- ✓ **Margin** - Crenate to dentate
- ✓ **Apex** - Obtuse or rounded
- ✓ **Venation** - Pinnate and prominent veinlets on the under surface
- ✓ **Extra feature** - The leaves are slightly pubescent on both the surface and generally leaves are broken and crumpled

Microscopy

- **Dorsiventral leaf**
- **Anomocytic stomata** in upper epidermis
- Numerous covering trichomes and few glandular trichomes are present
- Covering trichomes are uniseriate and multicellular with 2-7 cells
- Glandular trichomes are unicellular stalk and bicellular head
- Collapsed cell trichomes are important characteristic of digitalis leaf
- Free of Calcium oxalate crystals and sclerenchyma (stone cells)

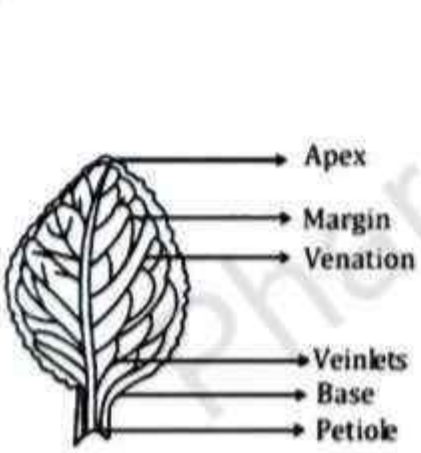


Fig. Digitalis leaf

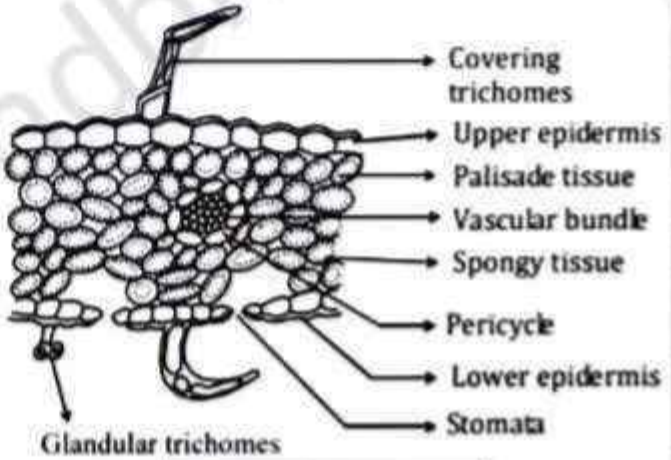


Fig. T.S of leaf

Chemical constituents :

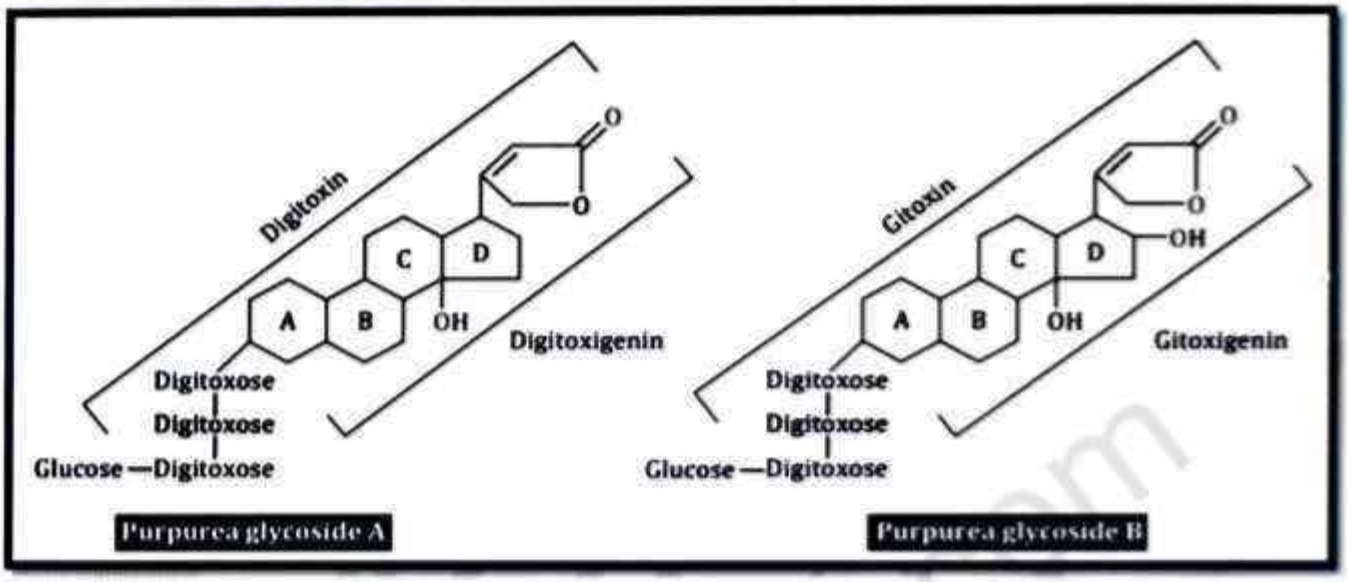
- **Contains** – 0.2 to 0.45% mixture of both primary and secondary glycosides
- **Primary glycoside** : Purpurea glycoside A and B

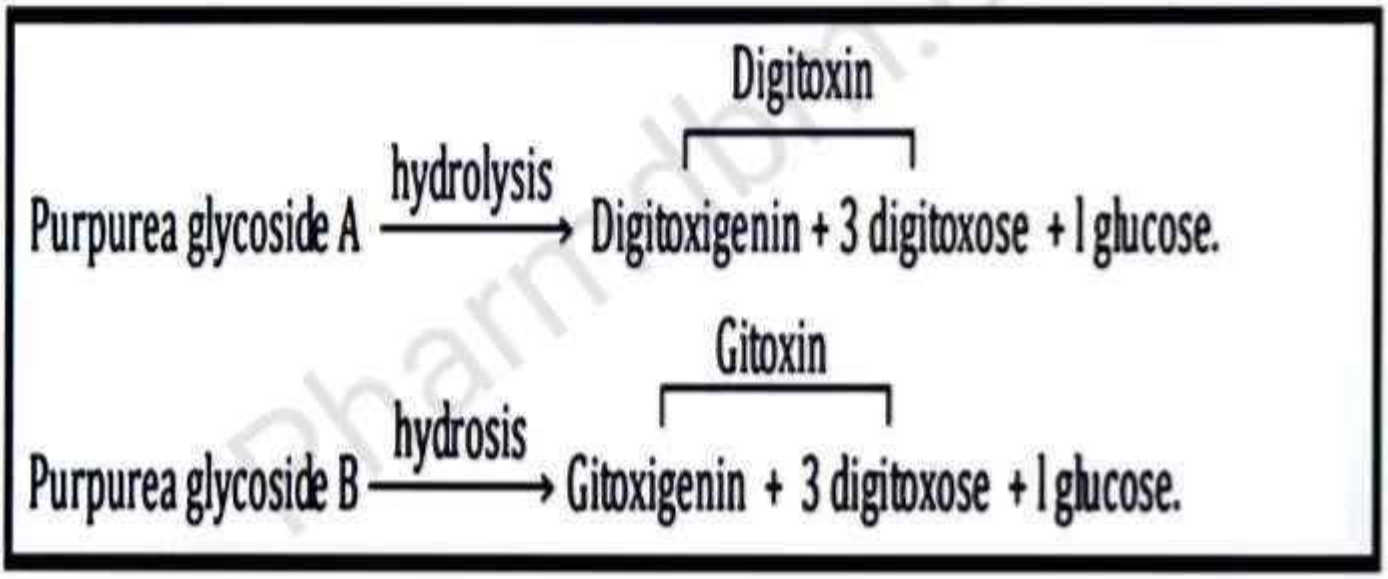
Fig. Digitalis Leaf

Contain linear chain of **3 digitoxose sugar** terminated by glucose

- **Secondary glycoside (less absorbable)** : **digitoxin, gitoxin and gitaloxin**

