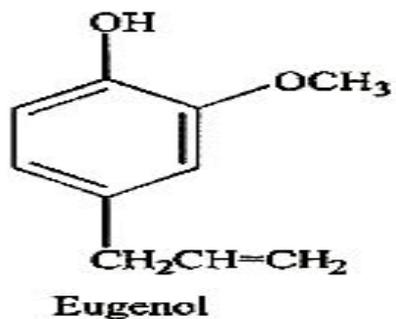
Dental analgesic

Flavouring agent

Carminative

Aromatic and stimulant

Antiseptic



CINNAMON

Synonyms: Cinnamon bark, Kalmi dalchini (Hindi).

Biological Source: It consists of the dried inner bark of the shoots of coppiced trees of *Cinnamomum zeylanicum*.

Family: Lauraceae.

Geographical Source: It is native of Sri Lanka and Malabar coast of India. It is also found in Jamaica and Brazil.

Macroscopic characters:

Colour: Yellowish brown

Odour: Fragrant

Taste: Warm, Sweet and aromatic

Shape: Single or Compound quills.

Size: 6-10 mm in diameter and 0.5mm thick.

Chemical constituents:

Volatile oil(0.5 to 1.0%)

Cinnamaldehyde (60-65%)

Eugenol

Mannitol

Pinene

Benzyl benzoate.

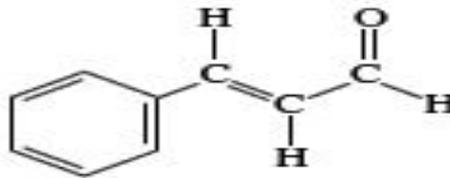
Therapeutic Uses:

Astringent

Expectorant and Condiment

Carminative, Aromatic and stimulant

Stomachic and inflammations



cinnamaldehyde

FENNEL

Synonyms: Fennel fruit, Saunf (Hindi).

Biological Source: Fennel consists of dried ripe fruits of *Foeniculum vulgare*.

Family: Umbelliferae.

Geographical Source: It is indigenous to the Mediterranean countries. It is cultivated in Russia, Romania, Britain, Germany and India. In India it is cultivated in West Bengal, Maharashtra, Uttar Pradesh and Punjab.

Macroscopic characters:

Colour: Greenish brown to Yellowish brown

Odour: Sweet and aromatic

Taste: Sweet, Agreeable.

Shape: Straight or Slightly ,Curved ,oval

Size: 6-10 mm in long and 3 to 4 mm wide.

Chemical constituents:

Volatile oil (3 to 7%)

Anethol (50-60%)

Fenchone (18 to 20%)

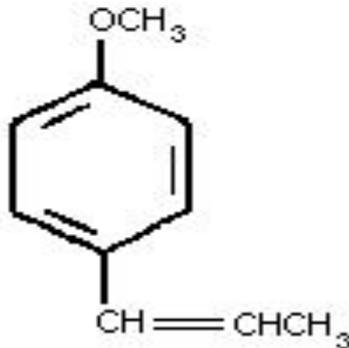
Limonene

Phyllandrene

Benzyl benzoate.

Therapeutic Uses:

Carminative, Stimulant, Flavouring agent and Expectorant



Anethol

CORIANDER

Synonyms: Coriander fruit, Dhaniya (Hindi).

Biological Source: It consists of dried ripe fruits *Coriandrum sativum*.

Family: Umbelliferae.

Geographical Source: It is cultivated in Russia, Hungary, Morocco and India. In India it is cultivated in Maharashtra, Andhra Pradesh, Rajasthan, Punjab and Uttar Pradesh.

Macroscopic characters:

Colour: Brownish yellowish

Odour: Aromatic

Taste: Spicy and characteristic.

Shape: Sub spherical

Size: 2-4 mm in diameter.

Chemical constituents:

Volatile oil(0.3 to 1%)

D-Linalol (Coriandrol 90%)

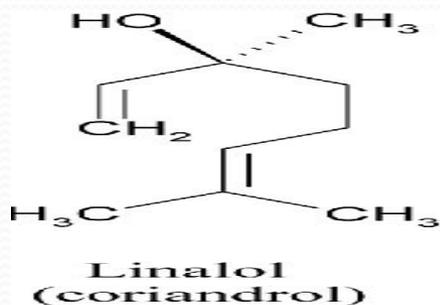
Borneol

Geraniol

Phyllandrene

Therapeutic Uses:

Antiinflammatory, Carminative, Stimulant, Flavouring agent, Expectorant and Emollient.



Tannins

Tannins are naturally occurring complex organic compounds possessing nitrogen free poly phenols of high molecular weight. They are found in plants as secondary metabolites.

Tannins are astringent, polyphenolic biomolecules that bind to and precipitate proteins and various other organic compounds including amino acids and alkaloids.

It is also called tannic acid any of a group of pale yellow to light-brown amorphous substances in the form of powder, flakes, or a spongy mass, widely distributed in plants .

