# GLYCOSIDES

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# INTRODUCTION

- **Definition:**

Glycoside is an **organic compound**, usually of plant origin, that is composed of a **sugar portion** linked to a **non-sugar moiety**.

- sugar portion - **glycone,**
- non-sugar portion - **genin or aglycone**.
- Glycosides hydrolyzed to yield one or more sugars & non sugar component.

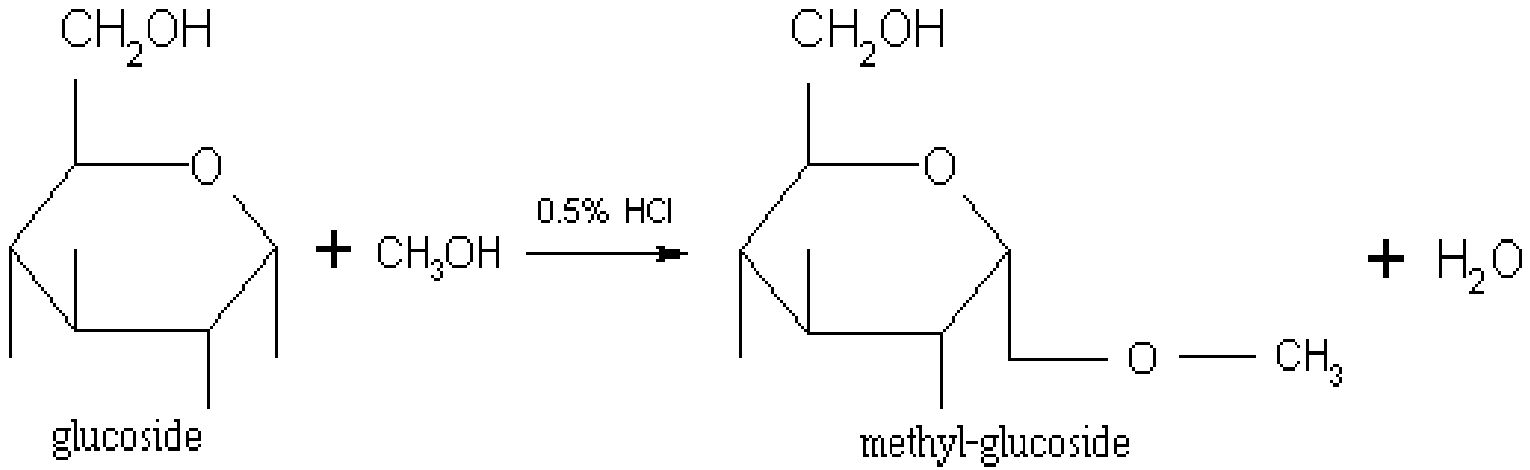
- Chemically glycosides are **acetals** – hydroxyl group of sugar condensed with hydroxyl group of nonsugar component.

- $C_6H_{11}O_5OH + HOC_6H_4CH_2OH \rightarrow C_6H_{11}O_5OC_6H_4CH_2OH + H_2O$

- Glucose (Sugar) + Salicyl alcohol (Aglycone) → Salicin (Glycoside)

- linkage between sugar & nonsugar called glycosidic linkage, it may be α or β glycosidic bond

- In simple form, glycoside synthesized from union of methyl alcohol & glucose.




- On hydrolysis of α methyl glycoside – α glucose & methyl alcohol
- On hydrolysis of β methyl glycoside – β glucose & methyl alcohol

- Glycoside can be hydrolyzed by enzyme, acid, alkali or sometimes with moisture.

- α – glycosidase like invertase & maltase hydrolyzed α – glycosides.

- β - glycosidase like gentianase, linarase, cellobiase hydrolyzed β – glycosides.

# SUGARS IN THE GLYCOSIDES

- Glucose – glycoside called glucoside
- Fructose – fructoside
- Also contain rhamnose, galactose etc.
- Glycoside – single unit or more than one unit of monosaccharide present

ex. amygdalin – one unit of glucose

digitoxin – three unit of digitoxose

- Glycoside – two or more different sugar unit present

Ex. Rutin – one unit of rhamnose & glucose

- In some glycosides, sugar moiety not a true sugar but sugar dvt. Ex. glycyrrhizin

# PROPERTIES

- colorless,

  - but flavone glycoside – yellow colored

    anthracene glycoside – red or orange colored

- Crystalline or amorphous solid substances
- Solubility – soluble in water & alcohol, insoluble in ether & chloroform
- Optically active & usually levorotatory

# CLASSIFICATION

- Classified as

1. Glycosides linkage
2. Nature of sugar
3. Therapeutic action
4. Chemical nature of aglycone

## 1. Based on glycoside linkage

O-glycoside, C-glycoside, S- glycoside, N-glycoside

**a. O-glycoside** – sugar combined with phenol or OH group of aglycone

- $RHO + C_6H_{11}O_5OH \longrightarrow ROC_6H_{11}O_5 + H_2O$

ex. Cardiac, cyanogenetic, flavone glycoside

**b. C-glycoside** – sugar directly attached to carbon atom

- CH + $C_6H_{11}O_5OH$ ⟶ $CC_6H_{11}O_5$

Ex, aloin in aloe & cascarosides in cascara

This glycoside hydrolysed by FeCl3, HCl & sodium meta periodate

**c. S- glycoside** – S or SH group attached to sugar

- - SH + $C_6H_{11}O_5OH$ ⟶ $S\text{-}C_6H_{11}O_5$

ex. Isothiocyanate glycoside

**d. N- glycoside -** Nor NH group attached to sugar

- NH + $C_6H_{11}O_5OH$ ⟶ $N\text{-}C_6H_{11}O_5$

## Based on chemical nature of aglycone

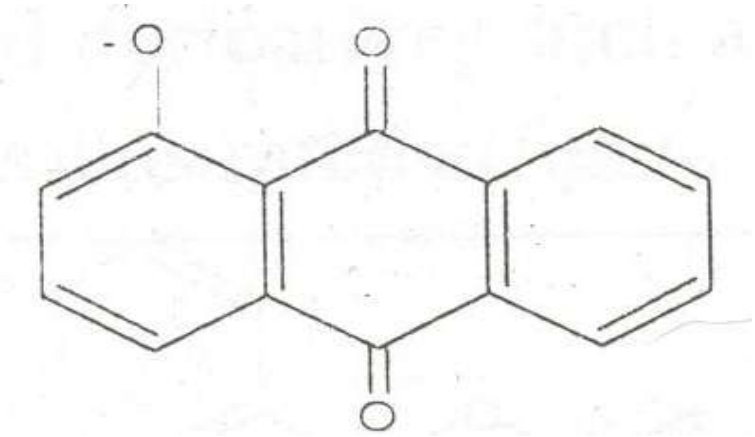
- Anthraquinone glycosides
- Cardiac glycosides
- Saponin glycosides
- Flavonoid glycoside
- Coumarin glycoside
- Cyanogenic glycosides
- Aldehyde, Phenol, Alcohol group containing glycosides

## 1. Anthraquinone glycosides

Ex. Sennoside (Senna)

Barbaloin (Aloe)

Cascaroside (Cascara)

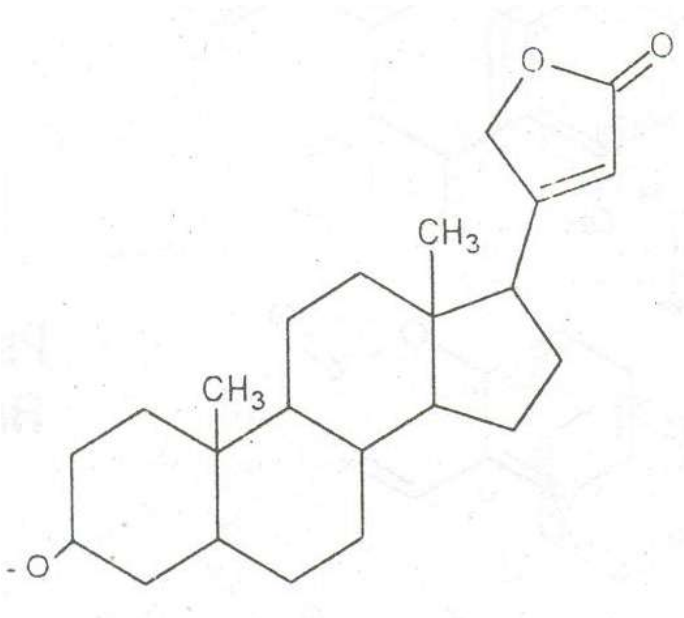


## 2. Cardiac glycosides

Ex. Digitoxin (D. purpurea)

Digoxin (D. lanata)

Stropanthoside (Stropanthus)

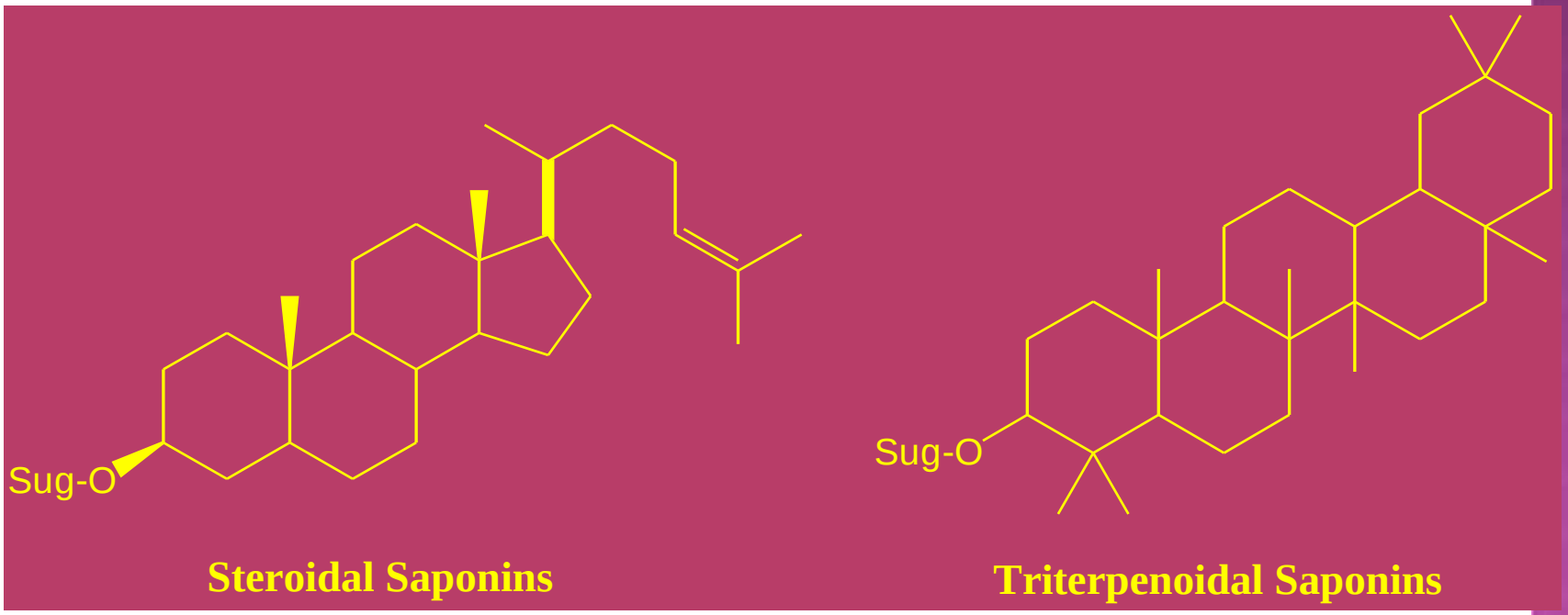


## 3. Saponin Glycosides

Ex. Glycyrrhizin (Glycyrrhiza)

Ginsenoside (Ginseng)

Senegin (Senega)

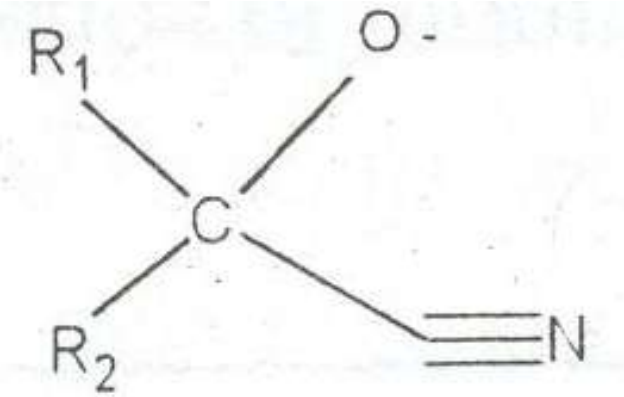



**Steroidal Saponins** **Triterpenoidal Saponins**

## 4. Cyanogenetic glycosides

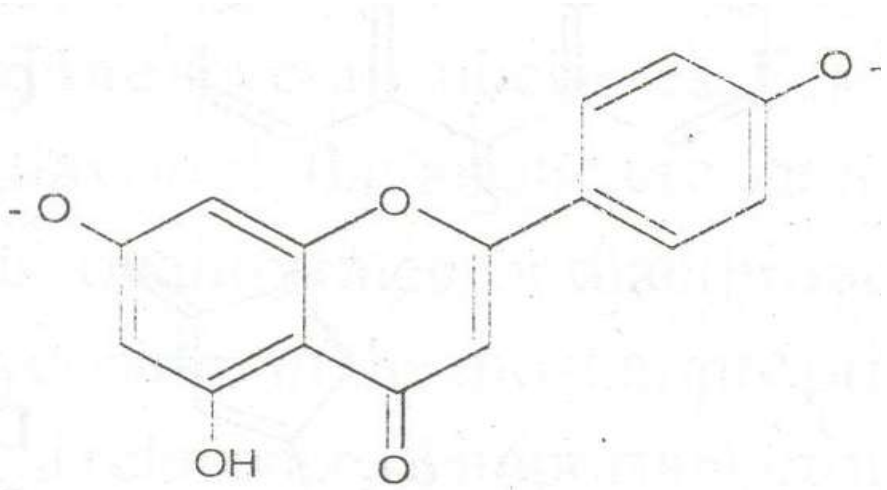
Ex. Amygladin (Bitter almond)

Prunasin (Wild cherry)



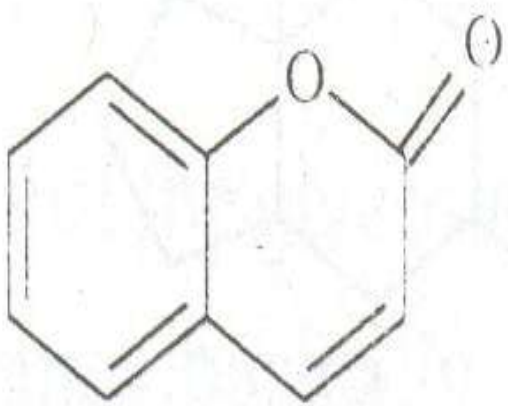
## 5. Flavonoids glycosides

Ex. Rutin (Buck wheat)




## 6. Coumarin glycosides

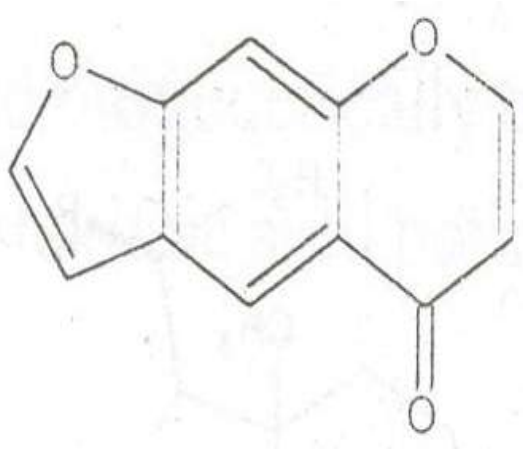
Ex. Psoralen (Psoralea)



## 7. Chromone glycosides

Ex. Khellin (Ammi majus)

Visnagin (Ammi visnaga)



## 8. Lactone glycosides

Monoterpene lactone – Gentiopicrin (Gentian)

Quassin (Quassia)

Diterpene lactone – Andographolide (Kalmegh)

## 9. Aldehyde containing glycosides

Glucovanillin (Vanilla)

## 10. Phenol containing glycosides

Arbutin (Uva-ursi)

## 11. Alcohol containing glycosides

Salicin (Salix)

# EXTRACTION

## Stas-otto method

- Drug – finely powdered
- Powder extracted by continuous hot percolation using Soxhlet apparatus using alcohol.
- In this process – enzymes present in plant deactivated due to heating
- Thermolabile glycosides extracted at temp. below 45°c.
- Extract treated with lead acetate to ppt tannins & eliminate non glucosidal impurities
- Then excess lead acetate ppted as lead sulphide by passing H2S gas.
- Then extract filtered, concentrated to get crude glycosides.
- For further purification different method like fractional crystallization & chromatographic techniques.

# SAPONINS

# SAPONIN GLYCOSIDES

- Saponin – Latin word ‘sapo’ means soap
- Get their name from the soapwort plant (Saponaria) – root used as soap.

- Aglycone of glycoside - produce **frothing in an aqueous solution**. Historically used for their detergent properties.

- Saponin have strong biological activity so saponins are plants active immune system.
- Saponins found in oats & spinach – increase & accelerate body’s ability to absorb calcium & silicon – thus assisting in digestion.

- Saponins have **haemolytic** properties → when injected into the blood stream are highly toxic (used as an arrow poisons).

- When taken orally, saponins are harmless.

- Saponins are toxic to lower organism like earthworm & fish & kill them

## Haemolysis of saponins –

- Saponins form insoluble **complexes with higher alcohols** like cholesterol.
- RBC membrane contains sterols – saponins combine sterols – alteration in cell wall, permeability changes & Hb comes out of cells (Haemolysis)
- Compared to triterpenoid saponins, **steroidal saponins more hemolytic** because have higher affinity for sterols present in RBC membrane. Since steroidal saponins **structurally analogous to cholesterol** than triterpenoids.