DIGITALIS PURPUREA





Allied drugs of digitalis

DIGITALIS LANATA

- It is **more potent than Digitalis Purpurea**
- It contains Lanatoside A, B, C, D and E as chemical constituents
- It contains **acetylated digitoxose sugar**

Digitoxin

Lanatoside A → Digitoxigenin + 3 digitoxose + 1 acetyl digitoxose + 1 glucose

Gitoxin

Lanatoside B → Gitoxigenin + 3 digitoxose + 1 acetyl digitoxose + 1 glucose

Digoxin

Lanatoside C → Digoxigenin + 3 digitoxose + 1 acetyl digitoxose + 1 glucose

Diginatin

Lanatoside D → Diginatigenin + 3 digitoxose + 1 acetyl digitoxose + 1 glucose

Gitaloxin

Lanatoside E → Gitaloxigenin + 3 digitoxose + 1 acetyl digitoxose + 1 glucose

Mullin leaves *(Verbascum thapsus)*

- Identified by **branched candelabra trichomes**

Comfrey leaves (*Symphytum officinale*)

- Identified by Multicellular trichomes forming look at the top

Primerose leaves (*Primula vulganis*)

- Identified by presence of uniseriate covering trichomes

Fig. Symphytum officinale

Fig. Verbascum thapsus

Fig. *Primula vulganis*

Chemical test for digitalis

CHEMICAL TEST FOR DIGITALIS	DESCRIPTION
Keller kiliani test (to detect the presence of **digitoxose** sugar)	1 gm Drug + 10 ml 70% Alcohol —2-3 min.→ Extract + **Lead** acetate —**$FeCl_3$ and Glacial acetic acid**→ Transferred to a tube containing 2 ml conc H_2SO_4 → **Reddish green colour**

Legal test	Solution of glycoside + pyridine + sod. Nitroprusside solution + NaOH solution ⟶ red pink colour formed
Baljet test	Section of digitalis + Solution of Sodium Picrate ⟶ Yellow or Orange coloured
Raymond's test	Section of digitalis and 50% C_2H_5OH +0.1 ml of m-nitrobenzene add 20 % NaOH gives Violet colour
Kedde test	Section of digitalis + Kedde reagent gives Blue or violet
Antimony trichloride test	Section of digitalis + Antimony trichloride and trichloroacetic acid Blue colour formed

Uses :

- Digitalis increase the force of systolic contraction, cardiac stimulant and cardiotonic
- Used in congestive heart failure
- Arterial flutter and arterial fibrillation

GLYCOSIDES

❖ Introduction

- Glycosides are **organic compound** from **plant or animal sources**
- On **enzymatic or acid hydrolysis yields one or more sugar moieties** known as **glycone and non sugar moiety aglycone**
- **Aglycone part** - Responsible for **chemical and therapeutic property**
- **Glycone part** - Responsible for **facilitates the absorption of glycosides and helps in transportation of aglycone portion** at the site of action
- Chemically they are **acetals or sugar ethers, formed by the interaction of hydroxyl group** to each of **sugar and non sugar moiety with loss of water molecule**
- Sugar is mostly β-D-glucose others are galactose, mannose, rhamnose, digitoxose, Cymarose etc.
- **Linkage between aglycone and glycone is called as glycosidic linkage** and on the basis of this linkage α and β stereoisomer is assigned

Properties :

- Most glycosides are **Colorless, Crystalline**
- **Anthraquinone - Red or Orange in color**
- **Flavone glycoside -Yellow in color**
- Glycosides are **soluble in water and alcohol but insoluble in chloform and ether**
- The **glycosides are extracted by using stass-otto method**

TYPE	DESCRIPTION
C-glycosides	In these glycosides sugar is connected to carbon atom aglycone - CH + OH – $C_6H_{11}O_5$ (aglycone - C- $C_6H_{11}O_5$ + H_2O)
O-glycosides	In these glycosides sugar is connected to O or phenol group aglycone - OH + OH – $C_6H_{11}O_5$ (aglycone - O- $C_6H_{11}O_5$ + H_2O)
S-glycosides	In these glycosides Sulphur of SH group is attached to the sugar aglycone - SH+ OH – $C_6H_{11}O_5$ (aglycone - S- $C_6H_{11}O_5$ + H_2O)
N-glycosides	In these glycosides N of NH (amino group) is attached to the sugar aglycone – NH + OH-$C_6H_{11}O_5$ (aglycone - N- $C_6H_{11}O_5$ + H_2O)

TYPE	EXAMPLE
C-glycosides	Aloe, Cascara, Cochineal (carminic acid)
O-glycosides	Senna, Rhubarb
S-glycosides	Sinigrin from black mustard
N-glycosides	Nucleoside

SENNA

Synonym : **Indian Senna, European Senna**

Biological source : Senna is obtained from leaflets and pods of ***Cassia anguistifolia*** and ***Cassia acutifolia*** Family : Leguminaceae

Macroscopy

- Isobilateral leaf-typical histological character of senna
- In Indian variety less hair is present as compared to **European senna**
- Active constituents are present in epicarp of leaf and pericarp of pods
- It is a leguminous plant so add nitrogen soil at regular interval

Microscopical Characters

- The leaflets are isobilateral
- The epidermal cells are polygonal with straight anticlinal walls, most of them contain thick deposit of mucilage on the inner tangential walls.. Numerous stomata occur on both surfaces of paracytic type
- Hairs: are of non glandular type. They are unicellular, thick- walled, with warty cuticle
- Mesophyll: shows a single layer of palisade abutting on each epidermis except in the midrib region where only the upper palisade layer is continuous. The cells of the lower palisade have wavy anticlinal wall and shorter than those of the upper.
- The spongy tissue shows idioblasts containing cluster crystals of calcium oxalate

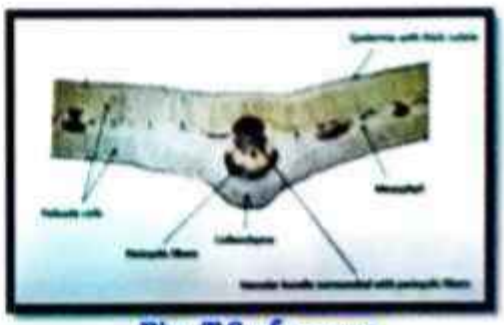


Fig. T.S of senna

- **The midrib:** shows a crescent - shaped vascular bundle, accompanied by an are of pericyclic fibers below and a compact mass of fibers above with cells containing **prismatic crystals of calcium oxalate** abutting on these groups of fibres forming crystal sheath . The **pericyclic fibers are lignified**