It used chiefly in tanning leather, dyeing fabric, making ink, and in various medical applications.

Tannin solutions are acid and have an astringent taste.

Tannin is responsible for the astringency, colour, and some of the flavour in tea.

Tannins occur normally in the roots, wood, bark, leaves, and fruit of many plants, particularly in the bark of oak species and in sumac and myrobalan.

They also occur in galls, pathological growths resulting from insect attacks.

Classification:

There are mainly two types of tannins. The tannins are classified on the basis of chemical nature as follows: (1) Hydrolysable tannins (2) Condensed tannins.

1. Hydrolysable tannins: These tannins are hydrolyzed by acids, or enzyme and produce gallic acid and ellagic acid. Chemically, these are esters of phenolic acid like gallic acid and ellagic acid. The tannins derived from gallic acid are known as gallitannins and from that of ellagic acid are known as gallitannins. The gallic acid is found in rhubarb, clove and ellagic acid is found in eucalyptus leave and myrobalans and pomegranate bark. These tannins treated with ferric chloride to produced blue or black colour.e.g.Rhubarb,Clove, Myrobalans and Eucalyptus etc.

2. Condensed tannins: These tannins are resistant to hydrolysis and they derived from the flavonols, catechins and flavan-3, 4-diols. On treatment with acids or enzymes they are decomposed into phlobaphenes. On dry distillation condensed tannin produce catechol. These tannins are called as catechol tannins. These tannins are found in cinchona bark, male fern, areca seeds, tea leaves and wild cherry bark, bahera fruits, Amla, etc. they produce green colour with ferric chlorides.e.g.Cinnamon Cinchona,Acacia bark and catechu etc.

Chemical tests:

1. Gelatin test:

To a solution of tannin, aqueous solution of gelatin and sodium chloride are added. A white buff coloured precipitate is formed.

2. Goldbeater's skin test:

A small piece of goldbeater skin (membrane prepared from the intestine of an ox) is soaked in 20% hydrochloric acid, rinsed with distilled water and placed in a solution of tannin for 5 minutes. The skin piece is washed with distilled water and kept in a solution of ferrous sulphate. A brown or black colour is produced on the skin due presence of tannins.

3. Phenazone test:

A mixture of aqueous extract of a drug and sodium acid phosphate is heated and cooled and filtered. A solution of phenazone is added to the filtrate. A bulky coloured precipitate is formed.

4. Match stick test (Catechin test):

A match stick is dipped in aqueous plant extract, dried near burner and moistened with concentrated hydrochloric acid. On warming near flame, the matchstick wood turns pink or red due to formation of phloroglucinol.

PALE CATECHU

Synonyms: Gambier, Terra japonica.

Biological Source: It consists of dried aqueous extract prepared from the leaves and young twigs of *Uncaria gambier*.

Family:Rubiaceae.

Geographical Source: The plant is climbing shrub and native of Malaya. It is cultivated in Singapore and Indonesia.

Macroscopic characters:

Colour: Reddish brown

Odour: None

Taste: Bitter, astringent, Sweet.

Shape: Cubes

Size: 3 to 4 cm long.

Chemical constituents: Catechin (7 to 33%), Catechutannic acid (22-50%), Quercetin, and Rubinic acid

Uses: Local astringent, Treatment of diarrhoea and Dyeing

BLACK CATECHU

Synonyms: Cutch, Katha(Hindi).

Biological Source:It consists of dried aqueous extract prepared from the heart wood of *Acacia catechu*. **Family:**Leguminosae.

Geographical Source: It found wild and cultivated in India and Myanmar.

Macroscopic characters:

Colour: Dark brown

Odour: Odourless

Taste: Bitter, astringent, Sweet.

Shape: Cubes or irregular masses

Size: 2 to 3 cm long.

Chemical constituents:

Acacatechin (10 to 12%), Catechutannic acid (25-35%), Quercetin and Gum(20-30%)

Therapeutic Uses:

Astringent, Diarrhoea properties and Ulcers

Cough and Skin disease

PTEROCARPUS

Synonyms: Indian kino tree , Malabar kino tree, Cochin kino and Bijasal (Hindi).

Biological Source: It is juice obtained by making incisions in the trunk of *Pterocarpus marsupium*.

Family: Leguminosae.

Geographical Source: It found throughout India in deciduous and evergreen forests. It is also found in Sri Lanka, Bangladesh and Pakistan.