# PROPERTIES

- Non crystalline
- Taste – bitter
- Irritate mucous membrane
- High molecular weight
- Carry many asymmetric centers & optically active
- Solubility – soluble in water & alcohol. It give ppt with alcoholic solutions of sterols (Cholesterol).

  insoluble in organic solvents like acetone, petroleum ether.
- Non alkaline nature

- Hydrolyzed by acids, enzymes & photolysis.
- In mild conditions using very dilute acids, organic acids give rise to partially hydrolyzed saponins – called **prosapogenin**
- Saponin have property of lowering surface tension

Saponins hydrolysed (by acids) ⟹ **aglycone** + different sugars related to uronic acids.

- Aglycone called **sapogenin** (insoluble in water) – high mol. Wt which by acetylation give crystalline forms

- Structure of the sapogenin (aglycone) determines the type of saponin
- Harmful sapogenin **- sapotoxins**

- Two types –

1. Tetracyclic triterpenoids (steroidal saponins)
2. Pentacyclic triterpenoid saponins

- Both types of glycosides have a glycosidal linkage at C-3.

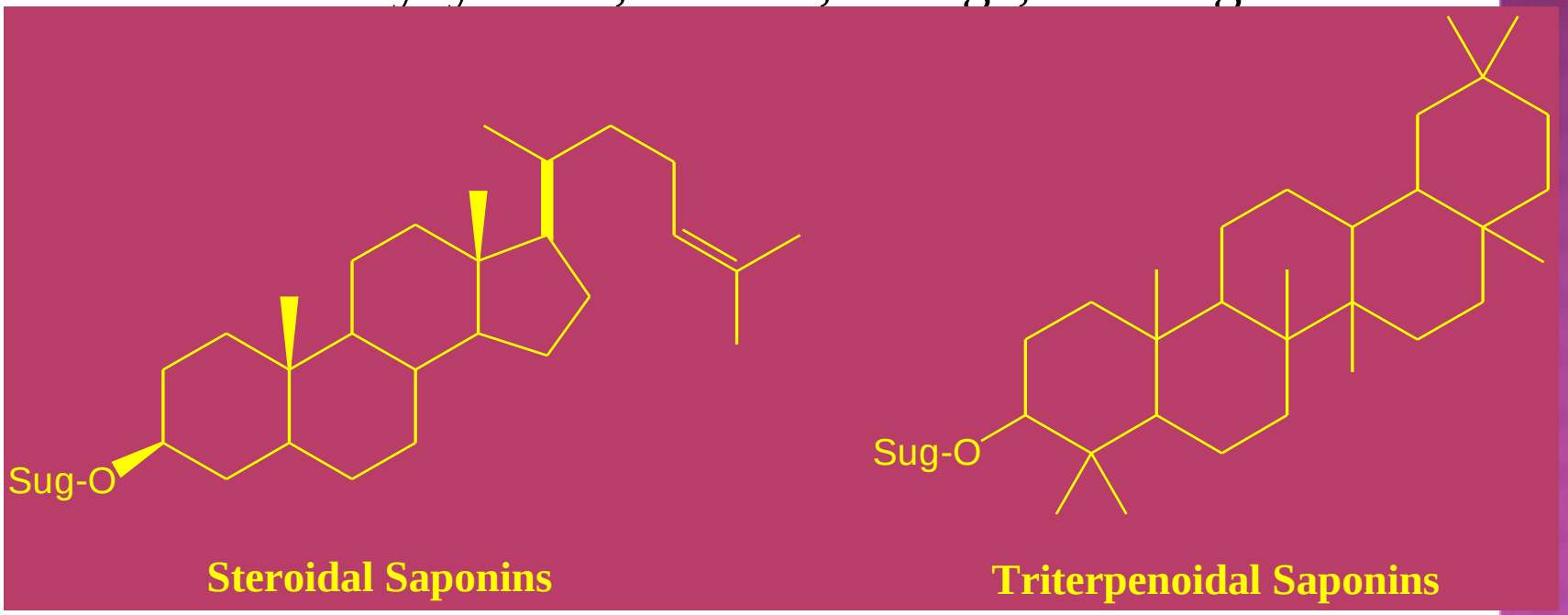
# STEROIDAL SAPONINS

- Also called tetracyclic triterpenoids
- Found in many monocotyledons such as Wild yam (*Dioscorea vilosa*).
- Also found in dicotyledons fenugreek
- **Saponin–** Diosgenin, Gitogenin, Sarsasaponin.
- ***Strophanthus*** and ***Digitalis*** contain both steroidal saponins (glycosides) and cardiac glycosides.

- relationship with compounds such as sex hormones, cortisone, diuretic steroids, vitamin D and the cardiac glycosides.
- Some are used as starting materials for the synthesis of these compounds.
- Diosgenin is the main sapogenin used by industry .
- In Dicot plants, important sources from Leguminosae, Solanaceae etc.
- In monocot plants, sources from Liliaceae, Dioscoreaceae.
- Sources – Digitalis, Dioscorea, Smilax

# PENTACYCLIC TRITERPENE SAPONINS

- Rare in monocotyledons, but abundant in dicotyledons. (Polygalaceae, Umbelliferae, Rubiaceae, Berberidaceae etc.)
- Triterpene saponins are β-amyrine dvts, α-amyrine & lupeol dvts.
- Sources – Glycyrrhiza, Brahmi, Senega, Ginseng



## Physiological properties :-

- Toxic to fishes
- Hemolyses RBC
- Accelerate germination & growth of seeds
- Saponins show fungicidal, bactericidal, antiviral, antibiotic, spermicidal, inflammation inhibition activity
- Saponins have Anthelmentic, sedative & antispasmodic effect.

- Glycyrrhiza
- Ginseng
- Senega
- Dioscorea
- Sarsaparilla

# GLYCYRRHIZA

- **Synonyms** – Mulethi, Jethi madh, Yastimadhu
- **B.S.** – subterranean peeled & unpeeled **stolons**, **roots** & subterranean stems of ***Glycyrrhiza glabra***

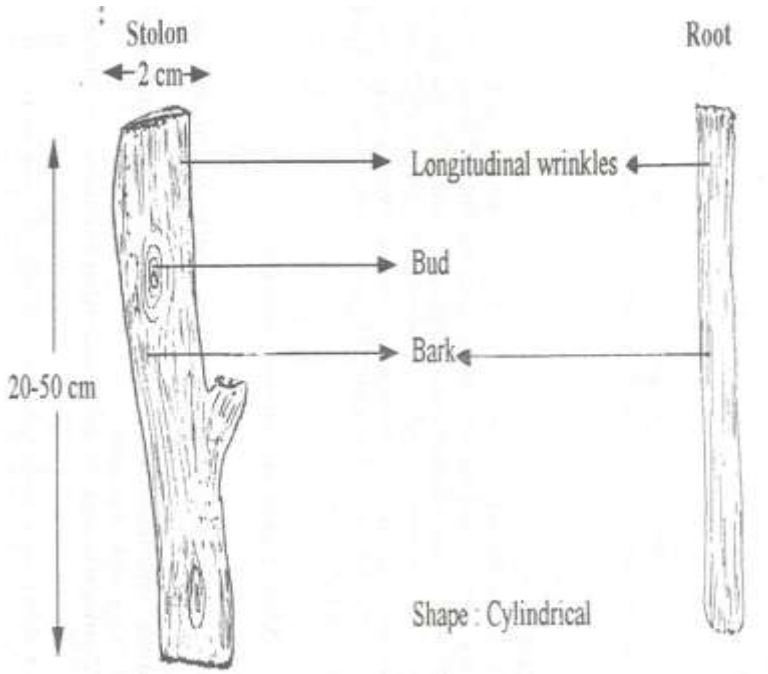
**- Glycyrrhiza –** derived from Greek – means sweet root

**- Glabra –** means smooth – smooth pod like fruit of this species.

- **Family –** Leguminoseae
- **G.S.–** Spain, Iran, Iraq, Sicily & England

Spain & Italy – drug collected from cultivated plants

Russia & Iran – from wild plants


Stolon
2 cm
Root
Longitudinal wrinkles
Bud
Bark
20-50 cm
Shape : Cylindrical

## Different varieties of G. glabra

1. G. glabra var. typica **(Spanish liquorice)**

- Has purplish blue flowers
- Underground portion consists long roots, rhizomes & stolons

2. G. glabra var. glandulifera **(Russian liquorice)**

- Fruits has glands hence name glandulifera
- Has big root stock with no. of elongated roots but no stolons

3. G. glabra var. violacea **(Persian liquorice)**

- Has violet flowers
- Usually unpeeled
- Largely consumed in America

4. Anatolian & Syrian liquorice

- From Smyrna& Alexandretta to United States
- Derived form G. glabra
- Some pieces – large size- 5-8 cm in diameter

## Cultivation:

- Cultivated by planting **rhizome or stolon** in deep, rich, loamy fertile soil.
- Collection – **in autumn** in 3rd or 4th year.
- Stolons & roots dug out & bud & rootlets are removed & then washed & dried in sun.
- Sometimes drug is peeled before drying.
- Peeled drug used for direct administration but for preparation tinctures unpeeled drug is used.

## Macroscopic characters:

- **Colour – unpeeled** – externally – dark brown
  internally – yellow
  **peeled** – pale yellow
- **Odour –** faint & characteristic
- **Taste –** sweet
- **Size –** long – 1 m, Diameter – 1-2 cm
- **Shape – peeled** – angular
  **unpeeled** – cylindrical, unbranched, straight
- **Surface –** longitudinally wrinkled
  stolon – small buds, scale leaves present
- **Fracture –** fibrous in bark & splintery in wood

# MICROSCOPY:

- **Cork –** radially arranged thin walled tabular cells
- **Phelloderm –** parenchymatous or sometimes collenchymatous cells.

-- Cells contain starch grains & ca. oxalate crystals

- **Secondary phloem** – composed of alternated zones of phloem fibers & sieve tissue.

--- phloem fibers – thick walled, lignified – surrounded by phloem parenchyma & show single prism of calcium oxalate

--- outer part of phloem is obliterated & collapsed – form ceratenchyma

- **Secondary xylem**

- Xylem fibers – more strongly lignified

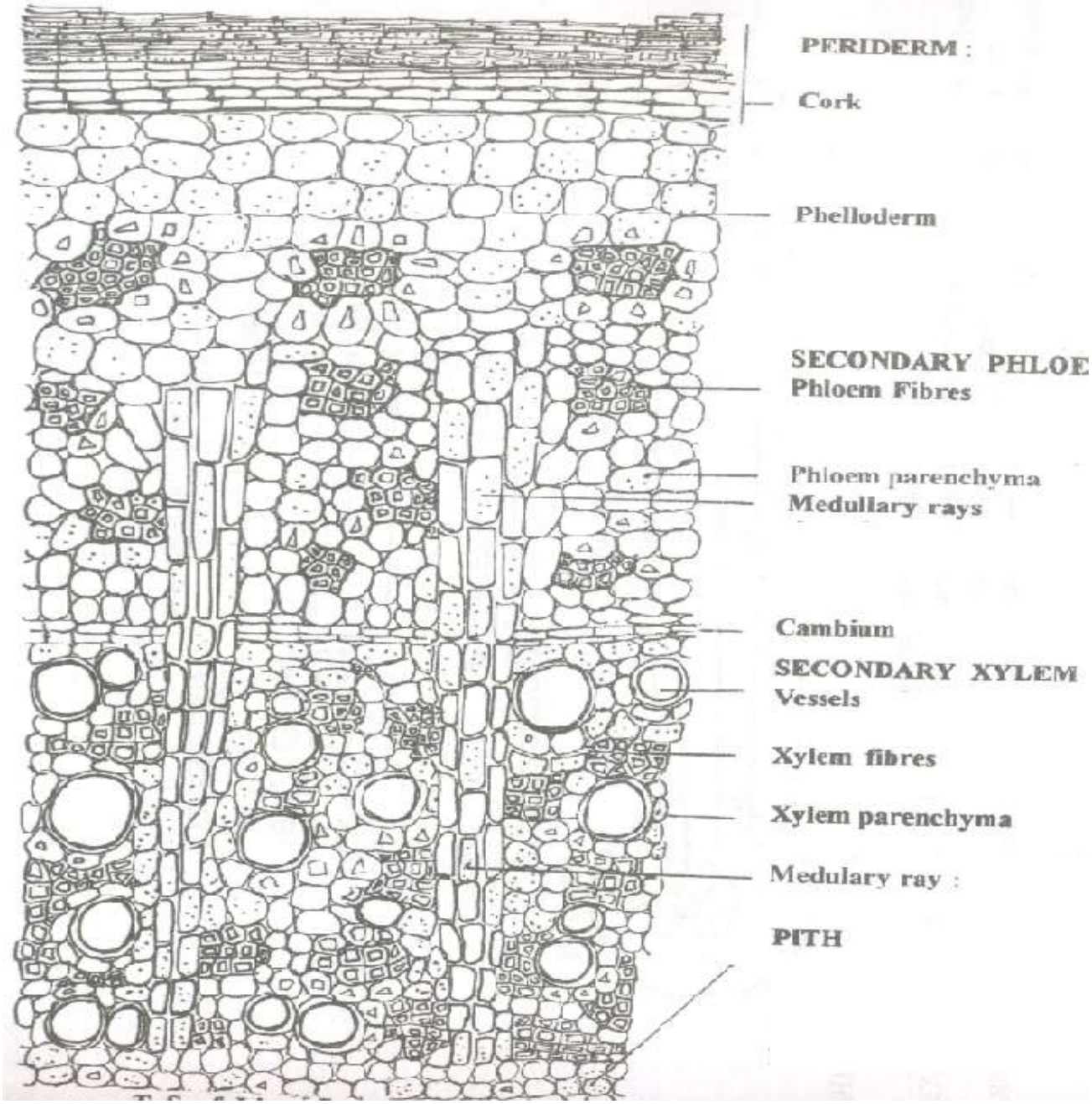
- Xylem vessels – size – 80-200 µ in Diameter

- **Parenchyma** – contain prism of ca. oxalate (10-15-25-35 µ) & starch (round – 2-10-20 µ)

- **Medullary rays** – composed of cellulosic parenchyma rectangular cells & bi or multiseriate

- **Pith –** parenchymatous

- **Root –** pith absent & presence of tetrach xylem


PERIDERM :
Cork
Phelloderm
SECONDARY PHLOE
Phloem Fibres
Phloem parenchyma
Medullary rays
Cambium
SECONDARY XYLEM
Vessels
Xylem fibres
Xylem parenchyma
Medulary ray :
PITH

## Chemical constituents:

- Pentacyclic triterpenoidal β-amyrine structure
- 2.5 to 7% **glycyrrhizin** – sweet water soluble sub.
- Glycyrrhizin – mixture of potassium & ca. salt of glycyrrhizinic acid
- glycyrrhizinic acid - glycoside
- glycyrrhizinic acid —hydrolyzed→ **glycyrrhetinic acid** (aglycone) + glucuronic acid (2 mole) (glycone)
- Other constituents – 18-OH glycyrrhetic acid (glabrin acid), glucose, sucrose, asparagin, β-sitosterol, bitter principle- **glycyramarin**

- Yellow colour drug due to **chalcone glycoside** (isoliquiritin)
- Isoliquiritin → (Drying) liquiritin (**flavone glycoside**)
- Isoliquiritin → (hydrolysis) **Isoliquiritigenin** (spasmolytic action)

Glycyrrhizin –

- Prevents **inactivation of glucocorticoid** in liver
- Glucocorticoid action – loss of potassium & retention of sodium so causes oedema
- As a result, use of Glycyrrhiza in candies & other preparations not permitted.

- Structure of glycyrrhetinic acid similar to cortisone. Both are flat & similar at 3 & 11 position. So Glycyrrhiza has **anti inflammatory action.**

- From the **Glycyrrhiza** – synthetic dvt **carbenoxolone** obtained & used as antiulcer drug.

- carbenoxolone – inhibits enzymes which inactivate prostaglandins & suppresses activation of pepsinogen so used in gastric & duodenal ulcers. Also used in treatment of oral ulcers.

## Chemical test –

section or powder + 80% $H_2SO_4$ – orange yellow colour (chalcone glycoside)


## Uses:

- Expectorant & demulcent
- Ammoniated glycyrrhizin – in tobacco industry
- **Sweetening agent** for improving bitter taste of bitter medicines like quinine
- In treatment of **peptic ulcer** for healing purposes
- Used in **skin diseases** because of anti inflammatory action

- Potentiates laxative action of senna
- Because of frothing property used as **fire extinguisher**
- Because of minerocorticoid activity used in treatment of **rheumatoid arthritis, inflammation & Addison's disease.**
- Inhibits liver cell injury caused by many chemicals & used in treatment of **hepatitis & cirrhosis**.
- **Antispasmodic**. Due to flavonoid glycoside has (isoliquritin) spamolytic property & contribute ulcer healing.
- Precaution – not given patient of high blood pressure prolonged use can cause formation of cataracts.

## Stick or block liquorice

- Decoction of fresh or dried drug prepared, filtered & allowed to become clear.
- Clear liquid concentrated till suitable consistency .
- Then add starch in semisolid mass & sticks or block prepared.
- Concentrated preparation of Glycyrrhiza
- Contain glycyrrhizin 10-13%,

sugar – 13%, starch & gum – 23%

- Home remedy used in respiratory

diseases & in cough.