Calcium oxalate crystals

Chemical Constituents

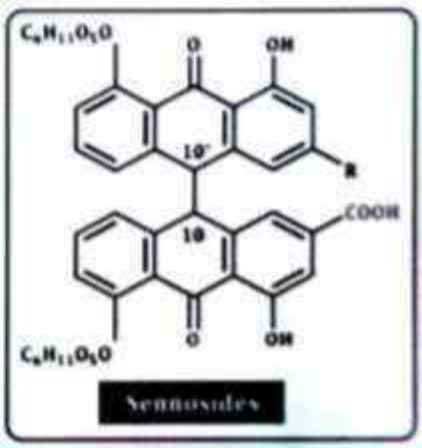
1. **Anthraquinones glycoside**
   a.) Sennosides A (**Dextrorotatory**), Sennosides B (**Mesoform**), Sennosides-C, Sennosides D
   b.) Emodin, Chrysophenol, Aloe emodin, Rhein
2. **Two naphthalene glycoside- 6-hydroxy musizin glycoside** (Alexandrian senna); and tinnevellin glycoside (Tinnevelly senna)
3. It also contains – flavanol, **kaempferol** (Yellow colouring material)

- **Sennoside A** and **Sennoside B** are the active constituents of drug and **stereoisomer** of each other
- **Sennidin :** Only dimer aglycone moiety, sugar is absent
- **Sennosides :** Dianthrone derivative of aglycone with glycone part of two identical compound

The percentage of sennoside in leaves and pods is **more (3-3.6%) in** ***Alexandrian senna*** as compare to ***Indian senna***

Adulterants and substitute

- ✓ **Dog senna** (*Cassia obovata*) - Leaves are obovate in shape, Consists of Papillose cells in lower epidermis
- ✓ **Arabian Senna** - Wild plant of *Cassia angustifolia*

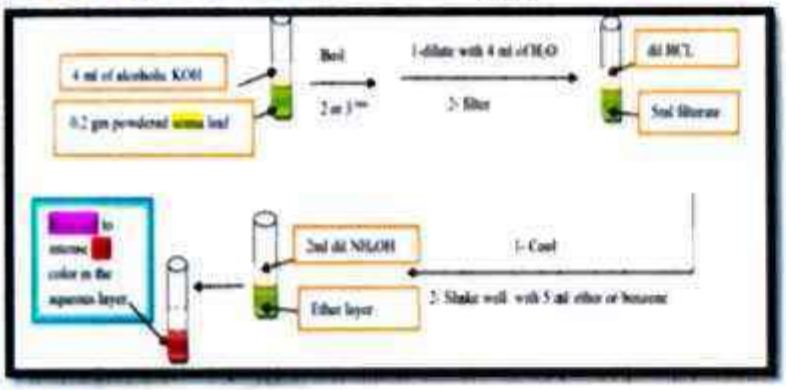


Sennosides

✓ **Palthe senna (*Cassia auriculata*)** - Characterized by absence of Anthraquinone glucoside

Chemical test :

Borntrager's Test : -C-O- glycosides



Uses :

- It is used as **Purgative**

ALOE

Synonyms : Ghritkumari, Musabar

Biological source : Aloes is obtained from the **dried juice** of leaves of aloe species Family : **Liliaceae**

Aloe species :

Aloe barbadensis	**Curacao aloe**
Aloe ferox, Aloe spicata	**Cape aloe**
Aloe perryi	**Socotrine aloe**
Aloe vera	**Indian aloe**
Zanzibar Aloe	**It is regarded as a variety of socotrine aloe**

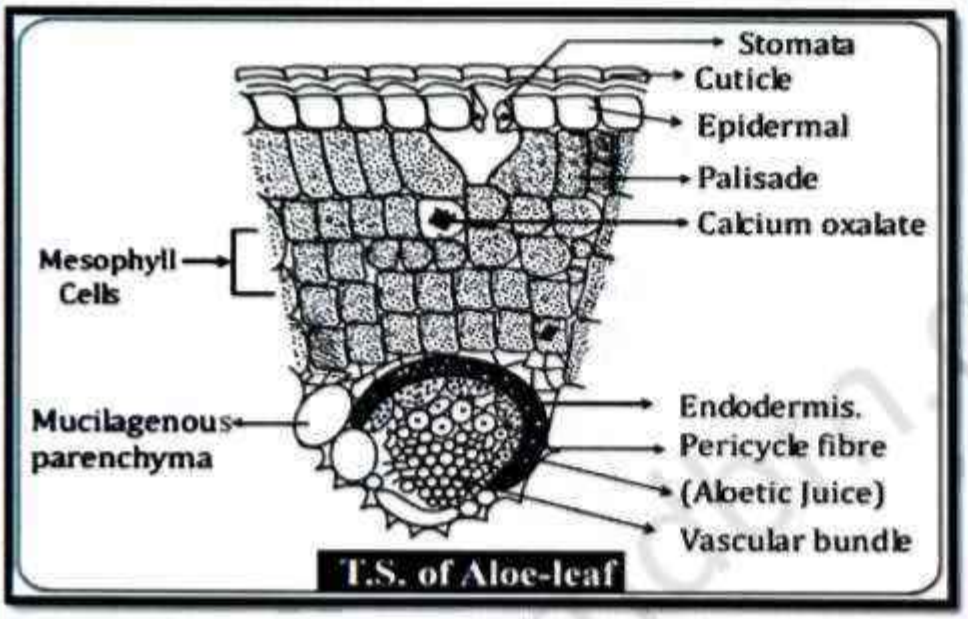
Microscopic characters

- **Epidermis** → Strongly cuticularized with number of stomata both side
- **Parenchyma** → Calcium oxalate present **(needle type)**
- Double row of vascular bundle which lies at the junction of two zones and well mark of pericyclic endodermis

✓ **Aloe gel present in Mucilagenous cell**

✓ **Aloe juice present in Pericycle fibre**

	Form	Colour	Fracture
Curacao	**Opaque masses**	**Yellow brown to chocolate brown**	**Waxy like**
Cape	**Transparent and glassy**	**Dark brown or greenish brown**	**Smooth and glassy**
Socotrine	**Opaque**	**Reddish-black to brownish black**	**Conchoidal**
Zanzibar	**Opaque**	**Liver brown colour**	**Smooth and even fracture**



Chemical constituents

- Principle active constituents of aloe is **(up to 30%)** and **aloin** is a mixture of three isomer - **Barbaloin**, **β-barbaloin**, and **iso-barbaloin**
- **Barbaloin** is chemically **aloe-emodin anthron C-10 glucoside** and it is water soluble
- *Aloe barbendis* (**Curacao aloe**) - (**22% barbaloin** present)
- *Aloe vera* (**Indian aloe**) - (**3.5 - 4% barbaloin** present)
- It also contains : -
  - ✓ **Aloesin** – Resin present which gives **purgative action**
  - ✓ **Aloctine** – Increase **removal of dead cells from skin**

Chemical test

General test :

1 gm. Aloe powder boiled with 10 ml water

↓

Filtered

↓

- Schoenteten's rection /Borax test → Green fluorescence is observed
- Bromine test → Pale yellow precipitate of tetrabromalin