Macroscopic characters:

Colour: Dark ruby red

Odour: Odourless

Taste: Astringent

Shape: Cubes

Size: 3 to 10 mm in diameter

Chemical constituents:

Kinotannic acid (70 to 80%)

Pyrocatechol (Catechol)

Kinoin and Gum

Gallic acid

Therapeutic Uses:

Powerfull astringent, Treatment of dysentery, Inflammation

Leprosy, Toothache

Gout and asthma, Greyness of hairs and Diabetes

Resins

Resins are defined as amorphous, non nitrogenous, heterogenous plant extractor exudates with complex chemical nature. Resins are natural or synthetic organic compound consisting of a non crystalline or viscous liquid substance. Natural resins are typically fusible and flammable organic substances that are transparent or translucent and are yellowish to brown in colour. They are formed in plant secretions and are soluble in various organic liquids but not in water. Synthetic resins comprise a large class of synthetic products that have some of the physical properties of natural resins but are different chemically.

Properties of resins:

They are insoluble in water.

They are soluble in ordinary solvents like alcohol, ether and turpentine.

They are brittle, amorphous and are transparent or semi-transparent.

They have a characteristics luster, are ordinarily fusible and when ignited, resins burn with a smoky flame. Most of the resins are heavier than water.

Classifications of Resins:

These are divided into 5 classes:

Oleoresins: Resins in homogenous combination with volatile oil. These are good carminative and disinfectant. e.g. Turpentine oil, Capsicum and Ginger etc.

Gumresins: Resins in homogenous combination with gum. These have soothing property. e.g. Myrrh.

Ole-gum resins: Resins in homogenous combination with gum and volatile oil. e.g. Asafoetida.

Balsam resin: Resins in homogenous combination with aromatic acid like Cinnamic acid and Benzoic acid e.g. Benzoin.

Glycoresins: Resins are found in combination with glycosides. On hydrolysis they produced sugar and complex resins acids as aglycones. e.g. Jalap, Podophyllum.

Benzoin

These are two commercial varieties of Benzoin: Sumatra Benzoin and Siam Benzoin. Benzoin is a pathological product tree and its formation is induced by injury to the tree.

SUMATRA BENZOIN

Synonyms: Benzoinum, Luban

Biological Source: Benzoin is the balsamic resin obtained from the incised stem of *Styrax benzoin*.

Family: Styraceae

Geographical Source: It deciduous tree of 8-9 meters in height and is cultivated in Sumatra, Java and Borneo.

Macroscopic characters:

Colour: Reddish brown

Odour: Balsamic

Taste: Sweet and acrid

Shape: Masses of varying size

Chemical constituents:

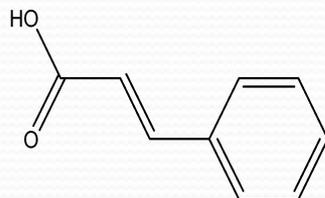
Balsamic acids (Cinnamic and Benzoic acid), Triterpenoid(Summaresinolic acid), Vanillin

Benzaldehyde and Phenyl propyl cinnamate

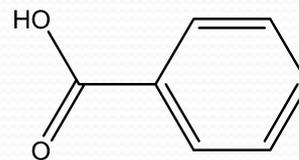
Chemical test: Sumatra benzoin powder (0.5g) is heated with 10ml of potassium permanganate solution. A strong odour of benzaldehyde is produced.

Therapeutic Uses:

Expectorant, Diuretic, Carminative, Antiseptic, Astringent and Wounds.



Cinnamic acid



Benzoic acid

SIAM BENZOIN

Synonyms: Siam

Biological Source: Siam benzoin is the balsamic resin obtained from *Styrax tonkinensis*.

Family: Styraceae

Geographical Source: It deciduous tree of 12-16 meters in height and is cultivated in Vietnam, Laos and Thailand

Macroscopic characters:

Colour: Yellowish brown

Odour: Balsamic vanilla like

Taste: Sweet and acrid

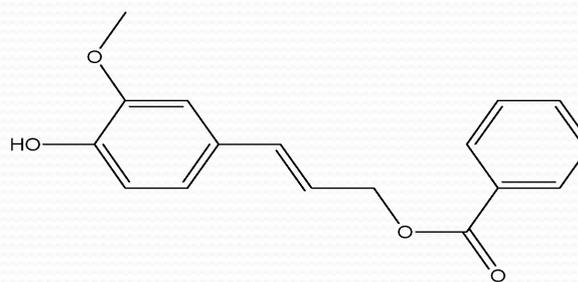
Shape: Masses of varying size

Chemical constituents:

Coniferyl benzoate, Sioresinolic acid, Vanillin and Ester of Benzoic acids .

Therapeutic Uses:

Mild disinfectant, Perfumeries, Carminative and Expectorant.



Coniferyl benzoate

GUGGUL

Synonyms: Gum guggul

Biological Source: Guggul is oleo gum resin obtained by making incisions to the stem bark of *Commiphora wightii*.

Family: Burseraceae

Geographical Source: It is a small tree, found in Kenya ,Ethiopia, West Indies and India. In India it is found Rajasthan, Karnatka and Gujarat.

Macroscopic characters:

Colour: Pale Yellow or dull green

Odour: Aromatic and Balsamic

Taste: Bitter

Shape: Rounded or Agglomerated tears.