## Adulterants:

**1. Manchurian liquorice** (*Glycyrrhiza uralensis*) –

- pale chocolate brown in colour & wavy medullary rays
- Free from sugar

2. **G. glabra var. glandulifera (Russian liquorice)**

**3. Indian liquorice (*Abrus precatorius*)**

- 1-2 % glycyrrhizin
- No sweet taste & neither frothing nor haemolysis
- Contain leucoanthocyanidin, alkaloid & amino acid

# GINSENG

## History :

- Ancient healers in India, Russia, China & Japan all revered ginseng for its medicinal & health-enhancing properties.
- In traditional Chinese medicine, ginseng used for – lowering blood pressure & sugar level & as tonic & strengthen overall health
- Panax come from Greek word **panacea** mean ‘ cure all’.
- Chinese name – **shen sang** means man root - shape resembles to human being

- **Synonyms :** Ninjin, Jintsam, Redberry, Fivefingers, Pannag
- **Source:** Dried roots of ***Panax ginseng*** (known as Asian ginseng) *or* ***P. Quinquefolium*** (known as American ginseng)
- **Family :** Araliaceae
- **G.S. :** China, Russia, Korea, Japan, Canada

## Other species –

- P. notoginseng (Sanchi ginseng)
- P. Japonicum (Japanese ginseng)
- P. Pseudoginseng (Himalayan ginseng)
- P. Trifolium (Dwarf ginseng)
- P. Vietnamensis (Vietnamese ginseng)

# CULTIVATION:

- Propagated by means of seeds in nursery beds & then transplanted into open fields i.e. permanent beds
- For propagation ripe seeds collected from four year old plants.
- Seeds sown in November in nursery beds. 3 type nursery beds – Yang-Jik, To-Jik, Ban-Yang-Jik. First type give high quality seedlings.
- After sufficient growth, seedling dug up in following may & transplanted to permanent beds

- Requires clay loam or sandy loam

  altitude – 100 – 800 m
- Potassium added in soil for better results
- Some times green grass mixed in soil before transplantation
- About 7-10 days after transplantation, shades are provided to plants to protect them from excessive sunlight.
- Plants are harvested 3 – 5 years after transplantation (July to October)
- **white ginseng** – obtained by removing outer layers of root
- **Red ginseng** – first steaming the roots & then dried

## Characteristics of plant

- Perennial herb with short underground stem associated with fleshy white root.
- Root consists primary root & some adventitious root developed from rhizome
- At age of 3-4 year, plant begins to flower
- Flowering plant – bear 3-6 palmately compound leaves
- The fruit is size of pea, green at first & red at maturity & contains 2-3 white seeds.

## Macroscopic characters

- Ginseng roots are tuberous corpulent roots
- Colour – yellowish brown, white or red
- Translucent
- Stem scars present

## Chemical constituents –

- Mixture of triterpenoid saponin glycosides – both tetracyclic triterpenoid (steroidal skeleton) & pentacyclic triterpenoid (structure related to oleanoic acid )

- Major glycosides – Ginsenoside, Chikusetsusaponin, Panaxoside
- Later on - Contain 30 Ginsenoside (–Ro, -$R_b$, -$Rb_2$, -Rc, -$R_d$, -$R_e$, -$R_f$, -$Rg_2$, $Rg_3$ & -$R_h$)
- Ginsenoside - 0.7-3%
- First sapogenins - 20-s-protopanaxtriol,
  20-s-protopanaxdiol

- $Rg_1$, $Rg_2$, $R_e$, $R_f$ – 20-s-protopanaxtriol

3β, **6 α**, 12 β & **20** position – hydroxyl group present

Sugar - attached at 6 & 20 hydroxyl group

- $Rb_1$, $Rb_2$, $Rb_3$, $R_c$, $R_d$ – 20-s-protopanaxdiol
- Rg1 – main saponin of panax
- Ro – pentacyclic triterpenoid

- Also contain starch, gum, resin & small amount of volatile oil, panaxans A-E, Sesquiterpene like elemene, sugar, starch & pectin
- Also contain acetylenic compounds like panaxynol, panaxydol & panaxytriol

## Uses:

- It has an **adaptogenic** (antistress, anti-fatigue) effect.
- It **improves both physical and mental performance** including learning, memory and physical capabilities.
- It **improves the immune function and metabolism**.
- Improve **liver functions**.
- Stabilize blood glucose and blood pressure.
- Rg1 – slight CNS stimulating action & antifatigue activity
- Rb1 – CNS suppressing & tranquillizing action

## Main activities

- Stimulation of immunological functions
- Effects on lipid metabolism (decreases LDL, cholesterol)
- Effect on alcohol metabolism by stimulation of alcohol dehydrogenase & oxidation of alcohol in liver
- Inhibition of tumor growth
- Inhibition of blood sugar levels
- Stimulation of pituitary-adrenocortical system
- Effect on CVS – lowering BP

- Ginseng not to be taken continuously exceeding 3 months.


GINSEN

## Allied drugs

**1. P. Pseudoginseng** (Himalayan ginseng)

- Contains ginsenoside Ro & Rb1, chikustesusaponins
- Also contains pseudoginsenoside which complex glycoside of oleanolic acid

**2. P. notoginseng** (Sanchi ginseng)

- Contain polysaccharide sanchinan & small quantities of proteins

**3. P. Vietnamensis** (Vietnamese ginseng)

**4. Siberian ginseng** (*Acanthopanax senticosus*)

- Found in Russia
- Roots used as tonic & sedative
- Contains series of glucans – eleutherans A-G & heteroxylan responsible for adoptogenic properties
- Also contains eleutherosides

## Substitutes:

**1.Codonopsis tangshen**

- Bell flowered plant
- Used by poor people in china as a substitute for costly ginseng

**2. Blue cohosh** (caulophyllum thalictroides)

- In United state – ‘blue or yellow ginseng’

**3. Fever root (Triosteum perfoliatum)**

4. Also substituted with **Senega root & Virginian snake root**

- Less wrinkled & tisted
- Yellow in color

# DIOSCOREA

- **Synonyms** – Yam
- **B.S.** – tubers or rhizomes of cultivated or wild species of genus Dioscorea such as Dioscorea deltoidea, Dioscorea composita, D. floribunda & other species of Dioscorea.
- **Family –** Dioscoreaceae


- **G.S.–** India, China & central America

Government & pharmaceutical agencies in Tamilnadu, Karnataka, Jammu & Kashmir cultivated Dioscorea

- Commercial sources, G.S., & Diosgenin content of Dioscorea

| Botanical source | Diosgenin % | Habitat |
|---|---|---|
| D. Deltoidea | 2-5 | Subhimalayan region |
| D. Floribunda | 2-5 | Central America, Mexico |
| D. Composita | 2-4 | Central America, |
| D. Mexicana | - | Central America, Mexico |
| D. Prazeri | 1-3 | North Eastern India |
| D. Zingiberensis | 4-8 | China |
| D. nipponica | 1.6 | China |
| D. tokoro | - | Japan |

## Cultivation

- Raised from seeds – longer time for harvesting
- Tubers are used for cultivation

Tubers – 70-80g in wt selected for cultivation

- Treated with fungicide & then sown in nursery beds
- Requires 30-40 days for sprouting
- After 2-3 months , transplanted in the field, which treated with insecticide earlier.
- Initially, veins are weak & tender so need support for optimum growth
- Tubers are exhaustive so high dose of farmyard manure added in soil

- Organic fertilizers applied at interval of one month
- Irrigation – every 10 days
- Inter cropping done with legumes
- Harvesting done during dormant season (Diosgenin content is high)
- After harvesting tubers are washed with water.
- Crown buds of tubers are highly susceptible to soil borne pathogens.
- Treatment with 3000 ppm solution of Benomyl for half an hour followed by dusting with 0.3% Benomyl give effective control.

## Macroscopic characters

- Colour – slightly brown
- Odour – odorless
- Taste – bitter
- Plant - climber with alternate leaves
- Drug is covered with scattered roots

## Microscopic characters

Epidermis – absent

T.S. of tubers shows cork, cortex, vascular bundles, starch & ca. oxalate crystals

## Chemical constituents:

- Contains triglycoside dioscin – steroidal saponin glycoside

**Dioscin** → **Diosgenin + 2 mole rhamnose + glucose**

- Chinese species D. gingiberensis – highest Diosgenin (4-8%)
- Also contain smilagenin & epismilagenin, yammogenin
- Rhizome contain enzyme sapogenase
- 75% starch

**Uses:**

- Rich source of diosgenin used as precursor for synthesis of several corticosteroid, sex hormones, & oral contraceptive
- Diosgenin converted to 16-DPA (dehydropregnenolone acetate) which used as substrate for different compounds.
- Nowadays hecogenin from Agave, Sarsapogenin from Yucca, stigmasterol from soya & solasodine from solanum used as starting material for pdtion of 16-DPA.

- Used in treatment of rheumatic arthritis
- Number of Dioscorea species used in Chinese folk medicine for different purposes like treatment of diarrhoea, asthma, polyurea & diabetes.
- Some species of dioscorea – good quantity of starch present in D. batatas (Chinese potato) & minute quantity of diosgenin – used as food especially in eastern countries.

## Allied species

**1. D. flouribunda –**

- central America, India (Karnataka)
- 3-5% diosgenin

**2. D. villosa –** Virginia & carolina in USA

- Twining pernnial with yellow flowers & triangular capsules

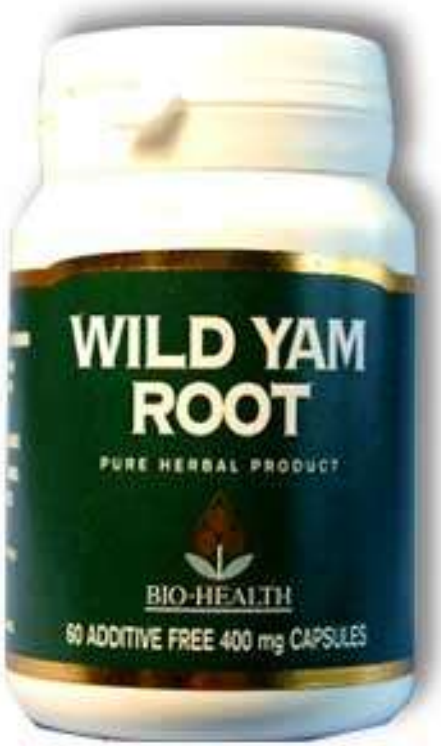
**3. D. Deltoidea var. sikkimensis** –

- Himalaya, nepal, sikkim, bhutan
- 2-2.8% diosgenin

**Alternative source of diosgenin**

- Trigonella seeds – ***Trigonellafoenum graceum***
- Diosgenin also present in ***Balanites roxburghii*** & other species of balanites
- Fruits of ***Tribulus terrestris***
- Tubers of ***Costus specious***

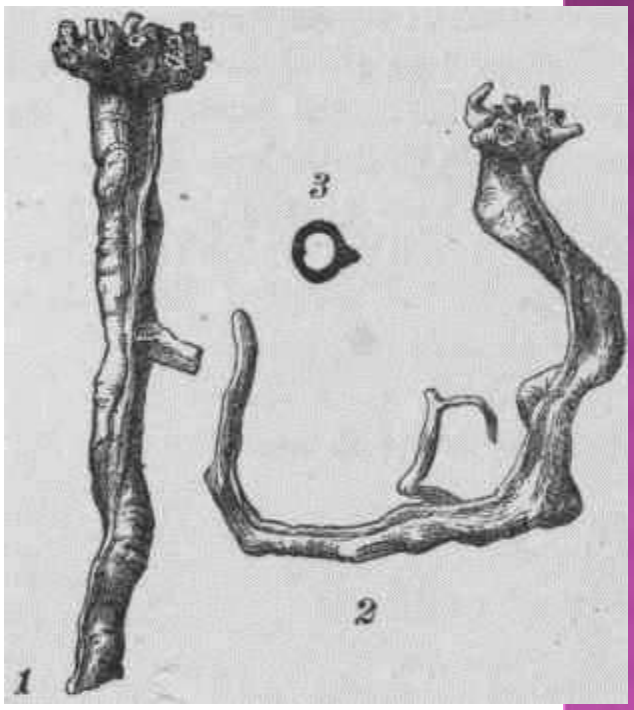

DIOSCOREA CREAM


WILD YAM
ROOT
PURE HERBAL PRODUCT
BIO-HEALTH
60 ADDITIVE FREE 400 mg CAPSULES


DIOSCOREA

# SENEGA

- **Synonyms** – Snake root, Milkwort, Radix senegae
- **B.S.** – Dried roots & rootstocks of ***Polygala senega***. It contains more than 5% stems
- **Family –** Polygalaceae
- **History –** polygala means ‘much milk’ alluding to its own profuse secretions.
- ‘senega’ derived from Seneca tribe of North America, among whom plant used as remedy for snakebites



**G.s.-** Central & western North America & Canada


**Cultivation:**

- Perennial plant
- Propagated by seeds or cuttings.
- Seeds sown in spring or autumn in cold farm.
- Seedlings are large enough to handle, kept in individual pots & grown in green house for first winter.
- Then transplanted in late spring or early summer.

**Collection –** roots gathered when leaves are dead, & before first frost.

- Roots are dug out & aerial stems attached are removed
- Roots are washed & dried

## Morphology:

**Appearance :** twisted branched roots with knotty crown

**Colour :** Grayish brown to yellowish brown

**Size –** length 5 to 20 cm, diameter 2 to 12 cm

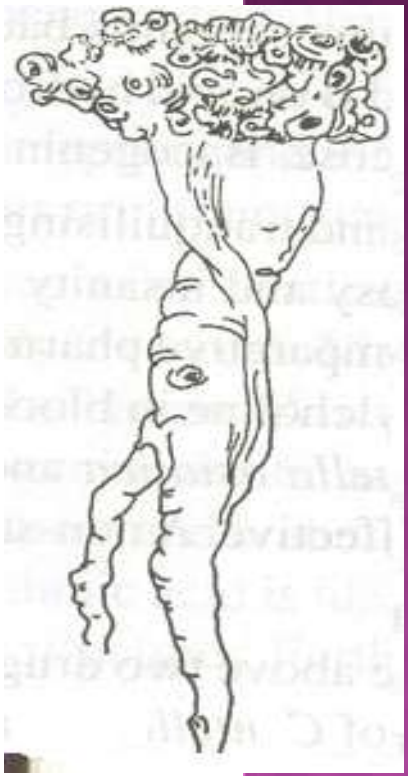
**Surface –** longitudinally striated. Below crown transverse wrinkles present.
Roots shows 2 to more branches.
Some roots on lower two third surface spiral keel seen.

**Shape –** curved, tapering. Knotty crown consists purplish buds & aerial stem bases.

**Odour –** characteristic, resembling methyl salicylate

**Taste –** first sweet then bitter, acrid & irritating

**Fracture –** short



- Fracture - the appearance shown by transversely broken surface is known as fracture.

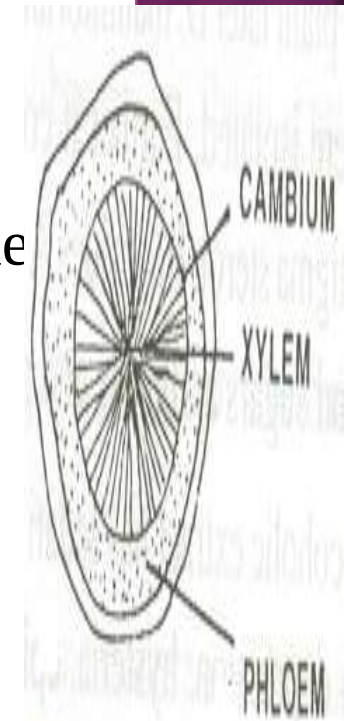
Types of fracture :

1. **Short fracture :** The fracture surface is **smooth**.
2. **Granular fracture :** The exposed surface shows **small rounded appearance**.
3. **Splintery fracture :** The broken surface shows the presence of **uneven projecting points**.
4. **Fibrous fracture** : The numerous **fiber** are seen on the transversely broken surface.
5. **Laminated fracture :** The exposed surface shows the arrangement of layer one over the other.

## Microscopy :

- **Phellogen –** 4 to 5 rows of thin walled yellowish brown cells
- **Phelloderm –** 2 to 6 layers of collenchymatous parenchyma
- **Xylem –** primary xylem – diarch & surrounded by secondary xylem

  - secondary xylem composed of tracheids & vessels with bordered pits
- **Medullary rays** – lignified & narrow being 1-3 cells wide
- **Phloem –** outside the cambium without phloem fibers
- Crystals, starch grains, fibers & sclerenchyma absent in root
- Oily droplets resent in parenchyma tissues




- Rootstock or upper part of drug possesses microscopically features similar to root, but central Parenchymatous pith

## Chemical constituents:

- Contains 8-10% mixture of 8 different saponins
- Active principle – **Senegin**
- Senegin – white powder soluble in hot water & alcohol forming soapy emulsion when mixed with boiling water.

- Senegin $\xrightarrow{\text{Hydrolysis}}$ presenegenin + glucose + galactose + xylose + rhamnose + fucose

- Glycoside – **primveroside** which on hydrolysis yields **methyl salicylate** (fragrance of drug)

- Sweet taste of drug due to polygalitol
- Also contains polygalic acid, virgineic acid, bitter coloring matter cerin, fixed oil
- Free from starch

## Uses:

- Senega cause irritation of gastric mucosa which leads to secretion of mucous in bronchioles hence used in **stimulant expectorant**.

- Used in treatment of various respiratory problems including pleurisy & pneumonia

- In North America used in treatment of snake bites

## Allied drugs:

**1.Northern senega** (Polygala senega Var. latifolia )

- Larger than usual variety (Western senega)
- Darker in colour
- Shows keel less distinctly
- Has very acrid taste

**2.Japanese senega**

- Cultivated in Japan in very cool regions
- Collected when one year old
- Drug composed very small roots with mush fibrous side roots

## Adulterants:

### 1. *Polygala alba* (White senega)

- More slender than western senega
- Has descending than spreading branching
- Lighter in colour
- Has no keel
- Taste is less acrid than western senega
- Less active

### 2. *Polygala tenuifolia*

- Chinese plant

**3. *Polygala chinensis* (Indian senega)**

- Also called chinensis root & official in IP'1955
- Root & rootstock closely resembles senega
- Collected from 3-4 years old plants
- Cortical cells contain brown amorphous contents which become oily drops by action of KOH
- Does not contain saponin & hence fails to show persistent frothing & haemolysis

**4. *Glinus (Mollugo) oppositifolia*** (F. Molluginaceae)

- Spurious 'Indian senega'
- Used instead of Indian senega
- Contains saponin
- Has vascular bundles in concentric rings
- Contains much starch

**5.** ***Andrachne aspera*** (F. Euphorbiaceae)

- Another substitute for Indian senega
- Sizes of roots are small compared to Indian senega
- Does not have keel & odorless
- Does not froth with water
- Section shows thin cork, pale yellowish xylem with 2 to 4 concentric rings
- no oil droplets, stone cells
- Phloem - scattered purplish cells, spherical to ovoid starch grains.