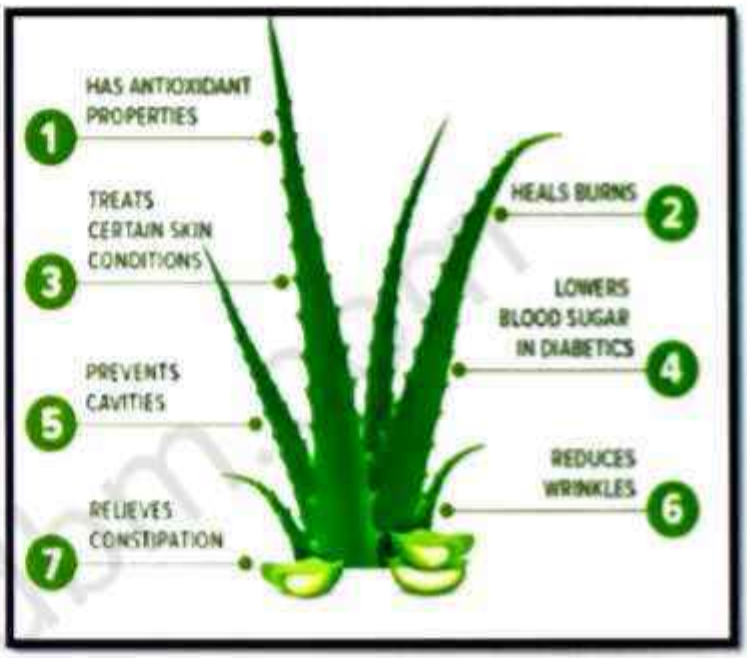
TEST FOR ALOES	VARIETY OF ALOES			
	CURACAO	CAPE	SOCOTRINE	ZANZIBAR
MODIFIED BORNTRAGER'S test indicate presence of C-glycoside which is aloe emodin	Aq. Solution of drug + $FeCl_3$ + HCl → on hydrolysis gives free anthraquinone which is Collected add organic solvent organic layer separated and shaken with ammonia. Ammoniacle layer shows rose pink to cherry colour			
NITROUS ACID TEST (This test is due to isobarbaloin)	Sharp pink to carmine color	Faint pink	Very less change in colour	
NITRIC ACID TEST 5 ml aq. Sol. +2ml nitric acid	Deep brown red colour	Brown colour to Green	Pale brownish - yellow colour	Yello wish brow nish
CUPRALOIN TEST (Klung's isobarbaloin test) CuSO4 + NaCl + 90% alcohol	Wine red persisting for 4 hrs	Faint colour to Yellow	No colour	

Adulterants and Substitute :

- ✓ Natalaloes - It resembles to cape aloes in microscopic character therefore it is used as substitute. It is a weak purgative.
- ✓ Mocha aloes - It is brittle, black and glassy aloe with strong odour

Uses:

- It is used as purgative
- It is an ingredient of compound tincture of benzoin (Friar's balsam)



BITTER ALMOND

Synonym : Amygdala amara, Badam

Biological source : Bitter almond is obtained from dried ripe seeds of plant *Prunus amygdalus and Prunus communis* (sweet almond tree)

Family : Rosaceae

Chemical Constituents – Contains colorless, crystalline glycoside amygdalin (2.5 to 4%)

Amygdalin emulsion $\xrightarrow{\text{emulsin enzyme}}$ Hydrocyanic acid + Benzaldehyde

Uses :

- Sedative and demulcent in skin lotion
- Flavouring agent

UNIT-II

Part- (C)

GENERAL INTRODUCTION , COMPOUND, CHEMISTRY AND CHEMICAL CLASS , BIOSOURCES, THERAPEUTIC USES AND COMMERCIAL APPLICATION OF VARIOUS SECONDARY METABOLITES

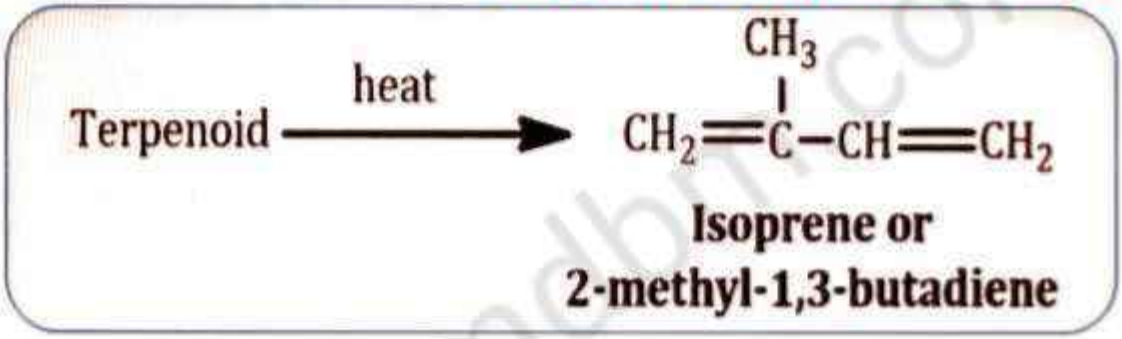
Points to be covered in this topic

- Volatile oil : Mentha, clove, Cinnamon, Fennel, Coriander
- Iridoids, other terpernoids and Napthaquinones : Gentian, Artemisia, Taxus, Carotenoids

VOLATILE OIL

❖ Introduction

- Volatile oils are defined as the **odorous and volatile constituent of plant and animal species**
- Volatile oils are also termed as **ethereal oil because they evaporate when exposed to air** at an ordinary temperature
- Also called as **essential oil** as they are the essences or active constituent
- They are composed of **terpenes, monoterpene, sesqueterpenes, diterpenes, polyterpenes** and their derivatives
- Terpenoids are regarded as **derivative of polymers** of **isoprene (C_5H_8)**



S.NO.	CLASS	NUMBER OF ISOPRENE UNIT	MOLECULAR FORMULAE
1	Hemiterpene or isoprene	1	C_5H_8
2	Monoterpenes or Terpenes	2	$C_{10}H_{16}$
3	Sesquiterpenes	3	$C_{15}H_{24}$
4	Diterpenes	4	$C_{20}H_{32}$
5	Triterpenes	6	$C_{30}H_{48}$
6	Tetraterpene or carotenoids	8	$C_{40}H_{64}$
7	Polyterpenes or Rubber	N	$(C_5H_8)_n$

❖ Drug containing volatile oils are classified as

CLASS	EXAMPLE OF DRUG
Aldehyde volatile oils	Bitter almond, Bitter orange peel, Lemon peel, Lemon grass, Cinnamon Cassia, Citronella oil

Alcohol volatile oils	**Coriander, Peppermint, Sandal wood, Cardamom, sandal wood, peppermint**
Hydrocarbon volatile oils	**Black pepper, Turpentine**
Ketone volatile oils	**Buchu, Caraway, Cumin, Camphor, Dill, Jatamansi, Musk, Spearmint, civet**
Phenolic ether volatile oils	**Anise, Calamus, Fennel, Nutmeg**
Oxide volatile oil	**Chenopodium, Eucalyptus**
Ester volatile oil	**Gaultheria, Lavender, Mustard**

❖ Terpenoids are broadly classified as

DRUGS CONTAINING	NAME OF CRUDE DRUG
Monoterpenoids	Fennel, Palmarosa, Citronella, Chenopodium, Eucalyptus oil, Lemon grass oil, Peppermint oil, Caraway, Anise, Cummin, Cardamom, Dill, Lemon peel, Orange peel, Nutmeg, Cinnamon, Tulsi, Musk
Sesquiterpenoids	Artemisia, Sandal wood oil, Clove
Diterpenoids	Taxus, coleus
Triterpenoids	Ambergris
Tetraterpenoids	Annatto, Saffron