Size: 0.5 to 2 cm in diameter.

Chemical constituents:

Steroids, Diterpenoids and Carbohydrates

Z-guggulosterone and E- guggulosterone

Aliphatic ester ,Progesterone and Volatile Oil

Therapeutic Uses:

Antiseptic, Anti inflammatory, Anthelmintic ,Nervine tonic and arthritis

Epilepsy, Bronchitis and Hypocholesterolesterolaemic activity

GINGER

Synonyms: Zingiber, Sonth(Hindi)

Biological Source: Ginger consists of the rhizomes of *Zingiber officinale*.

Family: Zingiberaceae

Geographical Source: It is native of south eastern Asia. It is cultivated in Jamaica, South India (Cochin), Africa, Japan and Nigeria.

Macroscopic characters:

Colour: Buff coloured

Odour: Aromatic

Taste: Pungent

Shape: Flattish and ovate.

Size: 5 to 15 cm in long.

Chemical constituents:

Volatile oil(1-3%)

Resin(5-8%)

Starch(50-56%)

Monoterpenes

Gingerol

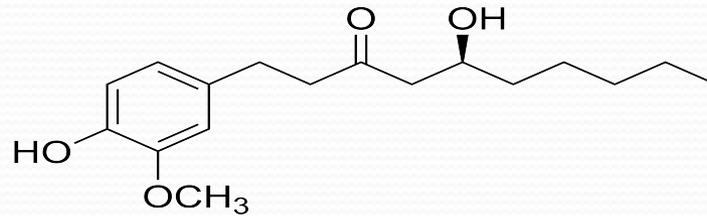
Shogaol

Gingerol

Therapeutic Uses:

Carminative, Stomachic, Stimulant, Condiment, Cure cough, Asthma, Vomiting, Mouthwashes

Motion sickness in GIT



Gingerol

ASAFOETIDA

Synonyms: Devil dung, Heeng (Hindi)

Biological Source: Asafoetida is an oleogum resin obtained from rhizomes and roots of *Ferula foetida*.

Family: Umbelliferae

Geographical Source: It is a small tree of 3 meters in height and mainly cultivated in Iran, Afghanistan and Pakistan.

Macroscopic characters:

Colour: Dull yellow to reddish brown

Odour: Intense and Alliaceous odour

Taste: Bitter, acrid and alliaceous taste

Shape: Masses

Size: 0.5 to 4 cm in diameter

Chemical constituents:

Volatile oil(8-17%)

Resin(40-63%)

Gum (25%)

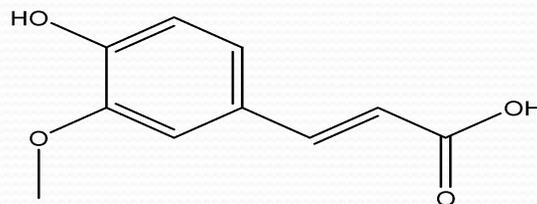
Ferulic acid

Umbellic acid

Asaresinol

Therapeutic Uses:

Carminative, Antispasmodic, Nervine tonic, Anthelmintic, Whooping cough, Asthma, Epilepsy Constipation and Flavouring agent.



Ferulic acid

MYRRH

Synonyms: Gum myrrh, Bol (Hindi)

Biological Source: Myrrh is an oleo-gum resin obtained from the stem of *Commiphora molmol.*

Family: Burseraceae.

Geographical Source: It is a small tree indigenous to north east Africa especially Somalia island. It is also found in Saudi Arabia, Iran and Thailand.

Macroscopic characters:

Colour: Reddish brown to reddish yellow.

Odour: Aromatic

Taste: Bitter

Shape: Masses of agglutinated tears or irregular rounded tears.

Size: 3 cm in diameter

Chemical constituents:

Volatile oil(3-7%)

Resin(25-40%)

Gum (57-61%)

Commiphoric acid

Heerabomyrrholic acids

Therapeutic Uses:

Stomachic, Digestive, Stimulant, Anthelmintic, Carminative, Dysmenorrhoea, Bronchitis, Asthma and Mouth washes.

COLOPHONY

Synonyms: Amber Resin and Colophonium

Biological Source: Colophony is the residue left after the distillation of the oil of turpentine from the crude oleo resin of *Pinus roxburghii*.

Family: Pinaceae.

Geographical Source: Colophony is prepared in Portugal, China, Morocco, Spain, France, Russia, U.S.A and India

Macroscopic characters:

Colour: Pale yellow or brownish yellow.