# SARSAPARILLA

- **Synonyms** – Smilax Medica, Red bearded sarsaparilla, Jamaica sarsaparilla
- **B.S.** – Dried roots of ***Smilax ornata***
- **Family –** Liliaceae
- **G.S. –** Central America

- The word sarsaparilla comes from the Spanish **Sarza**, meaning bramble, & **parilla**, a vine, in allusion to the thorny stems of plant
- The plant is native of central America. Root was formerly exported via Jamaica hence designation ‘Jamaica Sarsaparilla’.

## Description:

- Large perennial climber
- Drugs found bundles in market
- Colour – dark red to brown
- Odour – odorless
- Taste – slight bitter
- They are tough & difficult to break
- Stem erect, semiwoody with sharp prickles
- Leaves – alternate & stalked, prominent veins

## Chemical constituents:

- Main glycoside – sarsasaponin

Sarsasaponin $\xrightarrow{\text{Hydrolysis}}$ Sarsasapogenin + dextrose

- Also contain small amount of starch, sarsapic acid, fatty acid – palmitic, stearic acid

## Uses:

- In skin diseases, rheumatism, passive dropsy & in syphilis

## Varieties:

1. Honduras sarsaparilla
2. Lima sarsaparilla
3. Guayaquil sarsaparilla
4. Vera cruz or Mexican sarsaparilla
5. Native Jamaica sarsaparilla

## 1. Honduras sarsaparilla

- Imported from British Honduras
- Bundles – 75 cm long & 5-6 cm wide, much longer & narrower than bundles of Jamaica variety
- Sometimes closely whipped round or sometimes loosely bound with long root
- Roots – distinguished from Jamaica variety by their
  - – pale yellowish or brown colour
  - more plump & starchy appearance
  - Have fewer rootlets attached
  - Free from rhizome

- T.s. – pale, starchy cortex usually thicker than that of Jamaica sarsaparilla

## 2. Lima sarsaparilla

- Imported from panama
- Bundles – 60 cm long & 7 cm diameter, loosely folded, bound with a root
- Resemblance to Jamaica sarsaparilla, distinguished by different packing & anatomical characters of cells of endodermis & exodermis.

## 3. Guayaquil sarsaparilla

- 50 cm long & 15 cm wide
- Knotty rhizome & portions of stout round aerial stems present
- Has brown colour
- Larger than Jamaica
- Not so much furrowed
- Less numerous rootlets

## 4. Vera cruz or mexican sarsaparilla

- Obtained from ***S. medica***
- Drug not being made up into bales
- Roots deprived of rhizomes have been exported
- Characterized by cells of endodermis & exodermis

## 5. Native Jamaica Sarsaparilla – S. officinalis

- Arrives packed loose in bales
- Colour – pale reddish or greyish brown
- Stem – twining, angular, prickly
- Leaves – ovate, oblong, acute, cordate, smooth

- Consists very long roots with thick bark
- Roots bear scattered stout rootlets
- T.s. – pale cortex

# QUILLAIA

- **Synonyms** – Soap bark, Panama bark, Murillo bark
- **B.S.** – Dried inner bark of Quillaia saponaria.
- **Family –** Rosaceae

- The name of genus originates from the chilean word ‘Quillean’ which means to wash & hence name refers to its use as soap.

**G.S. –** native of western slopes of Andes in Chile, Peru & Bolivia

- Bark is called as ‘cullay’ by natives
- Also grown in California in USA & India

**Collection:**

- Quillaia is large tree attaining height of 18 m
- Bark is collected from trunk & outer dark colored rhytidoma separated & dried

- In India, bark is procured from trees after shaving off the outer bark which contains tannins & coloring matter but not saponin.
- Bark prepared by such method is odorless.
- As bark is thick, it does not go contraction during drying & has flat shape.
- Bark used in its native for washing silk & wool & exported to France via Panama canal so In France it named **‘Bois de Panama’.**

## Morphology:

Size – 1 meter long, 20 cm wide & 3-8 mm thick

Shape – Flat

Outer surface – brownish-white, smooth, showing occasional patches of reddish brown rhytidoma

Inner surface – smooth, yellowish white

Fracture – splintery & laminated

Odour – sternutatory

Taste – astringent, acrid & unpleasant

## Microscopy:

- Outer surface – rhytidoma – which consists of patches of dead secondary phloem along with band of several layers of thin walled cork
- Whole section shows chequered appearance due to crossing of medullary rays by **bands of lignified & nonlignified phloem**
- secondary phloem – **sieve tubes** & **parenchyma** with alternate bands of **lignified phloem fibers**
- Phloem parenchyma – contain single prism or cluster or microcrystal of Ca.oxalate.

- Medullary rays – tri to tetra seriate with radially elongated cells
- Inner part of bark – free of phloem fibers where phloem contains unlignified thin walled cells.

## C.C:

- 9-10% saponin glycosides
- Two colorless amorphous compounds – quillaic acid & quillaia sapotoxin
- On hydrolysis, quillaia saponin yields sapogenin quillaic acid & sugar
- Contain sucrose, starch & calcium oxalate
- Quillaia sapotoxin – white, amorphous, sternutatory & acrid

## Uses:

- Saponins irritating to skin & mucous membrane so has an expectorant action
- Used as emulsifying agents because of reduction of surface tension
- Tincture quillaia – used in preparation of coal tar emulsion
- Foaming agent in shampoos & in cosmetics
- In its native country used for washing as detergent
- Used in washing emulsion of photographic films

- Also added to tooth powder, tooth paste, mouth washes & hair lotions
- Diuretic & cutaneous stimulant

## Substitutes:

### 1. Quillaia poeppigii

- Quite thinner with very distinct outer reticulate layer
- Give tincture with pinkish brown color

### 2. Q. smegmadermos

- In form of long quill
- Long – 7-15 cm
- Wide – 1-2.5 cm
- Thick – 3mm
- Not laminated
- softer

# CARDIAC GLYCOSIDES

# INTRODUCTION

- Directly act on heart
- Has both beneficial & toxic effects on heart
- These glycosides used as poisons & heart drugs since 1500 B.C.
- In history plants or their extracts used as arrow poisons, emetics, diuretics & heart tonics
- Nowadays used in treatment of CHF & for atrial fibrillation & flutter

# HISTORY

- **In 1716** – William withering – utilized plant mixture from purple foxglove plant to treat CHF
- **In 1911** – McKenzie – showed digitalis induced direct effect on myocardium, decrease ventricular rate
- **In 1938** , found that digitalis has direct positive inotropic effect on isolated cardiac muscle.

# SUGARS IN CARDIOACTIVE GLYCOSIDES

- One or more monosaccharide units in the molecule
- Sugar part is attached at C-3 ß linkage
- Beside glucose, other sugars like rhamnose, digitoxose, digitalose, cymarose
- Out of which, only rhamnose is in L series where as digitoxose & cyamarose in D-series.
- The number & nature of sugars in glycoside determines its **miscibility** in water & other solvents.
- The presence of **acetyl group on sugar** affects the **lipophilic character & kinetics of entire glycoside**.

# AGLYCONE MOIETY

- The steroid nucleus has hydroxyls at **3 & 14** positions of which sugar attached at 3-OH group, 14-OH is unsubtituted.
- Many genins have OH groups at **12- & 16-** positions.
- These additional hydroxyl groups influence the **partitioning of cardiac glycosides into aqueous media & greatly affect duration of action.**
- The **lactone** moiety at **C-17** position is imp str. Feature.
- Normally plant sources provide 5-membered unsaturated lactone ring while animal sources give 6-membered unsaturated lactone ring

- Chemically, aglycone part of cardiac glycosides – steroidal moiety
- steroidal moiety - Either C23 or C24 because of five or six membered lactone ring
- So, cardio active steroids classified into two groups

1. Cardenolides
2. Bufadienolides

## Cardenolides

- Five membered butyrolactone ring – consist only one double bond & attached to steroidal nucleus through C-17 position
- C – 23 steroids

## Bufadienolide

- The term derived from **bufalin**, obtained from skin of toads
- six membered pyronelactone ring – consist two double bond & attached to steroidal nucleus through 17 ß position

- Presence & attachment through specific position to steroidal nucleus of **lactone** is essential for cardiac activity
- Occurrence of Cardenolides from nature is high compared to bufadienolide.

- Another chemical feature between Cardenolides & bufadenolides is – C/D ring junction have to be cis – configuration.
- Cardiac activity is maximum which depends upon the stereochemistry of molecule of aglycone.
- Aglycone should have unsaturated lactone ring which attached as β at 17 position of steroid nucleus & A/B & C/D ring junction to be cis – configuration.

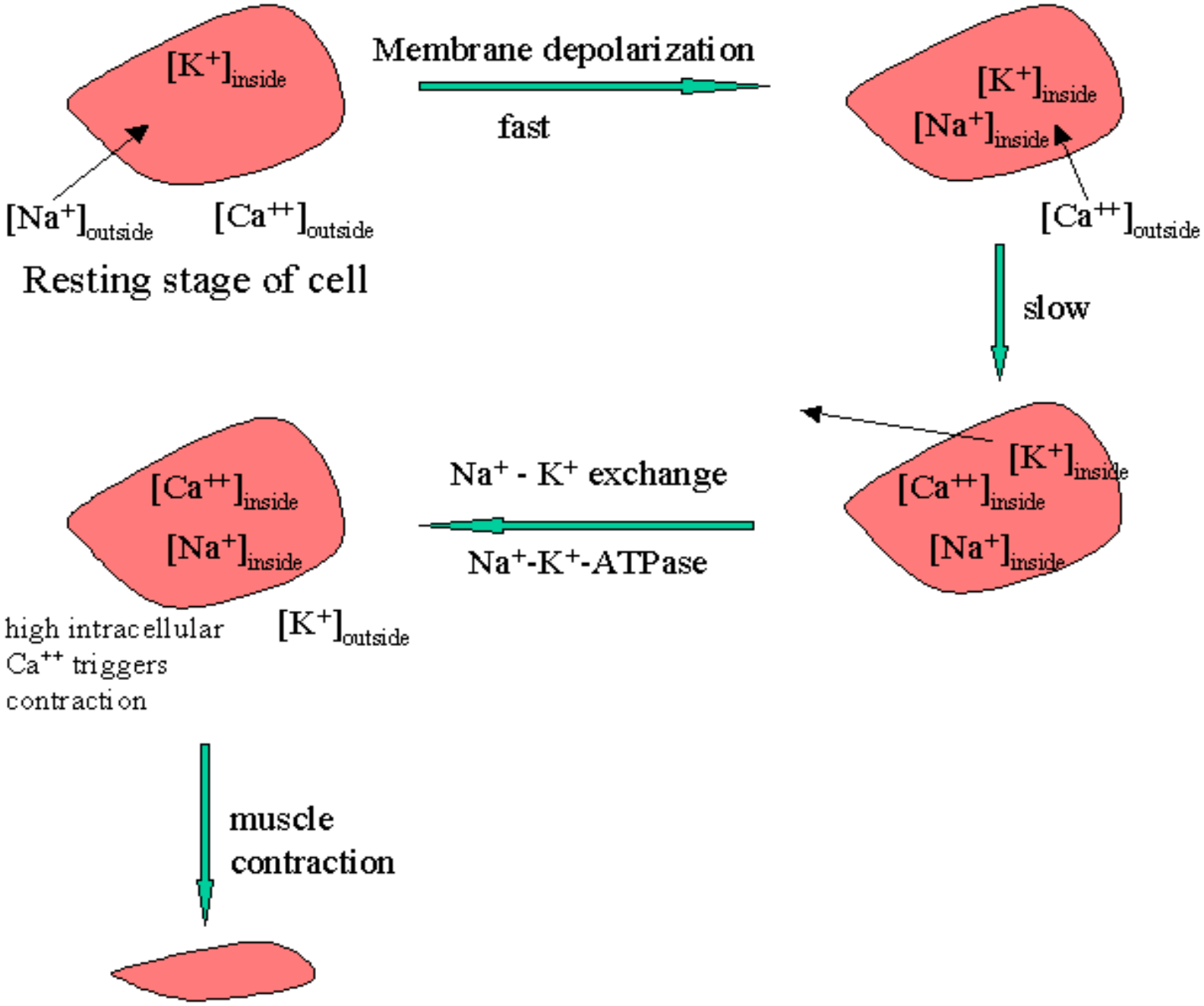
- Cardiac glycosides particular digitalis glycosides show better action when it is administered as glycosides with sugars attached
- Sugars do not potentiate medicinal activity of aglycone, but useful in solubilization of aglycone.
- So sugars beneficial in adsorption & distribution in body.
- Increase no. of OH group on aglycone leads to quicker onset of action & enhanced metabolism.

- Cardiac glycosides present in **angiosperms**.
- Leguminoseae, sterculiaceae, cruciferae, scrophulariaceae show presence of Cardenolides.
- Very few families like liliaceae & ranunculaceae contain bufadienolide.
- Glycosides occur in different plants, such as Digitalis, Strophantus, Thevetia, squill etc.

# MECHANISM OF ACTION

- Cardiac glycosides inhibit membrane bound **$Na^+$-$K^+$-ATPase** which responsible for $Na^+$-$K^+$ exchange.
- Membrane depolarization & repolarization controlled by movement of $Na^+$-$K^+$ & $Ca^{+2}$ in & out of cell
- At resting stage, con. $Na^+$ is high in outside.
- On membrane depolarization, sodium influx leading elevation of action potential
- Intracellular sodium triggers influxes of free $ca^{+2}$

- Higher Intracellular calcium – efflux of k+
- $Na^+$-$K^+$ exchange requires higher energy, provided by enzyme $Na^+$-$K^+$-ATPase.
- Cardiac glycosides inhibit this enzyme as result reduced sodium exchange with potassium.
- This result increased intracellular calcium which increase force of myocardial contraction.


$[K^+]_{inside}$
$[Na^+]_{outside}$
$[Ca^{++}]_{outside}$
Resting stage of cell
Membrane depolarization
fast
$[K^+]_{inside}$
$[Na^+]_{inside}$
$[Ca^{++}]_{outside}$
slow
$[K^+]_{inside}$
$[Ca^{++}]_{inside}$
$[Na^+]_{inside}$
$Na^+$ - $K^+$ exchange
$Na^+$-$K^+$-ATPase
$[Ca^{++}]_{inside}$
$[Na^+]_{inside}$
$[K^+]_{outside}$
high intracellular $Ca^{++}$ triggers contraction
muscle contraction

# DIGITALIS

- **Synonyms** – Foxglove leaves, Folia Digitalis
- **B.S.** – Dried leaves of ***Digitalis purpurea***.
- **Family –** Scrophulariaceae
- **G.S. –** European countries, England, Germany, France, North America, Kashmir


## History –

This plant used in England in 10th century

- **In 1542** – Fuchs – named the plant Digitalis
- In England, drug official in 1650.
- **In 1860** – digitalis included in Russian pharmacopoeia
- **In 1748** – French scientist salarve – strong criticism on uses of Digitalis, which led withdrawal of drug
- William withering – studies on digitalis, afterwards use this drug

## Cultivation

- Biennial or perennial herb
- Cultivated in Kashmir
- Propagated by seeds
- Seeds mixed with fine sand & sown in nursery beds in March/April
- Seedling transplanted in September & November
- **Soil** – calcarious, acidic sandy with traces of manganese
  - Soil is sterilized by steam before sowing
- **Altitude –** 1600 to 3000 m
- **Temp –** 20-30°c
- **Rainfall -** 30-40cm per annum

- Plant has flowers in April & followed by fruiting
- Leaves – picked up in afternoon during **August & September** in first year.
- In second year, 2/3$^{rd}$ flowers are fully developed.
- Basal leaves & top leaves collected at end.
- Collecting leaves **dry weather** is selected.
- After collecting, leaves are dried in vacuum dryer.
- Dried leaves packed in air tight containers with suitable dehydrating agent.
- Leaves **not** contain **more than 5% moisture**.
- Presence of moisture & enzymes (Digipurpuridase & oxidase) cause deterioration of glycosides
- If leaves dried above 60°c, potency lost due to chemical degradation.