❖ Identification test for terpenes

Salkowski test	**Drug (mg) + $CHCl_3$ + H_2SO_4 → Yellow colour which changes to red**
Noller test	20 mg drug + 2 ml of ($SnCl_2$ in $SOCl_2$) → **Red colour**
Antimony Trichloride test	**Antimony trichloride** in $CHCl_3$, dip filter paper soaked in above solution, in drug solution spray with H_2SO_4 and **acetic anhydride orange red colour** is produced

MENTHA OIL

Synonym : Peppermint oil

Biological source : Mentha oil is obtained by steam distillation of the fresh flowering tops of the plant ***Mentha Piperita officinalis*** –white mint

Mentha ***Piperita vulgaris*** – black mint

Family : Labiatae

Chemical constituents

- Peppermint oil contains chiefly l-menthol to the extent of 70 % in free, as well as, in the form of esters
- American peppermint contains 80% menthol while Japanese oil contains 70 – 90%
- The other terpenes include l-limonene, cineole, pinene, camphene, etc.
- Jasmone and esters are responsible for pleasant flavour

While menthofuran causes resinification and develops dirty smell

Uses

- Oil is used as carminative, stimulant, and flavouring agent
- It is used in toothpaste, tooth powders, and different pharmaceutical dosage forms
- It is also consumed in the preparation of chewing gums, candies, jellies, perfumes and essences
- Both mentha oil and menthol have calcium channel blocking activity causing spasmolytic and smooth muscle relaxant effects
- Mentha oil shows digestant activity by stimulating bile flow
- Azulene from the leaf is believed to be anti-inflammatory and anti-ulcer in activity
- Lozenges for its antitussive effects

CLOVE

Biological source : It is the dried flowers obtained from the plant ***Eugenea caryophyllus,*** Family: **Myratceae**

Macroscopic characters

- ✓ **Colour** - Dark brown or dusty red
- ✓ **Odour** - Strongly aromatic
- ✓ **Taste** - Pungent and aromatic followed by slight numbness of tongue
- ✓ **Shape** - Clove consist of a stalk and head. Stalk is also called as hypanthium and it is a cylindrical structure. It is surrounded with four thick acute divergent sepals surrounded by dome shaped corolla. The upper part of hypanthium places bilocular ovary containing numerous ovules attached to axile placenta. The head consist of four calyx teeth which slightly projects outwards

Microscopic characters

- The epidermis of the clove is covered with thick cuticle.
- The epidermis itself consists of straight walled cells and large anomocytic stomata.
- The oil glands, are ovoid and schizolysigenous.
- Phloem fibres, which are isolated, are occasionally found in the spongy tissue
- Cluster crystals of calcium oxalate and small number of stone cells are found in the drug
- Below the ring of vascular bundles there is zone of aerenchyma which is composed of air spaces separated by lamellae one cell thick which support central columella
- A transverse section through the ovary shows epidermis and zone of oil gland and bicollateral vascular bundles

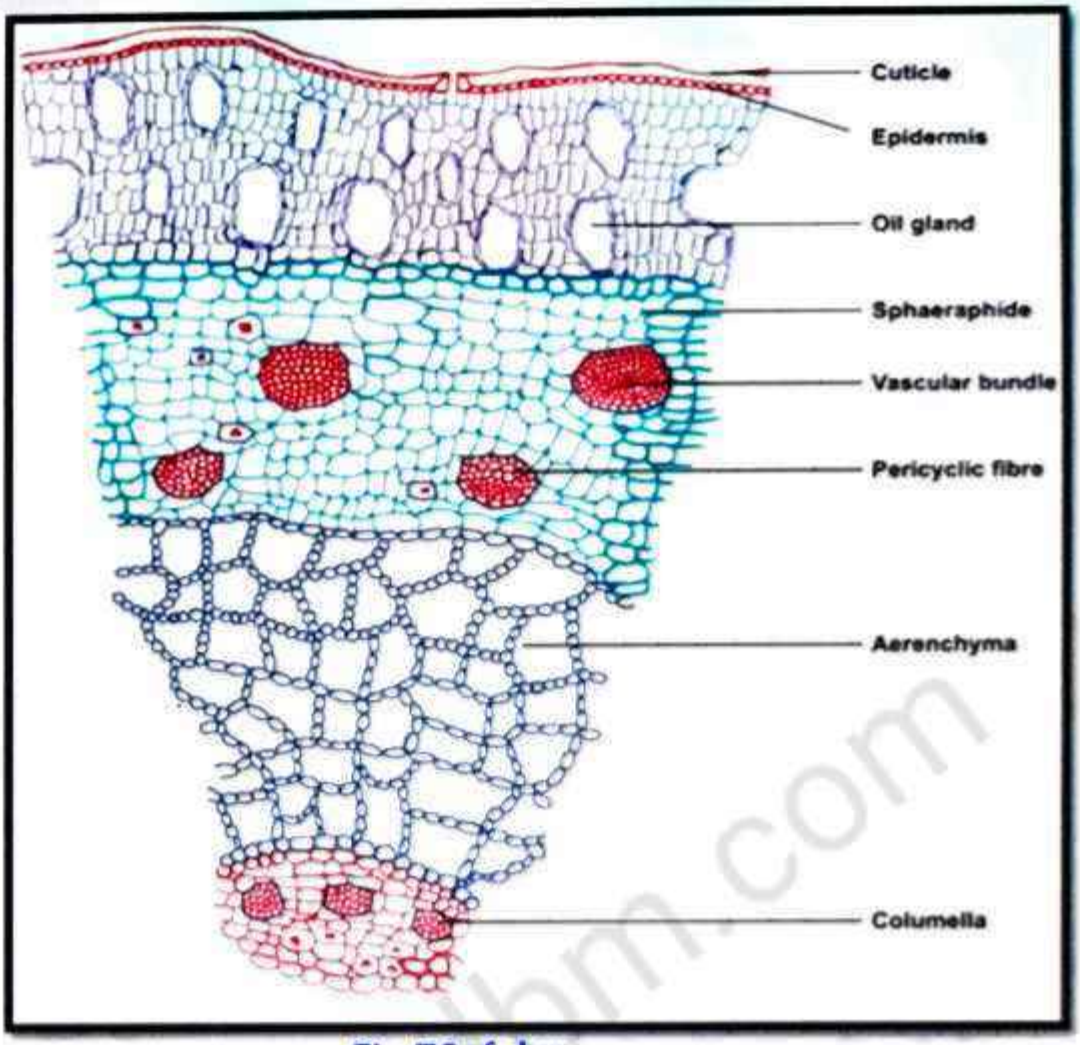


Fig. T.S of clove

Chemical constituents

- Clove contains **14-21%** of **volatile oil, 10-13%** of **tannins (gallotannic acid),** resin, oleanolic acid, **vanillin and eugenol**
- The volatile oil is colourless or pale yellow in colour and consists of phenolic substance called as **eugenol (80-95%),** acetyl **eugenol, α-caryophyllene, β-caryophyllene** and small quantities of esters, ketones and alcohols
- The **aroma of clove** is due to presence of **methyl amyl ketone**

Adulterants

✓ **Mother cloves**

- These are **dark brown, ovate ripened fruits of clove tree**
- They are **slightly aromatic and contain starch**

Fig. Mother cloves

✓ **Blown cloves**

- These are **expanded flowers of the clove tree**
- The stamens generally get detached
- They also contain volatile oil and **are similar in colour to the cloves**
- The **volatile oil content is less as compared to authentic drug**