Odour: Slight Turpentine

Taste: Bitter

Shape: Irregularly shaped pieces

Chemical constituents:

Volatile oil(0.5 %)

Resin(5-6%)

Abietic acid

Sapinic acids

Uses:

Stimulant

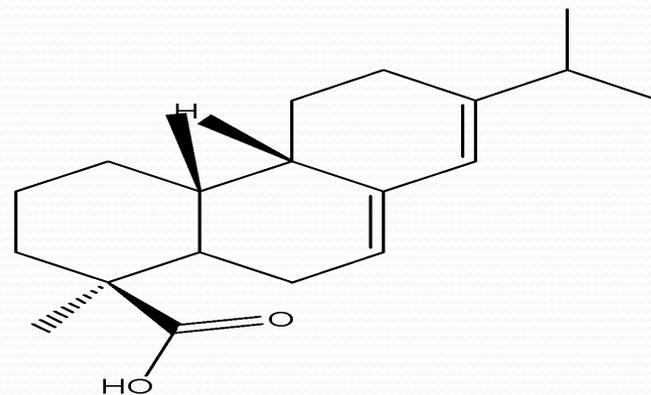
Diuretic properties

In ingredient of plasters and ointments

Manufacturing of varnishes, paint driers

Printing ink and Soaps

Wood polishes



Abietic acid

Glycosides

Glycoside can be defined as the organic compound mainly of plant origin and rarely of animal which on enzymatic or acidic hydrolysis yields one or more sugar moieties (Glycone) and a non sugar moiety (Aglycone or genin).

Glycoside → Aglycone (genin) + Glycone (Sugar)

Glycosides are considered to be sugar ethers or acetals and they are formed by condensation of hydroxyl group of non group and hemiacetal hydroxyl group of sugar. The sugar(glycone) present in glycosides are mono saccharides like glucose and rhamnose or more rarely deoxy sugars such as cymarose found in cardiac glycosides. The aglycone part may be alcohol, phenol or amines. The linkages between glycone and aglycone is known as glycosidic linkage.

Glycosides are naturally occurring substances in which a carbohydrate portion, consisting of one or more sugars or a uronic acid (*i.e.*, a sugar acid), is combined with a hydroxy compound. The hydroxy compound, usually a non-sugar entity (aglycon), such as a derivative of phenol or an alcohol may also be another carbohydrate, as in cellulose, glycogen, or starch, which consist of many glucose units.

Many glycosides occur in plants, often as flower and fruit pigments; for example, anthocyanins. Various medicines, condiments, and dyes from plants occur as glycosides; of great value are the heart-stimulating glycosides of *Digitalis* and *Strophanthus*, members of a group known as cardiac_glycosides. Several antibiotics are glycosides (*e.g.*, streptomycin). Saponins, widely distributed in plants, are glycosides that lower the surface tension_of water; saponin solutions have been used as cleansing agents.

▪ **Properties of Glycosides:**

Glycosides are colourless compounds but some of them are coloured like flavonoids are yellow and anthracene glycosides are red.

They are crystalline or amorphous solid compound.

Glycosides are optically active and normally levo form is more active.

Glycosides are soluble in water and alcohol but insoluble in chloroform and ether.

Glycosides can be hydrolyzed by mineral acids, water and enzymes.

Classification of glycosides:

1. Anthraquinones glycosides

e.g. Aloe, Rhubarb, Cascara, Senna etc.

2. Cardiac glycosides

e.g. Digitalis, Squill, Strophanthus, Quabain, Thevetia etc.

3. Saponin glycosides

They are classifying in two groups:

(i) Tetracyclic Triterpenoids saponins

(a) Dioscorea bark- Diosgenin; Solanum Berries- Solasodine

(b) Asparagus roots- Sarsapogenin

(ii) Pentacyclic Triterpenoid saponins

(a) Ginseng- Gingenoside

(b) Licorice- Glycyrrhizin

(c) Senega- Senegin- II

(d) Quillaja- Quillaia

(e) Sarsaparilla- Sarsapogenin

4. Coumarin and furocoumarin glycosides

e.g. Visnaga, Ammi and Psoralea etc.

5. Cyanophore glycosides

e.g. Wild cherry, Bitter almond

6. Flavonoids glycosides

i. Flavone glycosides:

(a) Parsley- Apin.

(b) Buchu- Diosmin.

ii. Flavonol glycosides:

e.g. Rutin , Quercetin.

iii. Flavanone glycosides:

(a) Lemon,

(b) Sweet orange-Hesperidin

(c) Bitter orange

iv. Chalone glycosides:

e.g. Safflor red-Carthamin

v. Isoflavonoid glycoside

(a) Sharapunkha-Tephrosin

6. Anthocyanidin glycosides:

(a) Pelargonium flower- Plargonidin

(b) Petunia flower- Petunidin

7. Isothiocyanate glycosides

e.g. Black Mustard

8. Phenol glycoside

e.g. Arbutin, Slicin

9. Aldehyde glycosides

e.g. Vanilla

10. Bitter glycosides

e.g. Gentian, Chirata, Picrorrhiza and Quassia etc.