## Morphology:

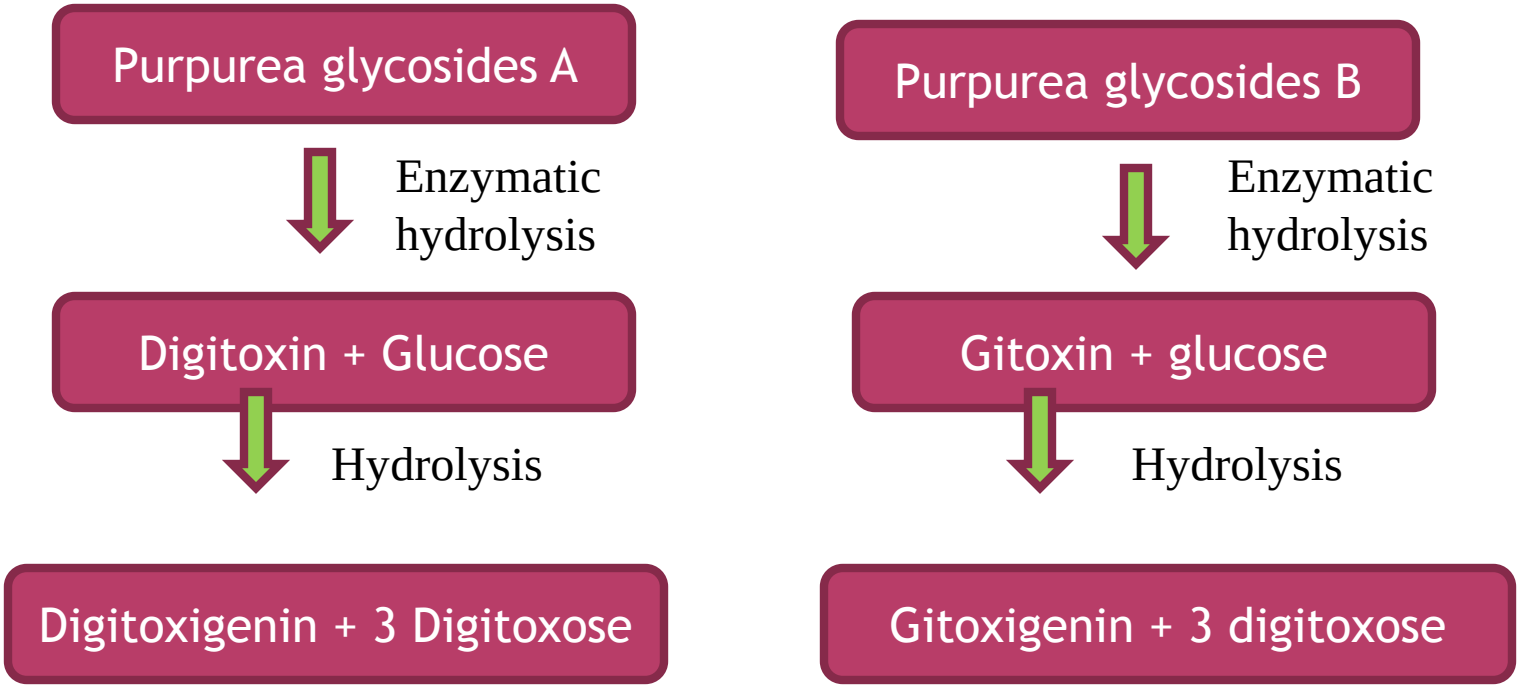
- General appearance : usually broken & crumpled
- Shape : Ovate – lanceolate
- Size : length – 10 to 40 cm, wide – 3 to 10 cm
- Margin – Crenate to dentate
- Apex – Obtuse or rounded
- Base – Tapering, decurrent
- Colour – Dark grayish green
- Venation – pinnate
- Petiole – winged
- Odour – characteristic
- Taste - Bitter

## Microscopy –

- Dorsiventral leaf
- Stomata – Anomocytic on both surface
- Trichomes – uniseriate, multicellular, bluntly pointed
- Glandular trichomes – unicellular stalk & unicellular or bicellular head
- Collapsed celled covering trichome is characteristic of digitalis
- Free from calcium oxalate & sclerenchyma
- Starch grains present in endodermis
- Collenchyma- upper & lower epidermis, pericyclic part - characteristic of digitalis

## Chemical constituents:

- 0.2 – 4.5% mixture of both primary & secondary glycosides present
- Primary glycosides – Purpurea glycosides A & B & glucogitaloxin



- Primary glycosides are less stable & less absorbed than secondary glycosides

- Other glycosides – odoroside, gitaloxin, verodoxin, glucoverodoxin

- Verodoxin $\xrightarrow{\text{Hydrolysis}}$ gitaloxigenin + digitalose

- Gitoxigenin – additional OH group at 16 position
- Gitaloxigenin – 16 formyl gitoxigenin

- Verodoxin potentiates the activity of digitoxin

- Also contain **saponin & flavone** glycosides

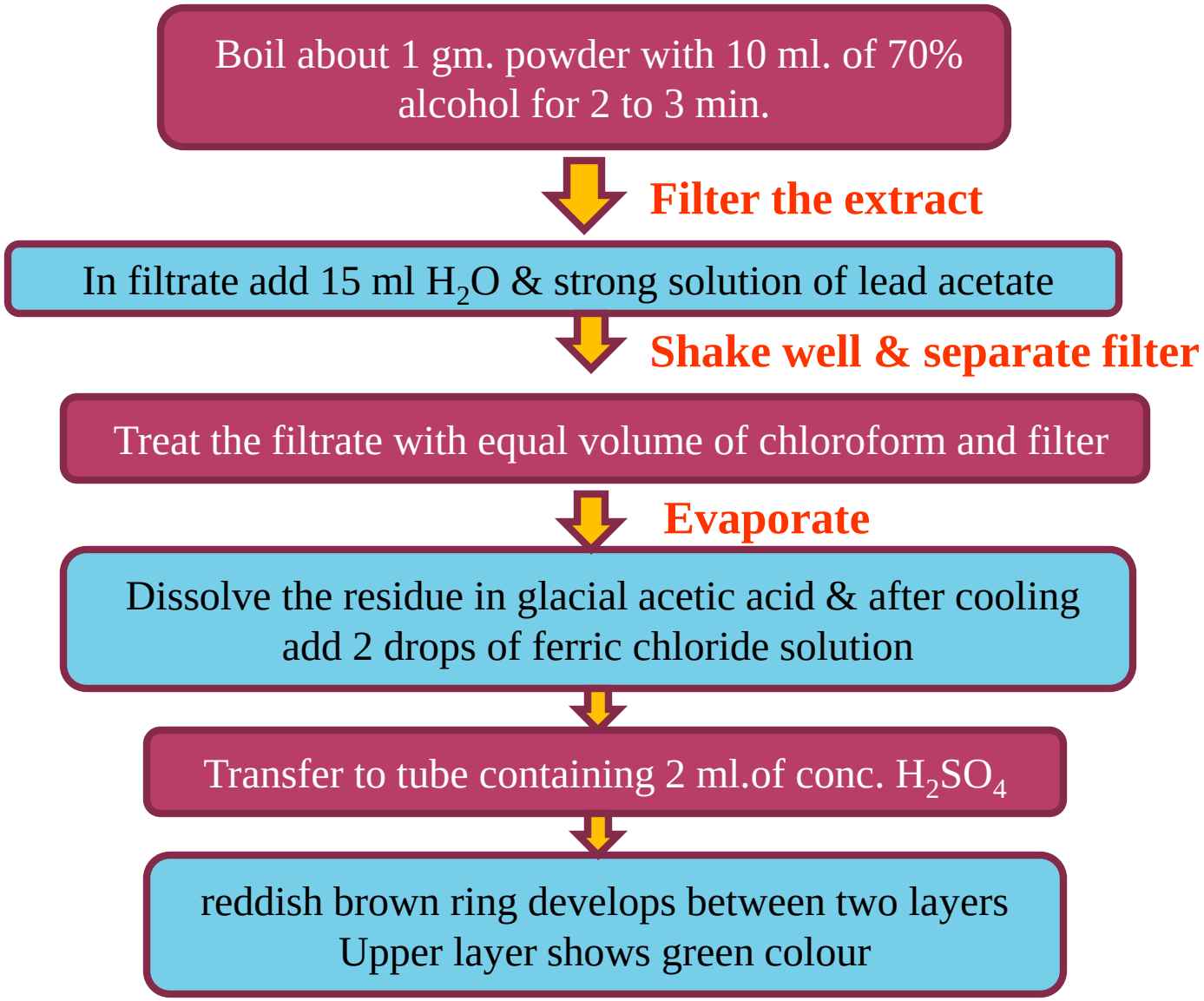
Saponin glycosides – digitonin & gitonin

Flavone glycoside – luteolin responsible for colour of drug

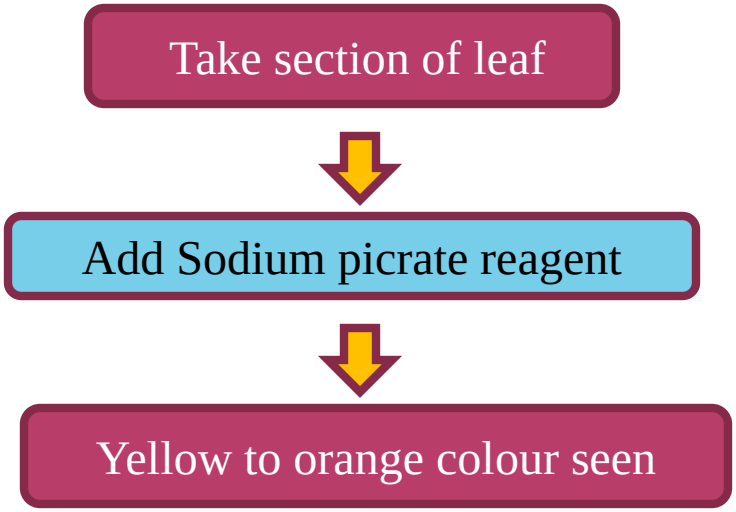
- Digitoxose & digitalose – desoxy sugars which show killer killiani test & only found in cardiac glycosides

# Chemical tests:

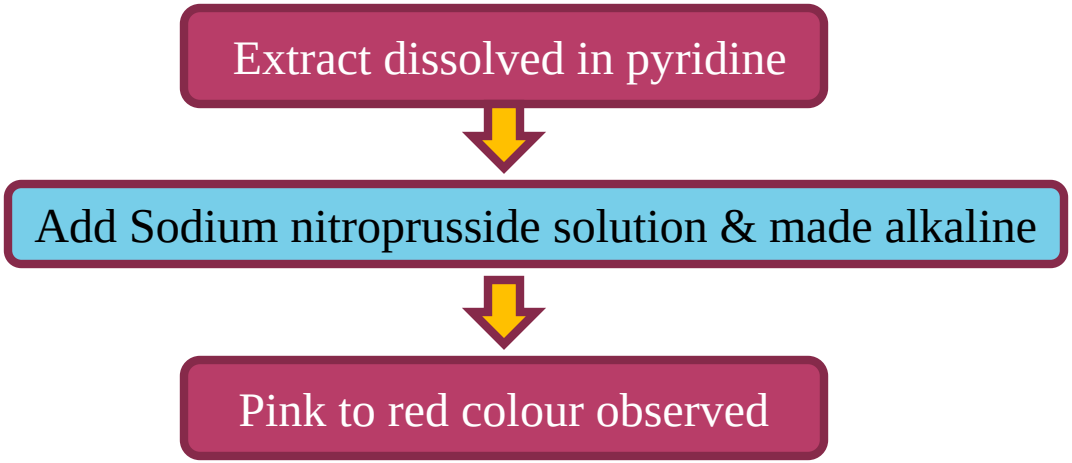
## 1. Killer Killiani test for Digitoxose



## 2. **Baljet test –** localization of glycoside




## 3.Legal test



## Uses:

- In treatment of CHF
- Slowing ventricular rate in atrial fibrillation, atrial flutter & supraventricular tachycardia – negative chronotropic effect (slowing heart rate) by suppressing conduction of electric impulses at auriculoventricular node
- Act as diuretic because decreases venous blood pressure

## Dose:

Initial dose – 1-2 g in 24-48 hrs

Maintenance dose – 100 mg daily

## Storage :

- Stored in well closed container in cool place away from light.
- While storing, leaves do not contain more than 5% of moisture
- In presence of moisture causes destruction of glycoside & loss of cardiac activity on storage
- So sometimes dehydrating agents like calcium chloride or silica gel put in containers which absorb water present in drug or atmosphere.

## Adulterants:

**1. Mullein leaves:** ***Verbascum thapsus*** (Scrophulariaceae)

- Detected by presence of **branched candelabra trichomes**

**2. Primrose leaves :** ***Primula vulgaris*** (Primulaceae)

- Detected by presence of **uniseriate covering trichomes**, which are **8 to 9 celled** long
- Lateral veins are straight

**3. Comfrey leaves :** ***Symphytum officinale*** (Boraginaceae)

- Detected by presence of multicellular trichomes forming **hook at top**.

**4. Ploughman's spikenard leaves** (*Inula conyza*

F. Compositae)

- Margin – entire or dentate with horny points to teeth

**5. Elecampane leaves** (*Inula helenium*)

- Lateral veins not decurrent

# ALLIED DRUGS

## DIGITALIS LANATA

- **B.S.** – Dried leaves of *Digitalis lanata*
- **Family –** Scrophulariaceae
- **G.S. –** Central Europe, England, USA, India
- **Morphology –**

**Leaves** – sessile, linear-lanceolate

**Size :** length – 30 to 40 cm, wide – 4 cm

**Margin :** entire

**Apex :** acuminate

## Chemical constituents:

- Lanatosides A,B,C & E
- Lanatosides A,B – acetyl derivatives of purpurea glycosides A & B

Lanatoside C $\xrightarrow[\text{Hydrolysis}]{}$ digoxin + acetic acid + glucose

Lanatoside E $\xrightarrow[\text{Hydrolysis}]{}$ gitaloxin + acetic acid + glucose

- Digoxigenin – aglycone of digoxin, contains OH group in $12^{th}$ position
- Aglycone of Lanatoside D - Diginatigenin
- Digoxigenin & Diginatigenin specific to D. lanata.

**Uses:**

- Used as commercial source for digoxin, lanatoside C & A
- lanatoside C & digoxin – similar action to D. purpurea
- Less cumulative & less absorbed
- Digoxin, oral route, show effect in 1 hr & max. effect reached within 6 hrs.
- Digoxin used for rapid digitalization in treatment of CHF & fibrillation
- It is preferred because less cumulative effects

## DIGITALIS LUTEA **(Straw foxglove)**

- Grown in U.S.A., Europe
- Leaves – sessile, oblanceolate, serrate or dentate margin
- This leaves is less irritant
- Free from calcium oxalate
- Posses long terminal trichome

## DIGITALIS THAPSI **(Spanish foxglove)**

- Found in Spain & Italy
- Yellowish green leaves similar but quite smaller in length (5-15cm) & width (1.5-5cm)

- Leaves – lanceolate having serrate or dentate margin
- Uniseriate glandular trichomes – present at both surfaces
- Nonglandular trichomes are absent
- Can be identified by striated cuticle, pericyclic fibers & prisms of calcium oxalate
- Vein islet number of D. thapsi is higher than purple foxglove.
- Drug is 1.25 to 3 times more potent than Digitalis purpurea.

Other species of digitalis containing cardiac glycosides are

- *D. subalpina*,
- *D. dubia*,
- *D. grandiflora*,
- *D. ferruginea*,
- *D. mertonensis*

**Herba Adonidis –** Spring Phesant's Eye

- Consists of aerial parts of Adonis vernalis (F. Ranunculaceae)
- Leaves divided into linear segments & have solitary flowers (brilliant yellow colour)
- Contains two glycosides – adonivernoside & adonidoside
- Herb used in place of digitalis, specially in Russia

## Pharmaceutical Companies Marketing Digoxin

- Glaxo Smithkline
- Aventis Pharma
- Cadila (le sante)
- Novartis
- Maceloids
- Burroughs Welcome
- Sanofi


25
TABLOID
BRAND
DIGOXIN
COMPRESSED
0·25 mgm.
Burroughs Wellcome & Co
London
Made in England
1474


NDC 0143-1240-01
Digoxin Tablets, USP
125 mcg (0.125 mg)
℞ Only
6505-00-449-0321
100 Tablets
Manufactured by:
West-ward Pharmaceutical Corp.
Eatontown, N.J. 07724
W
40

# STROPHANTHUS

- **Synonyms** – Semina Strophanthi
- **B.S.** – Dried seeds of ***Strophanthus kombe*** which are freed from the awns & endocarps.
- **Family –** Apocynaceae
- **G.S.** – Eastern tropical Africa

-- Mostly grows in neighborhood of East African lakes & Shire river valley.

-- Seeds are transported to Zomba in Malavi & exported from the port of Mozambique.

-- Nowadays also cultivated in Cameroon.

- Name Strophanthus derived from the Greek ***Strophos*** (a twisted cord or rope) & ***anthos*** (a flower), limb of corolla being divided into five, long, tail like segments.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## Cultivation, collection & preparation

Drug is obtained from wild plants because

1. Natural habitat of Strophanthus can not be easily reproduced.
2. Drug is required in small quantities, present supplies can fulfill the demands.
3. No technical workers necessary for the collection & preparation of Strophanthus seeds.
4. If suitable conditions for cultivation of Strophanthus are produced, the cost of drug would be higher.

- Plants are very large, woody climbers which take support of large trees in forest of Africa.
- Mature fruits collected from wild plants & some extent from cultivated plants in June – July.
- Fruit contain two dehiscent follicles & many seeded.
- After collection, outer epicarp & mesocarp is removed & seeds are separated from yellow brown leathery endocarp.
- The awn removed & seeds washed & dried.

## Characteristics:

- Length – 10 -12 cm
- Shape – lanceolate or linear lanceolate along with thread like awn
- Removal of awn shows broken point at apex
- Hilum seen as whitish point at apex
- Raphe runs along two third of length of seed
- Seed shows winged extension at base
- Testa of seed shows silky hairs
- Embryo & endosperm both are oily
- Fracture – short
- Colour – grayish green
- Odour – slight unpleasant
- Taste – bitter
- Weight of 100 seeds – 3-4 g

## Microscopy:

- Epidermis – made up of elongated polygonal tubular cells with straight, lignified anticlinal walls
- Epidermal cell bears unicellular trichome
- Beneath epidermis, narrow layer of collapsed parenchyma with occasional cluster of calcium oxalate crystals
- Endosperm & embryo made up of thin walled parenchyma with large of oil globules & aleurone grains.

## Chemical constituents:

- Contains 8-10% glycosides known as k-strophanthin
- k-strophanthin – mxture of glycosides cymarin, k-strophanthin ß, k-strophanthoside, cymarol, erysimoside

Strophanthus glycosides & their hydrolytic products

| Glycoside | Aglycone | Glycone |
|---|---|---|
| k-strophanthin ß | Strophanthidin | Cymarose + ß – D-glucose |
| k-strophanthoside | Strophanthidin | Cymarose + ß – D-glucose + α – D-glucose |
| Cymarin | Strophanthidin | Cymarose |
| Cymarol | Strophanthidin | Cymarose |

- Strophanthus seed produces green coloration with sulphuric acid
- Seed also contain fixed oil, kombic acid, choline, trigonelline, resins & mucilage
- Cymarose is methoxy digitoxose which gives positive reaction for keller killani test.