Fig. Blown cloves

✓ **Clove stalks**

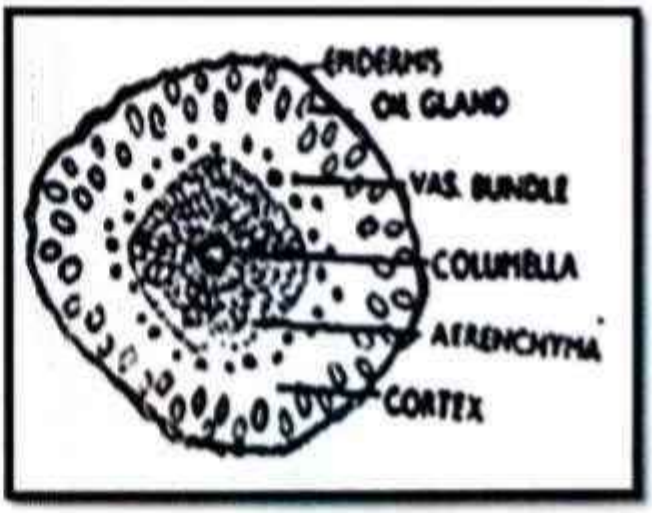
- These are generally used to adulterate the powdered cloves and are **detected by presence of isodiametric sclereids** and prisms of calcium oxalate
- The authentic cloves should not contain more than 5 % of stalks to pass the pharmacopoeial limit
- Due to similarity in colour, odour and taste, clove stalks are mixed with the cloves
- Clove stalks **contain only 5 % of oil**

Fig. Clove stalks

✓ **Exhausted cloves**

- These are the cloves from which **oil has been extracted by distillation**
- They are **dark in colour**, more **shrunken** and when pressed with finger nails, do not show the presence of oil
- **Exhausted cloves float on water**

Fig. Exhausted cloves



Chemical test for clove

1. To a drop of chloroform extract of clove or clove oil add a drop of 30% aqueous solution of sodium hydroxide saturated with sodium bromide. needle and pear shaped crystals of sodium eugenate arranged in rosette
2. Treat a thick section of hypanthium of clove with 50% potassium hydroxide solution. The needle shaped crystals of potassium eugenate are observed

Uses

- Clove is used as a stimulant aromatic
- As spice
- For preparation of volatile oil
- Employed as a remedy of toothache and applied topically to dental cavities
- Clove oil also shows antiseptic, counterirritant and carminative properties
- Eugenol is a colourless or pale yellow , strongly aromatic liquid with a pungent spicy taste
- Mixed with zinc oxide as a temporary dental filling
- In all Indian homes, clove is used as a culinary spice
- In Java, clove is used in the preparation of a special brand of cigarette for smoking

CINNAMON

Biological source : It consists of dried inner bark of ***Cinnamomum zeylanicum*** Family : Lauraceae

Macroscopic Characters

- The outer surface is **dull yellowish brown** while the inner surface is **dark yellowish brown**
- **Odour - fragrant**
- Found in the form of **compound quills**
- About 1 m length and 1cm in diameter. The thickness of the bark is approximately 0.5 mm
- **Taste is aromatic and sweet** followed by warm sensation

Microscopic characters

- Being an inner bark, the **cork and primary cortex are absent.**
- The stelar part shows **phloem, phloem fibres, biseriate medullary rays**
- Starch grains in **cortical parenchyma and medullary rays and calcium oxalate crystals in parenchymatous cells are also present**

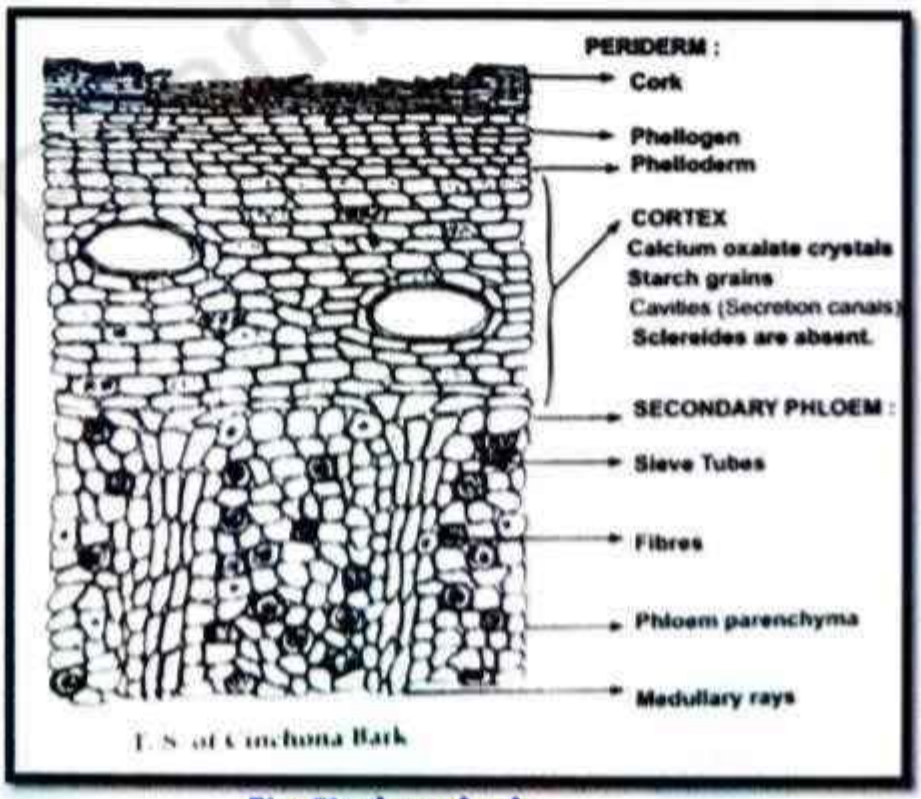


Fig. Cinchona bark

Chemical constituents

- Cinnamon bark contains about **0.5 - 1.0 per cent of volatile oil**

  1.2% of tannins (phlobatannins), **mucilage, calcium oxalate, starch and a sweet substance known as mannitol**

- It is light yellow (when freshly distilled) in colour and changes to red on storage
- Cinnamon oil contains 60-70 % of cinnamaldehyde, **5-10 per cent eugenol**, benzaldehyde, Cumminaldehyde and other terpenes like phellandrene, pinene, cymene, caryophyllene

Chemical test

- On addition of a drop of **ferric chloride solution** to a drop of volatile oil, produces a pale green colour
- With ferric chloride, **cinnamic aldehyde gives brown colour** and **eugenol gives blue colour**, resulting in the formation of pale green colour
- **In cassia oil**, brown colour is obtained, as it **contains only cinnamic aldehyde**

Uses

- Bark is used as **carminative, stomachic and mild astringent**
- It is also used as **flavouring agent, stimulant, aromatic and antiseptic**

FENNEL

Biological source : It is the dried fruit obtained from the plant ***Foeniculum vulgare.*** Family : Umbelliferae