Isolation of glycosides (Stas otto method):

The dried plant material is rendered into a moderately coarse powder. The powder is then extracted in a Soxhlet apparatus with aqueous ethanol. The non-glycosidal impurities which get extracted along with glycosides are removed by precipitating them with lead acetate solution. The excess of lead acetate is then removed by passing hydrogen sulphide gas through the extract. Lead gets precipitated as lead sulphide, which is filtered out. The filtrate contains the glycosides. The glycoside can be obtained by removal of the solvent under reduced pressure or any other suitable procedure. Further purification of the isolated glycosides is done by column chromatography.

SENNA

Synonyms: Tinnevelly senna (Indian senna)

Biological Source: It consist of dried leaflets of *Cassia angustifolia* known as indian senna, **Family:** Leguminosae

Geographical Source: It is grown in Tinnevelly, Madurai and Ramnathpuram Districts of Tamil nadu.

Macroscopic characters:

Colour: Yellowish green

Odour: Slight characteristic

Taste: Mucilaginous and bitter

Shape: Lanceolate, apex acute with spine

Size: 7-8 mm width, 25-60 mm length

Chemical constituents:

Anthraquinone Glycoside

Sennoside A,B, C,D

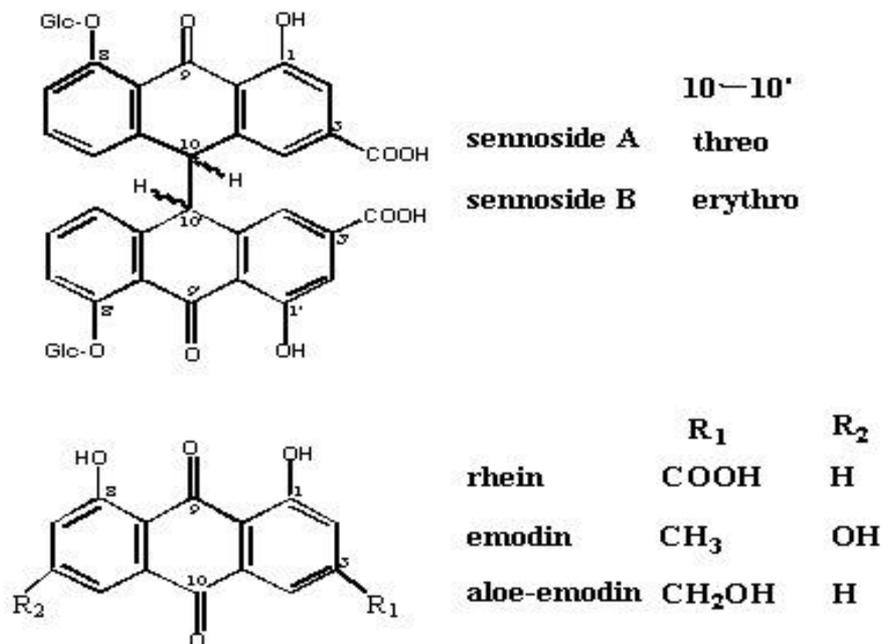
Rhein and Isorhamnetin

Kaempferol

Aloe- emodin

Mucilase, Resin

Myricyl alcohol and Salicylic acid



Chemical tests:

1. Borntranger's test: Powdered leaves of Senna are boiled with dilute sulphuric acid. Filtered and cooled. The filtrate is extracted with chloroform or benzene and dilute ammonia is added to it. The ammonical layer becomes pink to red due to the presence of anthraquinones derivative.

2. Modified Anthraquinones test: Take 0.1 gm of drug and add 5ml of 5% solution of ferric chloride and 5ml dilute hydrochloric acid and heat on boiling water-bath for 5 minutes, cool the solution and shake gently with an organic solvent like benzene. Separate the organic solvent layer and add an equal volume of dilute ammonia. A pinkish red colour is formed in ammonical layer. This test is of C. glycoside.

Therapeutic Uses:

Laxative and Purgative

MOA: Anthraquinone glycosides absorbed first in intestinal tract, then aglycone is separated and excreted in colon. it causes irritation and stimulation of colon, so movement(peristalsis) of colon increases, peristalsis also reduce water absorption hence soft and bulky faeces are formed. due to resin and emodin content griping occurs hence drug is given with carminatives.

ALOE

Synonyms: Ghritkumari, Musabbar (Hindi)

Biological Source: It consist dried juice of leaves of *Aloe barbadensis* miller known as curacao aloe or *Aloe perryi* baker known as socotrine aloes or *Aloe ferox* miller, and hybrids of this species *Aloe africana* miller and *Aloe spicata* baker known as cape aloes,

Family: Liliaceae

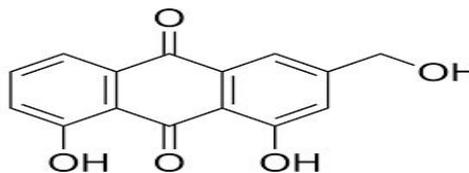
Geographical Source: Aloe is cultivated in southern and eastern Africa. It is also found in Europe and in various parts of India.