## Uses:

- Powerful cardiac poison & more potent as compared to digitalis & given in case of emergency
- Used as diuretic
- Unlike digitalis it is not cumulative & less GI irritation

## Substitutes:

- S. Gratus
- S. Hispidus
- S. Courmonti
- S. Nicholsoni
- S. Sarmentosus
- S. emini

## 1. S. gratus

- Comes from Cameroon & Sierra Leone
- Colour – brownish
- Surface – glabrous
- Unlike S. kombe neither epidermal testa nor embryo contain Ca. oxlate crystals
- Contains rhamnose glycoside **ouabain or G-strophanthin** which is more stable & more toxic than strophanthin
- Ouabain first isolated from the wood of an African tree ***Acokanthera ouabaio***.
- Used as reference standard for biological assay of cardiac glycosides

## 2. S. hispidus

- Grows in senegambia & congo
- Resembles to S. kombe
- Gives green colour with sulphuric acid

### 3. S. courmonti

- Comes from zanzibar & mozambique
- Reddish to violet colour with sulphuric acid

### 4. S. nicholsoni

- Grows in Central Africa
- Whitish with wolly appearance
- Known as ‘wolly strophanthus’
- Give red colour with sulphuric acid
- Ca. oxalate absent in both embryo & seed coats

### 5. S. emini

- Grows in Central Africa
- Contain e-strophanthin
- Give red or violet colour with sulphuric acid

## 6. S. sarmentosus

- Colour – reddish brown to greenish
- Testa & embryo contain ca. oxalate crystals
- Rose red colour with sulphuric acid
- Contain sarmentogenin which is used for synthesis of cortisone & steroidal hormones.

| S. gratus | S. hispidus | S. courmonti | S. nicholsoni | S. emini | S. sarmentosus |
|---|---|---|---|---|---|
| Cameroon & Sierra Leone | senegambia & congo | zanzibar & mozambique | Central Africa | Central Africa | senegambia , Sierra Leone, lower congo |
| brownish | Brownish | Brownish | white | Greyish green | Reddish brown - greenish |
| Rose red | H2So4 - green colour | H2So4 - Reddish to violet | H2So4 - red | H2So4 - red or violet | H2So4 - Rose red |
| Testa & embryo - no Ca. oxalate crystals | Testa & embryo - no Ca. oxalate crystals | Seed coat - contain ca. oxalate crystals | Testa & embryo - no Ca. oxalate crystals | Testa & embryo - no Ca. oxalate crystals | contain ca. oxalate crystals |
| ouabain or G-strophanthin | h-strophanthin | Unknown | Unknown | e - strophanthin | sarmentogenin |
| In microscope – warty hairs visible | Smaller glabrous | Smaller Lanceolate less bitter ¼ active | Wolly – wolly strophanthus | Resemble to kombe | Yellowish hairs easily break |

# SQUILL

- **Synonyms** – scillae bulbus, Jangli pyaj, Sea onion
- **B.S.** – Dried slices of bulb of ***Urginea maritima or U. scilla***.
- **Family –** Liliaceae
- **G.S.** – Spain, Portugal, Morocco, Algeria, France, Italy, Greece
- Two varieties, i.e. the red squill & white squill are known.
- Red squill which contains the red anthocyanin pigment produced in Sicily & Malta while white squill comes from Algeria & Cyprus.

## Collection & preparation

- Large pear shaped bulbs about 18-20 cm long & 12-15 cm diameter collected in August when flowers & aerial leaves wither away.
- The fibrous roots are removed & dry outer scales stripped off.
- The bulbs transversely cut into thin slices & are dried in sun or by artificial heat.

## Characteristics

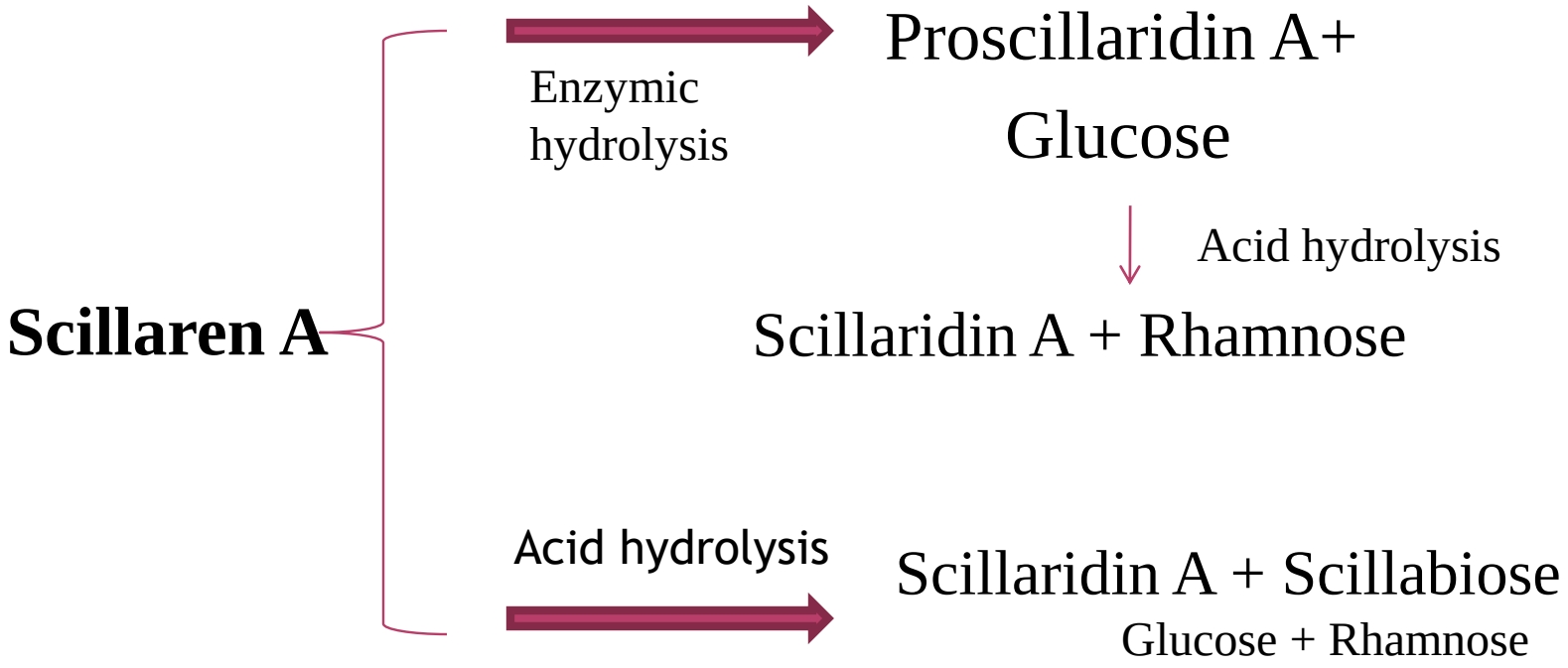
- Length – 3-6 cm, thickness – 3-7 mm
- Dried scales are translucent & brittle in dried conditions
- Hygroscopic in nature & absorb moisture & becomes tough & flexible
- Drug stored in tight closed containers with dehydrating agent
- Colour yellowish white
- Taste – bitter, acrid & disagreeable

## Microscopy:

- Rectangular polygonal cells along with circular stomata on lower epidermis
- Mesophyll consists polygonal parenchyma containing ca. oxalate crystals
- Mucilage does not give colour with ruthenium red & iodine water bur stains with corallin-soda
- Vascular bundles present in mesophyll.

## Chemical constituents:

- Contains scillaren A & B, enzyme scillarenase.
- Scillaren A – crystalline & responsible for activity of drug
- Scillaren B – amorphous



- In the mesophyll of Squill, mucilage, sinistrin, a fructose, polysaccharide inulin, calcium oxalate & yellow colouring matter xanthoscillide present.

- Squill glycosides does not show baljet test & legal test. Lieberman's sterol test is positive in Squill glycosides.

- Also contain glucoscillaren A
- glucoscillaren A → (Acid hydrolysis) Scillarenin + rhamnose + 2 glucose

- Calcium oxalate present in bundles of long acicular crystals which easily penetrate the skin when handled & causes intense irritation, sometimes eruption, if fresh Squill rubbed on skin.

## Uses:

- Squill is absorbed, about 25%, in human beings & can be administered orally in heart insufficiency, angina pectoris, nephrotic oedema.
- Action of scillaren A is more intensive & faster than digitoxin & cumulates very little.
- It has diuretic activity & small doses it is expectorant.
- Higher dose - emesis

# RED SQUILL

- Red Squill consists of bulb of red variety of Urgenia maritima.
- Colour of outer scales is reddish brown & inner scales deep purple.
- Chemical constituents similar to white Squill but contains **scillirosid & scillirubroside** & which are toxic to rats.
- Red colour is due to anthocyanin.
- Red Squill used as rat poison.

# INDIAN SQUILL

- **Synonyms –** Jangli pyaj
- **B.S. –** Indian Squill consist of dried slices of bulb of ***Urginea indica***
- **Family –** Liliaceae
- **G.S. –** Konkan & Saurashtra
- **Morphology :**

Size – length 1-5 cm, breadth 5-10 mm

Shape – curved or sickle shaped

Surface – fleshy

Fracture – brittle in dry but tough in moist drug

Colour- yellowish white

Odour – slight

Taste – bitter & acrid

**Chemical constituents:**

- Similar to European Squill
- Mucilage present in cells of mesophyll free or with ca. oxalate.
- Mucilage stains reddish purple with iodine water.
- This test distinguishes European Squill & Indian Squill

- Contain more proscillaridin A
- Contains inactive glycoside scillian & bitter principles **scillapicrin & scillatoxin**.

**Uses:**

- As cardiotonic
- Indian Squill contains more proscillaridin A & exported to Germany.
- In large doses, it is emetic & cathartic.
- Also found to possess anticancer activity against human epidermoid carcinoma of nasopharynx in tissue culture.

## ⊙ Test for steroids & tritepenoids

**Libermann-Buchard test** –

Extract + few drops of acetic anhydride – boil & cool – add con. Sulphuric acid from side of test tube –

brown ring formed junction of two layers &

upper layer turns **green** (**steroids**) &

**deep red** colour (**triterpenoids**)

- **Salkowski test**

Extract – add con. Sulphuric acid –

**Red** colour at lower layer (**steroids**)

**Yellow** colour at lower layer (**triterpenoids**)

# THEVETIA

- **Synonyms** – Yellow oleander
- **B.S.** – Thevetia consists of dried leaves of ***Thevetia peruviana***
- **Family –** Apocynaceae
- **G.S.** – tropical America & West Indies. Also cultivated in India

## Characteristics:

- Leaves – 10-15 cm long, linear, acute & bright green colour
- Flowers – bright yellow to pinkish yellow
- Fruits – triangular fleshy drupes with kernels
- All parts of plant contains cardiac glycosides but kernels contains seven times as much glycosides as leaves.

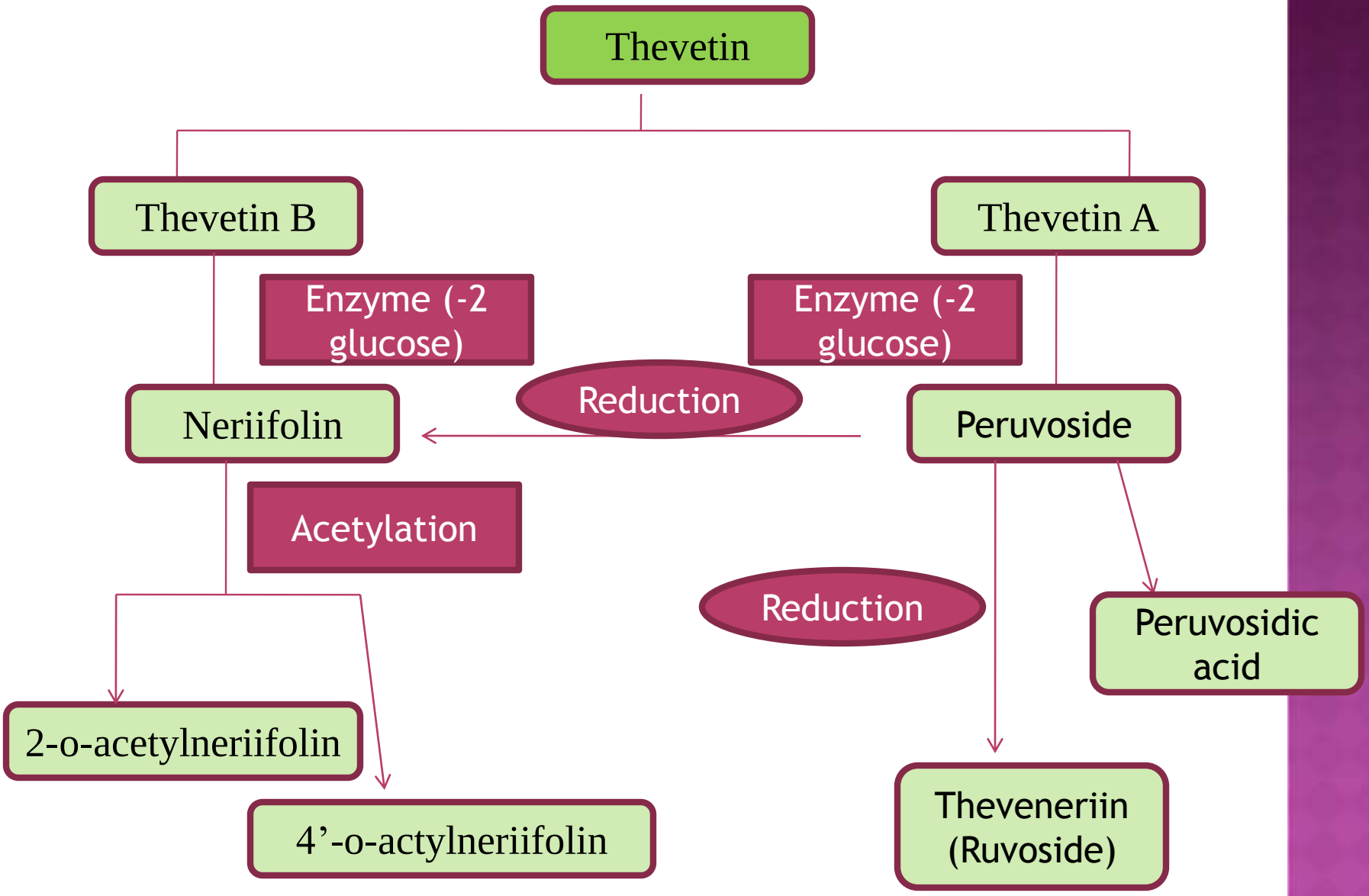
## Chemical constituents:

- Kernels are rich in cardiac glycosides, of which **thevetin** first isolated.
- Contain both **triosides** (aglycone with three sugar units) & **monosides**.
- Thevetin is mixture of thevetin B (cerebroside) & thevetin A.
- Aglycone are digitoxigenin, cannogenin & cannogenol while sugars are D-glucose & L-Thevetose.
- Small amount of 2-o-acetylcerberoside also found in seeds.

- Monosides found in seeds include neriifolin, cerberin, peruvoside, theveneriin (ruvoside) & peruvosidic acid.

- Monosides formed as a result of enzymatic hydrolysis of triosides.

# Conversion of Thevetia glycosides

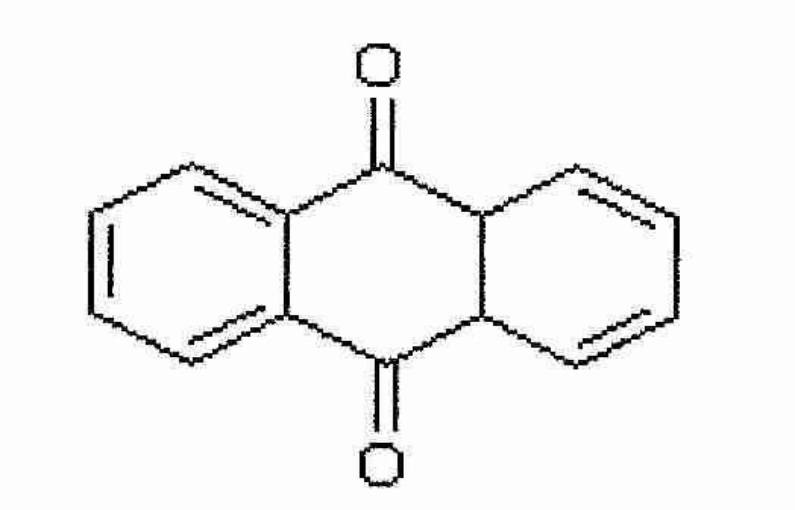


| Glycoside | Aglycone | Sugars |
|---|---|---|
| Cereberoside (Thevetin B) | Digitoxigenin | L-Thevetose + 2 mol D-glucose |
| Thevetin A | Cannogenin | L-Thevetose + 2 mol D-glucose |
| Peruvoside | Cannogenol | L-Thevetose |
| Neriifolin | Digitoxigenin | L-Thevetose |
| Thevenerin | Cannogenol | L-Thevetose |
| Peruvosidic acid | Cannogenic acid | L-Thevetose |

## Uses:

- Thevetia very successfully utilized in West Germany for all types of cardiac insufficiency.
- This drug marketed under name ‘Encardin’ which given orally or intravenously.
- Drug can be used in patients with liver & kidney diseases.
- Tincture of bark is bitter cathartic & emetic.
- Seeds used as abortifacient & as a purgative.
- Peruvoside is most important cardiac glycoside. It has quick & powerful positive inotropic effect.

# ANTHRACENE GLYCOSIDES



# INTRODUCTION TO ANTHRAQUINONES

- Historically: Rhubarb, Senna, Aloes and Cascara were all used as purgative drugs.

- Monocotyledons: Only Liliaceae.
  - Most commonly C-glycoside: barbaloin.

- Dicotyledons: Rubiaceae, Leguminosae, Polygonaceae, Rhamnaceae, Ericaceae, Euphorbiaceae, Lythraceae, Saxifragaceae, Scrophulariaceae .

- Also in certain fungi and lichen.

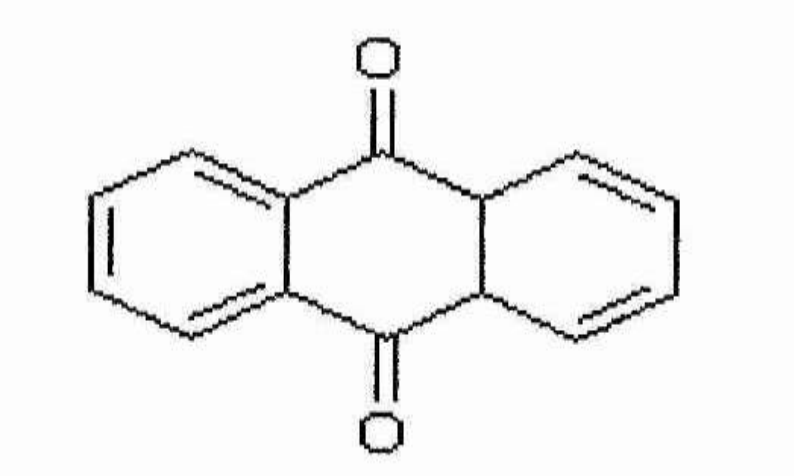
- This glycosides formed from aglycone moieties like anthraquinone, anthranols, Anthrone or dimer of anthrones or their derivatives.