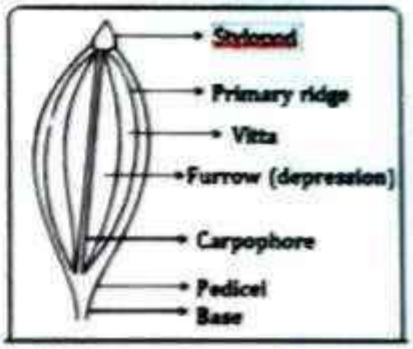


Fig. Commissural surface of mericarp of fennel

Macroscopic character

- Containing **bifid stylopod** at the top
- **Carpophore** in center

Microscopic characters

- The special features of the histological characters of fennel are the presence of **anomocytic stomata on the epidermis of pericarp**
- **Mesocarp containing lignified and reticulate parenchyma**
- **Parquetry arrangement of cells** on the inner epidermis of pericarp is another feature of the drug and common to all umbelliferous fruits
- Vittae, the secretory canals, contain volatile oil and are **brown in colour**
- Endosperm is made up of polyhedral thick-walled cells containing **fixed oil and aleurone grains and minute rosette crystals of calcium oxalate**
- **Trichomes and starch grains are absent**

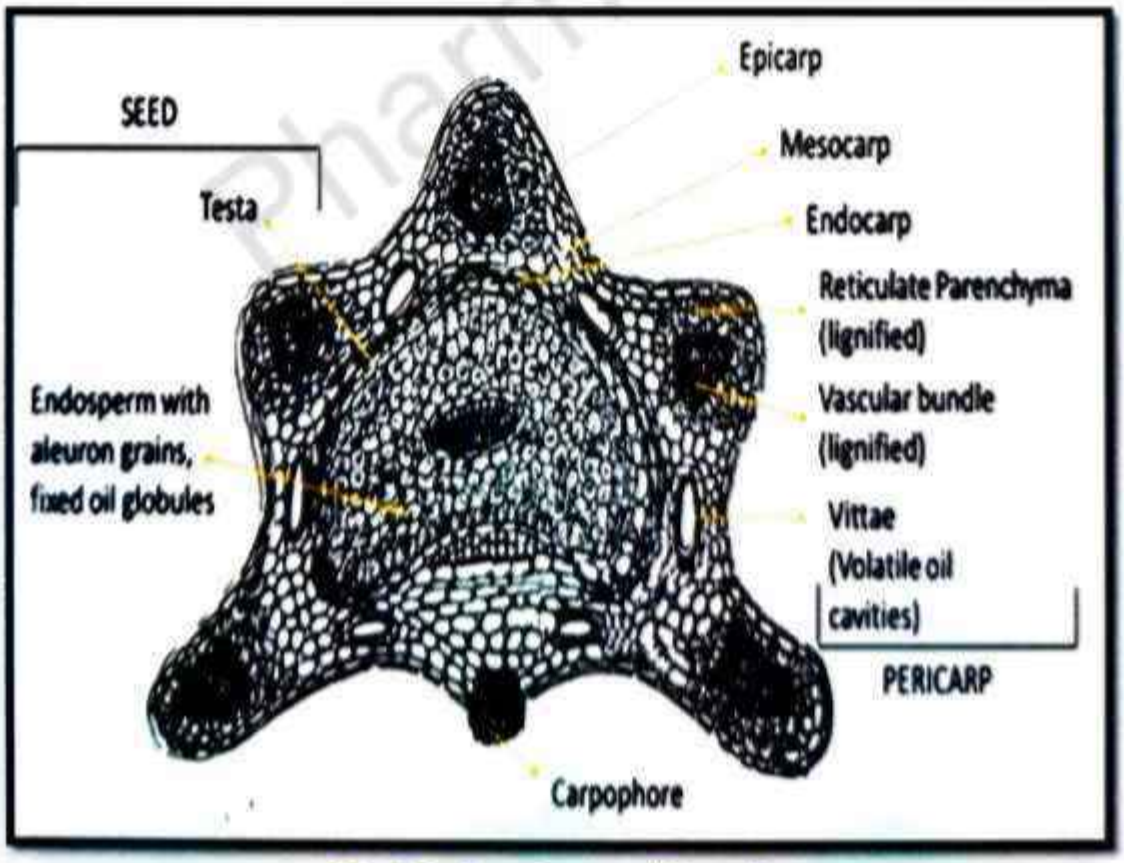


Fig. T.S of mericarp of fennel

Chemical constituents

- Fennel consists of 3 to 7 % of volatile oil, about 20 % each of proteins and fixed oil
- The chief active constituent of the volatile oil is a ketone, fenchone (about 20 %) and a phenolic ether anethole (about 50 %)
- Fenchone is a colourless pungent liquid with aromatic odour
- The other constituents are phellandrene, limonene, methyl chavicol, anisic aldehyde, etc.
- The anethole is sweet in odour and taste

Variety of fennel

Variety	Size in mm	Taste	Volatile oil content (%)	Fenchone Content of volatile oil (%)
Saxony	10 x 4	Aromatic	4.76	22.00
Russia or Rumanian	4 to 6 x1 to 2	Camphoraceous	4.50	18.00
French sweet or Roman	7 to 8 x 2 to 3	Sweet aromatic	2.1	nil
Indian	4 to 7	Camphoraceous	0.720	6.70
Japanese	3 to 4 x 2 to 3	Very sweet	2.70	10.20

Adulterants

Fennel is commonly **adulterated with exhausted fennel** fruits which can be distinguished by the following tests:

1. The fruits from which volatile oil is removed by treating with alcohol, contain less percentage of volatile oil and have a typical odour of fusel oil. Such fruits do not contain fenchone

2. If the fruits are exhausted by the application of steam, they look dark greenish-brown in colour and contain only traces of volatile oil and sink in water

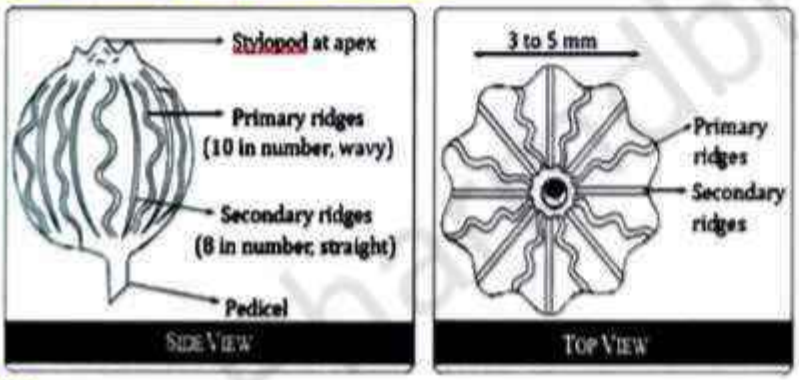
Uses

- It is used as carminative, aromatic, stimulant and also an expectorant
- Pharmaceutically used as flavouring agent

CORIANDER

Biological source : It is the dried fruit obtained from the plant *Coriandrum sativum* Family : Umbelliferae

Macroscopic character



Microscopy

- Four lacunae at dorsal and two vittae at ventral side
- Thick wavy sclerenchymatous layer in mesocarp
- On dorsal surface there are total five vascular bundles in just below each primary ridge of the mericarp of coriander fruit
- The inner epidermis of the pericarp (i.e. endocarp) is composed of parquetry cells
- The unripe plant has an unpleasant mousy odour, which is also present in oil distilled from unripe fruits, mainly aldehydes such as n-decanal contained in peripheral vittae

Chemical constituents

- Consists of **0.3 to 1 % volatile oil**
- 90% D-linool (Coriandrol) -: gives characteristic smell
- Also contain **transtridecanal (it gives bed bug like smell), after ripen – Coriandrol**
- Coriander leaves are rich in **vitamin A** content