Macroscopic characters:

Colour: Brownish black

Odour: Strong and Pleasant

Taste: Disagreeable and Bitter



Aloe- emodin

Chemical constituents: Anthraquinone glycosides. main active constituent is Aloin. Aloin is also called as barbaloin barbaloin is C-glycoside aloin, Other isobarbaloin, beta barbaloin, aloe- emodin, resin, aloetic acid, homonataloin, aloesone, saponins, mucopolysccharides, glucosamines, hexuronic acid. aloe resin contains aloesin (purgative action).

Chemical tests: Chemical tests general chemical tests 1 gm aloe is powder boiled with 10 ml water, filtered. Filtrate used for bromine test and schoenteten,s reaction.

1.Bromine test: filtrate+ freshly prepared bromine solution gives pale yellow ppt of tetrabromalin.

2.Schoenteten,s test: filtrate+ borax shake well until borax dissolves.few drop of this solution added in test tube filled with water gives green fluorescence appears.

Uses: Stronger purgative than all anthraquinon glycosides. To prevent gripping action carminative can be given. It is ingredient of compound tincture of benzoin, aloe gel is used for topical application and many cosmetic uses.

BITTER ALMOND

Synonyms: Amygdala amara, Badam (Hindi)

Biological Source: Bitter almond consist of the dried ripe seeds of *Prunus amygdalus*.

Family: Rosaceae

Geographical Source: The tree is cultivated in France, Italy, Spain, Morocco, Portugal and India. In India it is grown in Kashmir.

Macroscopic characters:

Colour: Brown

Odour: None

Taste: Bitter

Shape: Flattened, Oblong-ovoid in shape

Size: 20 mm long and 8 mm thick.

Chemical constituents:

Fixed oil(40-45 %)

Proteins (20%)

Amygdaline (2.5 to 4%)

Amygdalase and Prunase

Volatile oil(0.5-0.8%)

Hydrocynaic acid

Uses:

Cough syrups

Demulcent in skin lotion

Perfumery

Flavouring agent

Iridoids, Other terpenoids and Naphthaquinones

Iridoids:

Iridoids are a type of monoterpenoids in the general form of cyclopentanopyran, found in a wide variety of plants and some animals. They are biosynthetically derived from 8-oxogeranial. Iridoids are typically found in plants as glycosides, most often bound to glucose. They are used as bitters, sedatives, hypotheticals, antipyretics, cough, medicines, wound remedies and skin disorders.

Naphthaquinones:

Naphthoquinone is a class of organic compounds structurally related to naphthalene. Two isomers are common for the parent naphthoquinones: (A) 1, 2-Naphthoquinone and (B) 1,4-Naphthoquinone.

Other terpenoids:

The terpenoids are a large and diverse class of naturally occurring organic chemicals derived from the 5-carbon compound isoprene, and the isoprene polymers called terpenes. Most are multicyclic structures with oxygen-containing functional groups. The important therapeutic uses of terpenoids include antimicrobial, antifungal, antiviral, antihyperglycemic, anti-inflammatory, antioxidants, antiparasitic and immunomodulatory.

Terpenoids are modified terpenes, wherein methyl groups have been moved or removed, or oxygen atoms added. The terpenoids can be classified according to the number of isoprene units that comprise the parent terpene:

Hemiterpenoids, 1 isoprene unit (5 carbons)

Monoterpenoids, 2 isoprene units (10C, i.e., derived from monoterpenes)

Sesquiterpenoids, 3 isoprene units (15C, i.e., derived from sesquiterpenes)

Diterpenoids, 4 isoprene units (20C, i.e., derived from diterpenes). ginkgolides.

Sesterterpenoids, 5 isoprene units (25C, i.e., derived from sesterterpenes).

Triterpenoids, 6 isoprene units (30C, i.e., derived from triterpenes). Example: sterols.

Tetraterpenoids, 8 isoprene units (40C, i.e., derived from tetraterpenes. Example: carotenoids)

Polyterpenoid with a larger number of isoprene units

GENTIAN

Synonyms: Radix gentianae, Getiana.

Biological Source: Gentain consists of the dried fermented rhizomes and roots of the *Gentiana lutea*.

Family: Gentianaceae

Geographical Source: It is herbaceous perennial plant indigenous to central Europe like Jura and Vosges mountain. It is also found in Spain.

Macroscopic characters:

Colour: Yellowish -brown

Odour: Pleasant and Characteristic

Taste: First sweet then intense bitter

Shape: Cylindrical

Size: 5 to 30cm in length and 1.5 to 2cm thick.