- **Reduced derivatives of anthraquinones**
  - Oxanthrones, anthranols and anthrones

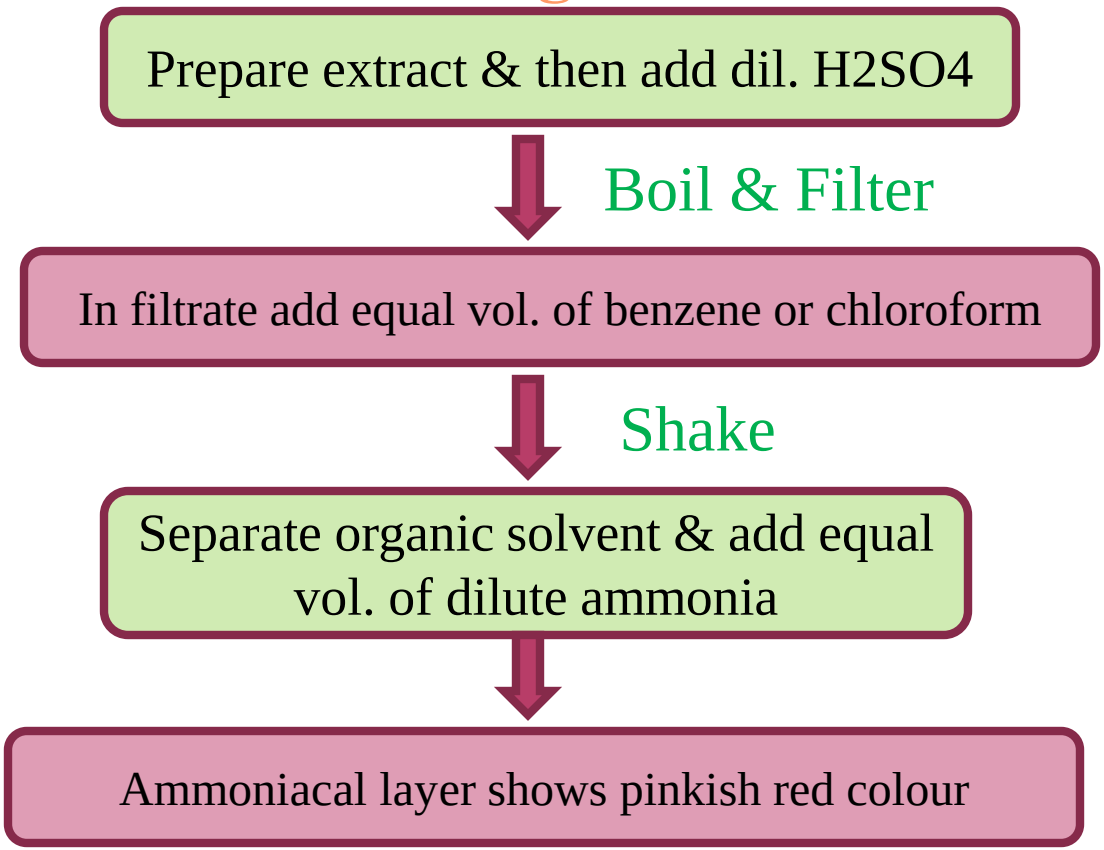
- **Compounds formed by the union of 2 anthrone molecules**
  - Dianthrones

## Anthraquinones –

- Aromatic organic compound & derivative of anthracene
- Colour – yellow or light grey to grey green
- Solid crystalline powder
- Chemical formula – C14H8O2
- Melts at 286°c & boils at 379.8°c
- Solubility – insoluble in water or alcohol, but dissolves in nitrobenzene & aniline.



- Identified via **Borntrager's test**




- This test is negative in case of reduced form of anthraquinone (anthranol)
- Anthrone detected with their fluorescence tests.

# Anthranonls and Anthrones

- Reduced anthraquinone derivatives
- Occur either freely (aglycones) or as glycosides.

- **Anthrone:** pale yellow, non-soluble in alkali, non-fluorescent

- **Anthronol:** brown-yellow, soluble in alkali, strongly fluorescent
  - Anthronol derivatives (e.g. in Aloe – have similar properties – fluorescence used for identification)

## Oxanthrones

- Found in Cascara bark
- Intermediate products (between anthraquinones and anthranols)
- When oxidised → form anthraquinones
- Accomplished via Modified Borntrager's Test – for C-glycosides

## Dianthrones

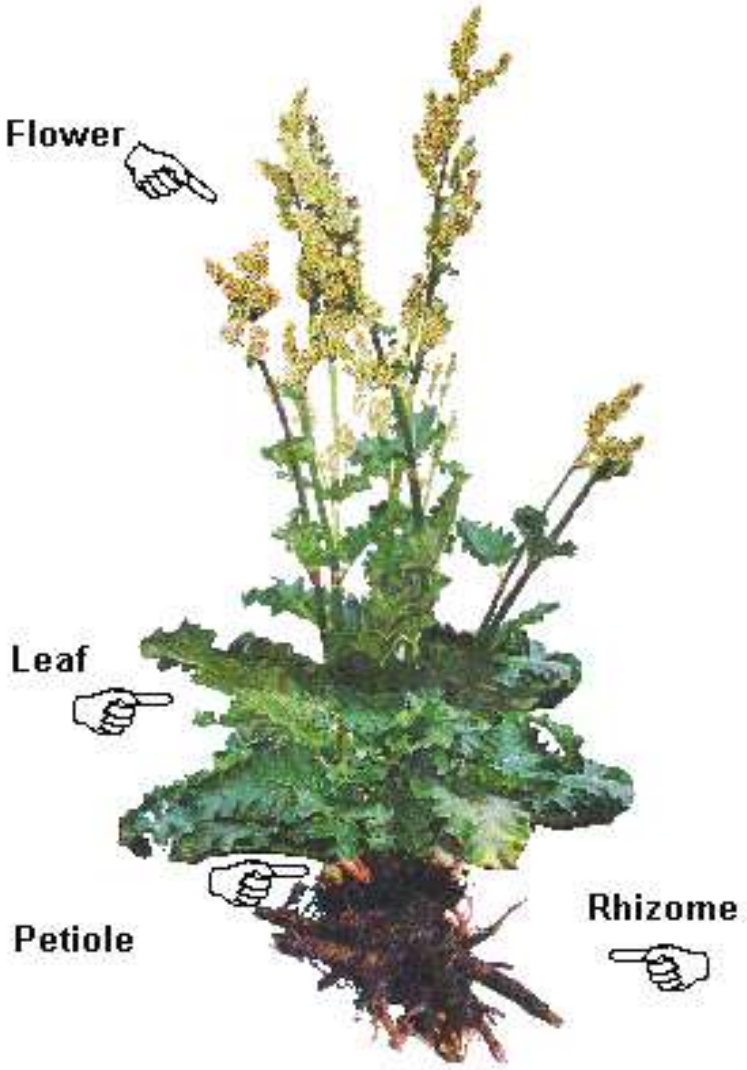
- Derived from 2 anthrone molecules
- Form easily due to mild oxidation of anthrones
- Form important aglycones
  - *Cassia*
  - *Rheum*
  - *Rhamnus*

  - In these glycosides sugars moity – arabinose, rhamnose & glucose

# RHUBARB

- **Synonyms** – Rhizoma Rhei, Rhei Radix, Revandchini
- **B.S.** – Rhubarb consists of peeled dried rhizomes or roots of ***Rheum palmatum, Rheum officinale*** or other species of rhubarb excepting Rheum rhaponticum
- **Family –** polygonaceae
- **G.S.** – China, Tibet, Germany & other Eu countries


Rhubarb
'Crimson Red'
rhizome
6 inch
(15 cm)

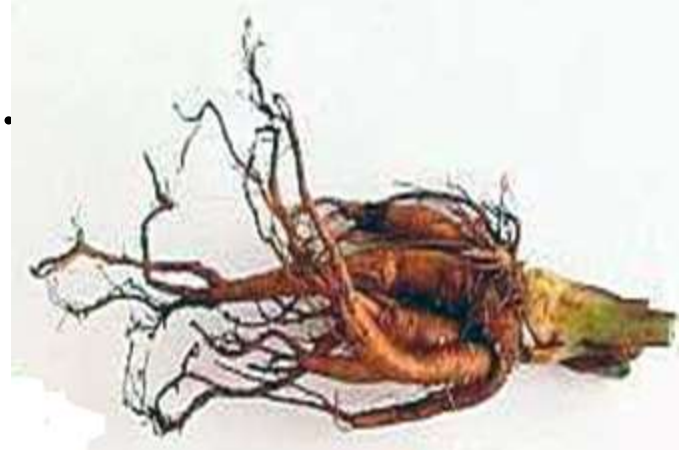

Flower
Leaf
Petiole
Rhizome

## Cultivation & collection

- Drug mostly collected from wild plants
- Perennial
- Roots – thick branched, rhizomes – large & vertical

- Plant grows at an altitude 2500 to 4000 meters
- At higher altitude drug of better quality obtained.

- Plant propagated by rhizomes or seeds.



- Drug is collected in **autumn** in September or October from 8 to 15 years old plants.
- Rhizomes are dug out, crown & lateral roots are removed & outer bark separated by peeling.
- Small rhizomes kept as such or cut into transverse slices & known as **rounds**.
- Large rhizomes cut into longitudinal slices & known as **flats**.
- These slices dried by boring holes & passing thread into them & hanging between shades of trees

- Where climate not favorable, rhubarb dried on heated stones but previously dried by wood fire. Drug dried in this way called high dried & darker in colour & inferior quality

- Superior qualities packed in wooden boxes & exported from Shanghai & Hongkong.

- In china rhubarb, classified as different varieties like ‘Shensi’, ‘canton’, & high dried rhubarb.

## Morphology:

- General appearance : round, flats or high dried drugs
- Size: **rounds** – L-5-12 cm, D- 3-8 cm
  **flats** – up to 15 cm, D- 5cm
- Shape : **round** – cylindrical, conical, barrel shaped
  **flat** – Plano convex
- Surface : pale brown to reddish.

Abnormal or accessory vascular bundles known as star spots & drying holes are seen.

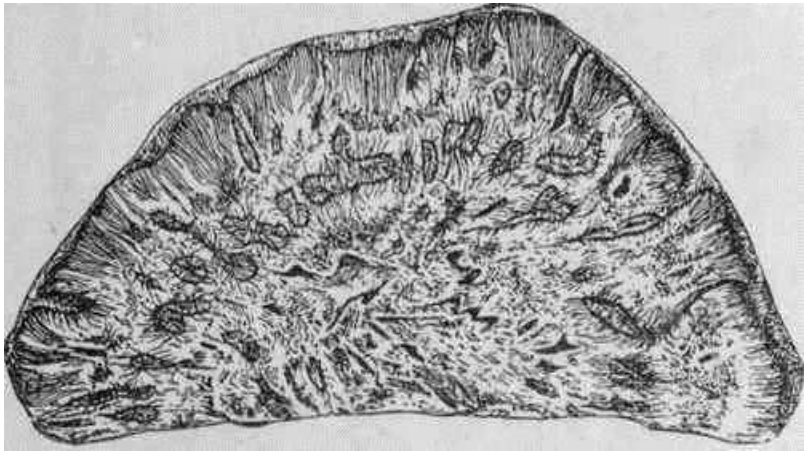
- Outer surface is dusted with yellow powder of Rhubarb to improve appearance.

- Fracture : irregularly granular,

drug with pink fracture is considered as good qu

- Odour –characteristics, slightly aromatic
- Taste – bitter
- Drug consists of large quantities of ca. oxalate crystals which produces gritty feeling between teeth when chewed.
- Star spots – within cambium abnormal vascular bundles or star spots present. They are continuous ring in palmatum & irregularly scatter in officinale.

- Star spots have internal phloem, cambium, or star shaped medullary rays & external xylem



Chinese Rhubarb

| Shensi Rhubarb | Canton | High dried |
|---|---|---|
| Very compact | Less compactness | Dark patches |
| Non shrunken nature | | Grayish to brownish colour |
| Bright yellow coat | Dull yellow coat | Coat quite dull & rough |
| Distinct whitish reticulation | Less whitish reticulations | |
| Bright pink colored is shown by fresh fractured surface & nutmeg fracture | Granular fracture | |

## Microscopy:

- Rhizomes of R. palmatum & R. officinale show similar microscopically features except size & distribution of **‘star spots’.**
- T.S. of rhubarb shows presence of more or less circular distinct cambium.
- ‘star spots’ or abnormal vascular bundles observed as continuous ring within inner margin of secondary xylem in R. palmatum while in R. officinale star spots are larger & irregularly scattered.
- Older star spots show **mucilage cavities**.
- In parenchyma, **simple or compound starch grains present.**

- In parenchyma, **large cluster crystals of calcium oxalate crystals** (200 µ) found.
- In rhubarb, sclerenchyma & cork are absent.

## Chemical constituents:

Contains free anthraquinone, their glycosides, reduced derivative, dianthrone & heterodianthrone

1. Free anthraquinone aglycones – chrysophanol, aloe emodin, rhein, fragula emodin & physcion

2. Monoglycosides of above anthraquinone such as chrysophanein, glucoaloe-emodin, glucoemodin, & glucophyscion

3. Dianthrone & their glycosides are present.

Dianthrone like chrysophanol dianthrone, aloeemodin dianthrone, sennidin A,B,C, Palmidin A,B,C, Rheidin A,B,C

4. Four Anthrone have been reported in rhubarb roots which named as rheinoside A,B,C & D. Rheinoside A&B are stereoisomer of rhein anthrone. Rheinoside C&D are stereoisomer of rhein oxanthrone.

- Also contains tannins compounds such as Gallic acid dvts, catechins, procyanidins & no. of chromone dvts.

- Astringency of rhubarb is due to tannic acid (Rheo tannic ) which is soluble in water & alcohol

## Chemical tests:

1. Modified borntrager test
2. With solution of 5% KOH gives red blood colour.

## Uses:

- Bitter stomachic
- Used as laxative, haemostatic in treatment of constipation, gastrointestinal indigestion, & jaundice
- Also used in cases of bleeding of GI tract, menstrual disorders, conjunctivitis, & ulcer.
- Also recommended for treatment of thermal burns

# INDIAN RHUBARB

**B.S. –** it is obtained from roots & rhizomes of R. emodi & R. webbianum

**G.S. –** Pakistan, Nepal, Kashmir

- Marketed as peeled & unpeeled drug.
- Freshly fracture surface show orange to yellowish colour
- Soft & easily cut
- Give positive test of anthraquinone derivatives
- Shows violet fluorescence under UV light.

# RHAPONTIC RHUBARB

**English rhubarb**

**B.S. -** it is obtained from roots & rhizomes of Rheum rhaponticum

- Indigenous to southern **Siberia & Volga**
- Much shrunken & pinkish in colour
- Distinguished by transverse section which exhibits diffused circle of isolated star spots
- Do not contain emodin, aloe emodin, rhein but contain crystalline glycoside, **rhaponticin**.
- Rhaponticin fluoresces blue in UV light.

- Also contain chrysopontin (crystalline substance), anhydrorhapontigenin, rhabarberone, gluco-chrysarone & rhapontic acid.
- It has estrogenic action due to rhaponticin.

Rhaponticin can be demonstrated by following test:

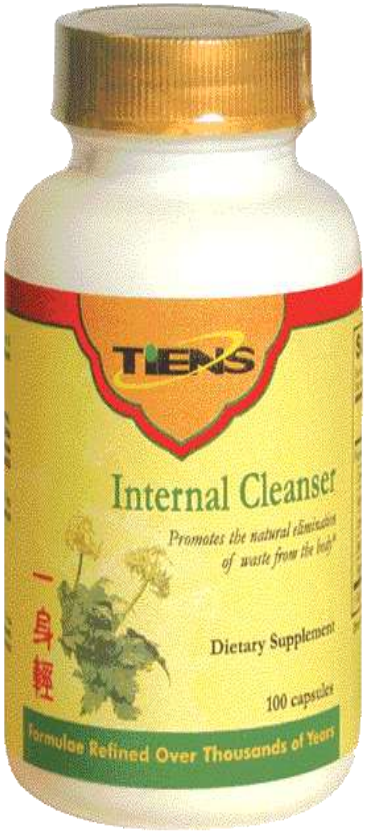
- Percolate powder with 70% alcohol. Then collect the percolate & evaporate at 80°c.
- Then add ether & shake vigorously when warm.
- Then separate ethereal solution into small flask & cork it & put aside.
- Needle shaped crystals of rhaponticin separate within 24 hrs.

## Chinese rhapontic rhubarb:

- Form china
- Resemble to English rhapontic rhubarb but darker
- Hollow in centre
- Exhibiting alternating paler & darker concentric rings
- Yellow rather than pink colour
- Contain rhaponticin


Rhubarb


RHUBARB


TIENS
Internal Cleanser
Promotes the natural elimination of waste from the body*
Dietary Supplement
100 capsules
Formulae Refined Over Thousands of Years

# SENNA

- Two varieties

Alexandrian senna – Cassia acutifolia

Indian senna – Cassia angustifolia


# INDIAN SENNA

- **Synonyms** – Tinnevelley senna, Senna ki patti, Cassia senna
- **B.S.** – it consists of dried compound leaflets of Cassia angustifolia
- **Family –** Leguminoseae
- **G.S.** – South India, Tinnevelly district & Pakistan

# ALEXANDRIAN SENNA

- **Synonyms** – Nubian senna, cassia aethiopica, Cassia lanceolata, Cassia officinalis, Cassia lenitiva
- **B.S.** – it consists of dried compound leaflets of Cassia acutifolia
- **Family –** Leguminoseae
- **G.S.** – Egypt, Nubia, Arabia, Sennar

## Cultivation & collection:

- Cultivated twice in a year i.e. in month of February & in October
- Soil – red loamy or coarse gravelly soil
- Semi irrigation preferred for its growth
- Seeds are triturated with sand for quick germination & plants fully grown after 2-3 months.
- Plant is sensitive to temperature & temperature fall below 10°c, plant dies.
- Collection before flowering season.
- Leaflets are harvested in three stages.