Uses

- The fruit and volatile oil are used as an **aromatic, carminative, stimulant and flavouring agent**

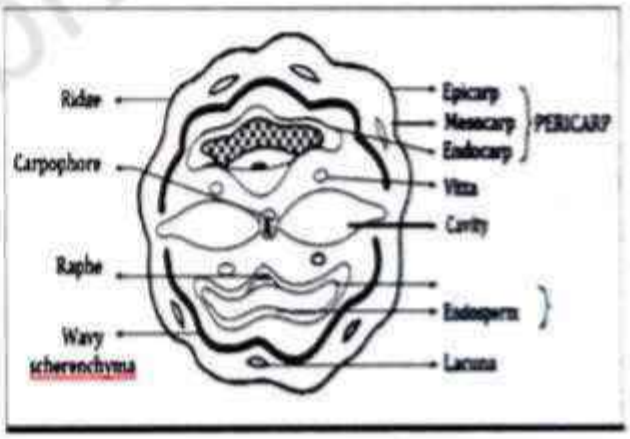


Fig. T.S of coriander fruit

IRIDOIDS, OTHER TERPERNOIDS AND NAPTHAQUINONES

- 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
- The iridoids produced by plants act primarily as a defense against herbivores or against infection by microorganisms

NAPHTHOQUINONES

- Naphthoquinone is a class of organic compounds structurally related to naphthalene
- Two isomers are common for the parent naphthoquinones :
- 1,2 – Naphthoquinone
- 1,4 – Naphthoquinone
- Naphthoquinones usually do not occur as glycosides in higher plants
- Naphtoquinones represent the group of plant secondary metabolites with cytotoxic properties based on their ability to generate reactive oxygen species and interfere with the processes of cell respiration
- The most important naphthoquinones containing plants belong to the group of phytogenetically heterogenous plant families

GENTIAN

Synonym : Gentian root, Radix Gentianae

Biological source : Gentian is the dried partially fermented rhizome and root of yellow gentian i.e. *Gentiana lutea*

Family : Gentianaceae

Macroscopy

- The **rhizome is yellowish – brown** and has **transverse annulations** and shows conical buds at the top
- The root is **narrower but continuous with rhizome**
- It is **longitudinally wrinkled** and has **circular scars of rootlets**
- The drug has a **peculiar odour**
- The drug **first gives a sweet taste**, followed by an **intensely bitter taste**

Microscopy

- The transverse section of rhizome shows **bark, cambium, wood and pith**
- The root shows these parts but **no pith**, in place of which a **triarch primary xylem is present**
- The **cork cells are thin walled**
- Cortex has **parenchyma with oil globules and calcium oxalate**
- **Phloem is present** in small groups and **phloem fibres** are **absent**
- The xylem contains **spiral and annular vessels** and also shows **presence of inter xylary phloem**

Chemical Constituents

- The drug contains bitter glycosides mainly **gentiopicrin**, which is also called gentiopicroside
- It is a **water soluble, crystalline** compound with a **bitter value of 12,000**. During fermentation and drying, it breaks down to gentiogenin and glucose

Gentiopicrin —(hydrolysis)→ **Gentiogenin + glucose**

Chemical Test

Under UV radiation gentian extract shows light **blue fluorescence**

Uses

- It is used as a **bitter tonic** to stimulate the **gastric secretion** and hence improving the appetite

ARTEMISIA

Synonym : Santonica , Worm seeds

Biological source : These are the unexpanded flower heads of ***Artemisia brevifolia***, *Artemisia maritime* and other species of Artemisia

Family : Compositae

Microscopic characters

- leaves are characterized by isobilateral arrangement
- Anomocytic stomata along with glandular trichomes
- Abundant in number on both the surfaces with very short stalk and multicellular head
- T shaped covering trichomes are the special character of leaves

Chemical constituents

- Santonica contains essential oil and two crystalline substances i.e. santonin and artemisin
- The volatile oil content varies from 1.0 - 2 per cent
- While the percentage of santonin is about 2.0 per cent
- The volatile oil contains cineole, pinene and resin
- The chief active constituent of the drug is santonin
- Santonin is a sesquiterpene lactone which is anhydride of santonic Acid
- Artemisinin (it is sesquiterpene lactone with peroxide linkage)

Identification

Boil **1g finely powdered drug** with **10 ml alcohol** and **filter**

↓

To the filtrate, add **sodium hydroxide** and **heat again**

↓

The **liquid develops red color**

Uses

- Santonica is used as a strong anthelminthic, especially for **round worms**
- It has **less or no effect on hook worms and tape worms**

TAXUS

Synonym : Yew, Himalayan Yew

Biological source : This consists of dried leaves, bark and roots of various species of Taxus

The four important species with parts used are

1. *Taxus baccata* (English or European yew) mainly leaves
2. *Taxus brevifolia* (Pacific yew) mainly stem bark.
3. *Taxus Canadensis* (Canadian or American yew) leaves and roots.
4. *Taxus cuspidate* (Japanese yew) leaves

Family : Taxaceae

Chemical Constituents

- The main constituent **taxol is present in all parts of the plant especially in leaves, roots and bark of the plant**
- Three most important member of taxol, **cephalomannine and 10-deacetyl baccatin**
- A derivative of taxol, called **taxotere** has been reported to have **better bio-availibility** and **pharmacological properties** and has been claimed as a **promising anticancer agent**

Chemical test

Sample + Aq. methanol → **needle or fine white powder** is form

Uses

- Taxol brings out the **polymerization to microtubule** in absence of MAP and GTP
- Taxol also **inhibits cell migration thus, preventing spread of metastatic cancer cells**
- Taxol has been **approved by USFDA for treatment of refractory ovarian cancer**

✓ **Tetraterpenoids and carotenoids**

- They are **C40 compounds of terpenoid groups** and **biosynthetically prepared by tail-to-tail condensation of geranyl geraniol**
- They contain **long sequence of conjugated double bonds**
- Carotenoids are a prominent group of **natural coloring matters exhibiting purple, red, yellow or orange colors**
- They are **present both in plants and animals**
- In plants, they **act as photosynthetic accessory pigments** and in animals as a **source of vitamin A** and also as antioxidants

CAROTENOIDS

Synonym : Carotenoid

Chemical class : Belongs to tetraterpenoid

Biological source : They are **plant pigment such as red , yellow and orange coloured** which are abundantly available in **fruit and vegetables** even available in **fungi and bacteria**

Properties

- They are **most wide spread accessory in nature**
- They are **light sensitive pigment**
- They are **yellow red brown or greenish in colour**
- **Hydrophobic in nature**

They are more than 600 type of carotenoid , among them the most important are α - carotenoid , β - carotenoid, lutein, Zeaxanthin and lycopene

General extraction of carotenoid

Sample + acetone in nitrogen atom → filter → re-extract with acetone till colour → combine filtrate → extract with diethyl ether add NaCl → carotenoids ppt.

Chemical test

Sample + $CHCl_3$ + 8% H2SO4 → blue colour at interface is formed → Indicate presence of carotenoid

Therapeutic uses

- Antioxidant activity
- β – carotene may help to protect against sun burn , lower risk of metabolic syndrome (HTN, High RBC, abnormal cholesterol level etc) in middle age
- Both α – carotene and lycopene reduce risk of lung cancer