Chemical constituents:

Bitter glycoside –Gentiopicroside (2 %)

Gentiopicrocin and Gentiamarin

Gentioside

Amaroanin and amarogentin

Gentisic acid and Gentianose

Gentiamarin

Getialutine and Gentianine)

Fixed oil

Uses: Bitter tonic and Improving the appetite by the gastric secretions

ARTEMISIA

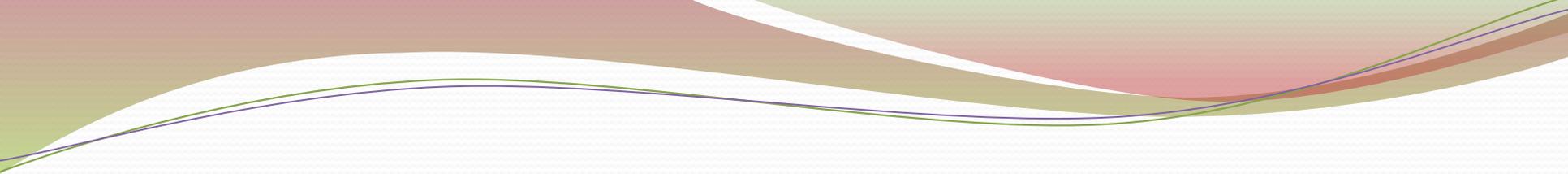
Artemisia is a large diverse genus of plants of aromatic herbs and shrubs with between 200 and 400 species belonging the Asteraceae family examples include wormwood, sagebrush and tarragon. Many species are valued as ornamentals for their attractive silvery gray foliage, which is frequently used in horticultural plantings to create contrast or to smooth the transition between intense colors. The leaves of common_wormwood_(*A. absinthium*) have been used in medicines and beverages such as vermouth. An extract from the Eurasian *A. annua* is used to treat quinine-resistant malaria. Artemisia comprises hardy herbaceous_plants and shrubs, which are known for the powerful chemical constituents in their essential_oils *Artemisia vulgaris* (mugwort) was used to repel midges fleas and moths, intestinal worms, and in brewing (mugwort beer, mugwort wine) as a remedy against hangovers and nightmares. *Artemisia absinthium* is used to make the highly potent spirits absinthe Malort also contains wormwood. *Artemisia arborescens* (tree wormwood, or *sheeba* in Arabic) is an aromatic herb indigenous to the Middle East used in tea, usually with mint A few species are grown as ornamental_plants, the fine-textured ones used for clipped bordering. All grow best in free-draining sandy soil, unfertilized, and in full sun.

Taxus

Taxus is a genus of coniferous trees or shrubs known as yews or badgers in the family Taxaceae. They are relatively slow-growing and can be very long-lived, and reach heights of 2.5–20 metres. The most distinct is the Sumatran yew (*T. sumatrana*, native to Sumatra and Celebes north to southernmost China), distinguished by its sparse, sickle-shaped yellow-green leaves. The Mexican yew (*T. globosa*, native to eastern Mexico south to Honduras) is also relatively distinct with foliage intermediate between Sumatran yew and the other species. The Pacific yew (*Taxus brevifolia*), native to the Pacific Northwest of North America, and the Canada yew (*Taxus canadensis*) were the initial sources of paclitaxel or Taxol a chemotherapeutic drug used in breast and lung cancer treatment. Taxanes are the most important group of chemical constituents and until now 4 different taxane compounds have been found, all of which are diterpenoids structures. The stem bark of Himalayan yew has been used to make tea by the Bhotiya tribal community in the Garhwal region of Himalayas and to cure colds, coughs, hypertension and cancer (Breast cancer, Ovarian cancer and Lung cancer) and also treatment of Snake bites, Blood clots, Rabies and wound related diseases.

Carotenoids

Carotenoids belong to the category of tetraterpenoids (i.e., they contain 40 carbon atoms, being built from four terpene units each containing 10 carbon atoms). Carotenoids are a class of phytonutrients ("plant chemicals") and are found in the cells of a wide variety of plants, algae and bacteria. There are two broad classifications of carotenoids: carotenes and xanthophylls. The difference between the two groups is chemical: xanthophylls contain oxygen, while carotenes are hydrocarbons and do not contain oxygen. They help plants absorb light energy for use in photosynthesis. They also have an important antioxidant function of deactivating free radicals single oxygen atoms that can damage cells by reacting with other molecules. Carotenoids are plant pigments responsible for bright red, yellow and orange hues in many fruits and vegetables. These pigments play an important role in plant health. People who eat foods containing carotenoids get protective health benefits as well. Foods rich in beta-carotene and other carotenoids include: Apricots, asparagus, beef liver, beets, cantaloupe, carrots, corn, guava, mangoes, mustard and pink grapefruit, pumpkin, squash (yellow and winter), sweet potato, tangerines, tomatoes, and watermelon. Carotenoids also act as antioxidants in the human body. They have strong cancer-fighting properties. Some carotenoids are converted by the body to vitamin A, which is essential to vision and normal growth and development. Carotenoids also have anti-inflammatory and immune system benefits and are sometimes associated with cardiovascular disease prevention.



Thank you