- First collection done when leaflets are greenish in colour & thick.
- Second harvesting done after 30 days & final plucking done after 30-45 days.
- After final plucking whole plant uprooted.
- After collection, leaflets are dried in shade because natural green colour is maintained.

Morphology:

| | Alexandrian senna | Tinnevelley senna |
|---|---|---|
| **Size of leaflets** | 2-4 cm long<br>7-12 cm wide | 2.5-6 cm long<br>7-8 mm wide |
| **colour** | Pale grayish green | Yellowish green |
| **Shape** | Lanceolate to ovate lanceolate | lanceolate |
| **Apex** | Acute & mucorante | Acute & mucorante |
| **Base** | More asymmetry | Less asymmetry |
| **Margin** | Entire | Entire |
| **Texture** | Brittle, papery | firm |
| **Surface** | More pubescent | Less pubescent |

## Microscopy:

- Transverse section shows upper & lower epidermis with straight wall cells, few of which contain mucilage
- Paracytic stomata & nonlignified unicellular trichomes found on both surface.
- Single layer of palisade parenchyma observed at both sides but discontinued in midrib of lower epidermis
- Collenchyma – midrib of lower epidermis
- Spongy parenchyma – Mesophyll portion & contain ca. oxalate

- Mid rib – vascular bundle containing xylem & phloem which surrounded by lignified pericyclic fibers & crystal sheath which contains prismatic crystals of calcium oxalate.
- Trichomes – unicellular, slightly curved at their bases & both surface. Trichomes are comparatively less numerous in Alexandrian senna
- Paracytic or Rubiaceous stomata – present on both sides. Stomatal index of Alexandrian senna is lesser as compared to Indian senna.
- Vein islet no. of Alexandrian senna is higher.

| | Alexandrian senna | Tinnevelley senna |
|---|---|---|
| **Trichomes** | Less numerous | More numerous |
| **Vein islet no.** | 25-29.5 | 19.5-22.5 |
| **Stomatal index** | 11.4-13.3 | 17-20 |
| **Palisade ratio** | Upper epidermis – 9.5<br>Lower epidermis – 7.0 | 7.5<br>5.1 |

## Chemical constituents:

- Two major crystalline glycosides **Sennoside A & B** – first isolated & reported by Stoll in 1941
- Sennoside A – dextrorotatory
- Sennoside B – meso compound
- These are homodianthrone of rhein with glycosyl unit
- Hydrolysis of Sennoside A & B gives two molecules of glucose & two aglycone Sennidin A & B.
- The purgative activity of Sennoside A & B accounts up to 40-60% activity of crude drug
- Alexandrian senna – 2.5-4.5% of Sennoside A & B
- Tinnevelley senna – 1.2-2.5% of Sennoside A & B

- In 1951, Fairbarin & his associates reported presence of two more glycosides name as **Sennoside C & D**.
- Sennoside C – dextrorotatory
- Sennoside D – meso compound

- Among other compounds are palmidin A, aloe emodin, rhein anthrone glycoside, rhein diglucosides, aloe emodin glucoside & aloe emodin diglucoside.

- Two naphthalene glycosides – Tinnevelin glucoside & 6-hydroxy musizin glycoside.

- Other includes kaempferol, its glycoside kaemferin, isorhamnetin, phytosterol, mucilage & ca. oxalate.

## Chemical tests:

- Borntager test
- Alexandrian senna & Tinnevelly senna distinguished by following test:

| | Alexandrian senna | Tinnevelley senna |
|---|---|---|
| Ether extract of hydrolyzed acid solution + then add methanolic magnesium acetate solution | **Day light** – Pink colour<br><br>**UV light** – greenish orange | **Day light** – orange colour<br><br>**UV light** – yellowish green |

## Assay:

- Senna assayed either chemical or biological method.
- For chemical assay, TLC, Spectrophotometric methods are employed.
- For biological assay, no. of faeces produced by groups of mice in 24 hrs after oral administration of drug suspension.

## Uses:

- Used as purgative in habitual constipation.
- Anthraquinone glycosides are absorbed first in intestinal tract after aglycone part separated & excreted in colon.
- The excreted anthraquinone irritate & stimulate the colon thereby movements increased due to local action.
- The increase in peristalsis also causes reduction in water absorption & results in soft & bulky faeces.
- Senna also **causes gripping effect** by senna due to resin or emodin content. To counteract gripping effect , senna combined with carminative drugs like dill, cardamom or antispasmodic drugs like belladonna.

## Substitutes & adulterants:

### 1. Dog senna – *Cassia obovata*

- G.S. – Upper Egypt & France
- Also cultivated in Italy & sometimes referred as **Italian senna.**
- Leaves – shape: obovate, Apex: tapering
  venation: pinnate
- Show papillose cells in lower epidermis.
- Contain 1% anthraquinone glycosides.

## 2. Palthe senna – *Cassia auriculata*

- Shape – oblong to obovate
- Thick walled unicellular trichomes – three times longer then genuine drug.
- When leaves boiled with chloral hydrate solution – trichomes give crimson colour
- Devoid of anthraquinone glycosides.
- Upper palisade consists of two layer of cells.
- With $H_2SO_4$ – red colour.

### 3. Bombay, Mecca or Arabian senna

- Obtained from wild plants of ***C. angustifolia***
- Grown in Arabia
- Brownish green in colour
- More elongated & narrower in shape

### 4. Cassia holosericea

- Smaller, hairy & more obtuse

### 5. C. montana

- Obtained from Madras
- Rounded apex
- Upper surface colour - brown

**6. Argel leaves** – ***Solenostemma argel*** (F. Asclepiadaceae)

- Egypt, Sudan,
- Distinguished by wrinkled surface, twisted appearance & three celled trichomes.
- Mixed with Alexandrian senna

**7. Tephrosia apollinea** F. Leguminoseae

- Obovate-oblong
- Pubescent
- Emarginate
- Lateral veins are straight & parallel
- Fruits – narrow & cylindrical
- Found in Alexandrian senna

**8. Ailanthus glandulosa**

- Large triangular ovate leaflets
- Size – 7-10 cm long
- No stomata on upper epidermis
- Cluster crystals near veins

**9. Globularia alypum** F. Globulariceae (Province senna)

- Shape - Spathulate
- Rounded apex
- Prism of Ca. oxalate crystals in epidermal cells

# CASCARA

- **Synonyms** – Sacred bark, Chittem bark, Cascara sagrada, Californian Buckthorn
- **B.S.** – Cascara sagrada is dried bark obtained from the trunk & branches of ***Rhamnus purshiana***
- **Family –** Rhamnaceae
- This plant stored for at least one year before being used.
- **G.S.** – North America (California, Washington Oregon), Columbia Canada, Kenya

## Cultivation & collection:

- Plant – 6-18 m
- Grown from seeds
- Plant collected from 9-15 years old plants.
- Dry season from April to august considered as the best season for collection.
- Longitudinal cuts are produced of 5-10 cm on tree trunk & bark removed.
- Later tree cut down & bark stripped from the branches.
- Moss & epiphytes grow on bark so it is removed by scrapping before collection.
- If bark collected in rainy season it becomes blackens & stains darker

- Pieces of bark dried in shade which takes about four days & such bark known as ‘Natural bark’
- For faster drying, it dried over galvanized iron wires.
- If bark stored for a period about 1 to 4 years, it shows increased activity.
- Protected from damp weather & rain during preparation & storage.

## Characteristics:

- **Shape –** single quills, channelled or flat
- **Size –** L – 20 cm, W – 10 cm & thick – 1-4 mm
- **Colour –** outer surface – dark brownish – purple
  inner surface – yellowish to reddish brown
- **Outer surface** – patches of lichens
- It shows transversely elongated lenticels
- Inner surface consists longitudinal striations & fibrous
- **Fracture –** outer bark – short, inner bark – fibrous
- **Odour –** characteristics
- **Taste -** bitter

## Microscopy:

- **Cork -** Flattened, thin walled cells which contains yellowish brown material.
- **Cortex**
  - ✓ Outer cortex – collenchymatous cells
  - ✓ Inner cortex – several layers of thin walled parenchyma with cluster crystals of ca. oxalate, chloroplasts & starch.

    **-** also contains groups of irregular, ovoid & thickly lignified sclereid cells
- **Phloem** – phloem parenchyma, fibers, medullary rays, sieve tubes.

- Tangentially elongated cells of phloem fibers surrounded by phloem parenchyma which alternatively occur with sieve tubes.
- Phloem parenchyma shows presence of chloroplasts, starch & cluster o ca. oxalate crystals.
- **Medullary rays** – wavy, parenchymatous.

- Phloem parenchyma & medullary rays show presence of **brownish coloring mater** which turns to **purple when treated with alkali**.

## Chemical constituents:

- Contains O-glycosides, C-&O- glycosides & free aglycones.

1. C-&O- glycosides – Cascaroside A,B,C & D

| Glycoside | R-group | Isomer | Aglycone |
|---|---|---|---|
| Cascaroside A | CH2OH | 10 β | Aloe emodin anthrone |
| Cascaroside B | CH2OH | 10 α | Aloe emodin anthrone |
| Cascaroside C | CH3 | 10 β | Chrysophanol anthrone |
| Cascaroside D | CH3 | 10 α | Chrysophanol anthrone |

2. Secondary glycosides - C-glycosides of

- Aloe-emodin anthrone – barbaloin
- Chrysophanol anthrone – chrysaloin
- These glycosides derived from primary glycosides i.e. cascarosides

3. O-glycosides – aloe emodin, frangula emodin, emodin anthrone, chrysopahnol

4. Hetrodianthrones - Palmidin A,B & C

- Cascara bark stored for 1 year increased medicinal value & better tolerance

## Uses:

- Purgative
- Also available in form of liquid extract, elixir or tablets
- Smaller doses stomachic & tonic
- Also used as veterinary medicine

## Substitutes & adulterants:

- **R. crocea & R. californica** – identified by more uniform patches of lichen & wider medullary rays.
- **R. fallax** – deep yellow colour with choral hydrate

# ALOE

- **Synonyms -** Kumari, Musabbar
- **B.S.** – unorganized drug prepared as dried juice or solid residue obtained by evaporating liquid juice form transversely cut fleshy leaves of various species of aloes.

**- *Aloe barbadensis* – Curacao aloe**

**- *Aloe perryi* – Socotrine aloe or Zanzibar aloe**

**- *Aloe ferox & hybrids species of Aloe africana & Aloe spicata* – Cape aloe**

- **Family –** Liliaceae

**G.S. –**

- indigenous to eastern & southern Africa
- **Cape aloe** – South Africa & Kenya
- **Curacao aloe** – Aruba & Bonaire region of West Indies
- **Socotrine aloe** – Socotra region of Eastern Africa
- Also grow in India, North coast regions of South America, Spain, Venezuela

## Cultivation & collection:

- Leaves – sessile & strong spine at apex & no. of spines at margin
- For cultivation, root suckers used.
- Water logging near plant must be prevented.
- Roots not penetrate much in soil
- For cultivation, mixture of N,K & P add in soil.
- Drug obtained form 12 years old plants.
- After 12 years, plant harvested by uprooting.

## Preparation:

## Curacao aloe

- Make transverse cut near bases of fleshy leaves of Aloe barbadensis
- Because of spines on leaves, immediately put into kerosene tins after cutting.
- Then put leaves along sides of V shaped wooden troughs
- Juice collected by this way is boil in large copper pans
- During boiling, juice is thickened
- Thick juice is poured into gourds or metal containers.
- This aloe also called **Barbados aloe**.

## Cape aloe

- Obtained from Aloe ferox & its hybrids in South Africa.
- A basin shaped depression made in ground & lined with canvas or goat skin
- Leaves are arranged in circular manner which directed into skin
- They are allowed to stand for 4-5 hrs.
- Then collected juice transferred to large iron kettle where it is boiled & stirred continuously with wooden paddle.
- When juice attains desired concentration, poured into wooden cases.

## Socotrine aloe

- Prepared form Aloe perryi
- Juice collected in goat skin
- Then evaporate spontaneously which becomes pasty mass.

## Zanzibar aloe

- Variety of socotrine aloe
- Aloe juice poured into skin in which solidifies & skin containing aloe packed in wooden cases for export.
- This aloe also known as ‘monkey’ aloe but skin are usually of small carnivorous animals, not monkey.
- Some aloe is allowed to evaporate in small depressions lined with leaves, thus forming cakes & coated on one side of leaf.

# Preparation of various aloes

| Aloes | Leaf arrangement | Juice collection | Preparation |
|---|---|---|---|
| **Cape aloe** | 200 leaves arrangement | Juice collected in round, shallow hole covered Goat skin or canvas with | Transferred to large iron kettle & boiled & stirred with wooden paddle the poured into wooden cases. |
| **Curacao or Barbados aloe** | Leaves arranged in v shaped trough | Juice collected in small vessels attached to trough | Juice evaporated in copper vessels at low temp. & packed in gourds |
| **Socotrin aloe** | Leaves stocked in Goat skin | Collected in Goat skin, evaporated for month to get pasty mass | Dried in wooden pans with hot air until 10% moisture |
| **Zanzibar aloe** | Leaves stocked in Goat skin | Collected in Goat skin | Allowed to dry in leaves & then made into small cakes |

## Vitreous & Hepatic aloe

- If the juice rapidly concentrated & resulting aloe quickly cooled. This drug is obtained that breaks with vitreous or glassy fracture & is quite homogenous & transparent even when examined under microscope. Such aloe termed as ‘vitreous’, ‘lucid’, or ‘glassy’.
- But evaporation carried out slowly, drug is opaque & minute crystals observed under microscope. Such aloe termed as ‘hepatic’, or ‘livery’.

## ⊙ characteristics

| Type | Colour | Odour | luster | fracture | In lactophenol |
|---|---|---|---|---|---|
| Cape | Dark brown Greenish brown | Characteristic | Glassy & transparent | Glossy | No crystals |
| Curacao (Livery) | Yellowish brown Chocolate brown | Like iodoform | opaque | waxy | Acicular small crystals |
| Curacao (Vitreous) | Reddish | Like iodoform | Transparent | waxy | Acicular small crystals |
| Socotrine | Dark brown | pleasant | opaque | irregular | Amorphous |
| Zanzibar | Livery brown | pleasant | opaque | Smooth waxy | Minute crystals of aloin |

## Microscopy:

- Epidermis – strongly cuticularized with stomata
- After epidermis – zone of parenchyma contains chlorophyll, starch & acicular bundles of Ca. oxalate crystals
- Central region – large mucilagenous parenchymatous cells, large pericyclic fibers
- Vascular bundles present

## Chemical constituents:

- Major – C-glycosides & resin
- C-glycosides – barbaloin, β-barbaloin, isobarbaloin
- Barbaloin – pale yellow, crystalline substance
- On heating, isomerizes to amorphous β-barbaloin
- β-barbaloin – cape aloe
- Isobarbaloin – crystalline, present in Curacao & cape aloe, absent in Zanzibar & socotrine aloe
- Anthrone devt - aloin

- Cape aloe – contains o-glycosides – aloinoside A & B in which rhamnose sugar present
- Also contain small quantities of aloe-emodin
- Also contains nonanthracene dvt. – resin (aloenin A & B), Aloesin A & B
- Chromone glycosides present in A. ferox

## Chemical tests:

- Modified borntrager's test
- General tests:

| Name | Test | Observation | Inference |
|---|---|---|---|
| **Schonteten test (Borax test)** | • 5 ml of 1% aqueous solution + 0.2 g borax<br>• Heat then pour few drops liquid in test tube full of water | Green fluorescence | anthranol |
| **Bromine test** | 2 ml of 1% aqueous solution + 2 ml of bromine solution | Pale yellow ppt | Aloin converts to tetrabromalin |

## ⊙ Special tests

| Name | Test | Observation | Inference |
|---|---|---|---|
| **Nitric acid test** | 5 ml of aqueous solution + 2 ml of nitric acid | **Curacao aloe –** deep brownish red colour<br>**Cape –** brownish colour change to green<br>**Socotrine** – pale brownish yellow colour<br>**Zanzibar** – yellowish brown colour | |
| **Klunge's test (Cupraloin test)** | 20 ml of 05% solution + drop of saturated CuSO4 solution + 1 g NaCl | **Curacao aloe –** wine red colour<br>**Cape –** faint reddish color changes to yellow<br>**Socotrine & Zanzibar** – no colour | isobarbaloin |
| Nitrous acid test | aqueous solution + few crystals of sodium nitrite + acetic acid | **Curacao aloe –** deep pink<br>**Cape –** faint pink<br>**Socotrine & Zanzibar** – very little changes in colour | isobarbaloin |

**Uses:**

- Strong purgative
- Higher dose – act as abortifacient
- If used alone causes gripping, so combined with carminatives & antispasmodic
- Activity increases if administered with small quantities of alkaline slats.
- Also used in skin abrasion & irritations, for treatment of ulceration
- Used in herbal cosmetics like creams, lotions & shampoo
- One of ingredient used in preparation of compound Benzoin tincture (Friar's balsam)

**Aloe gel** - formed inner parenchymal cells of leaf

- Slightly viscous & clear liquid
- During collection, it should not contaminated with aloe juice
- Used in topical therapeutic applications & in cosmetic products.
- Gel possesses good moisturizing properties.
- It shows anti-inflammatory properties due to chemical contents like salicylates, carboxypeptidases (inactivating bradykinen) & magnesium lactate (interfering with conversion of histidine to histamine in mast cells).

- Polysaccharide & sugar content have role for hydrocolloid dressing & osmotic bactericides.
- Aloe gel increases removal of dead tissue due to its Aloctine – A content which stimulates macrophage production.
- Also used in treatment of pains & itching & slow down ulceration & keratosis.
- Aloe gel used in skin cosmetics due to its antiwrinkle properties.
- Used externally for painful inflammation.

## Substitutes & Adulterants:

### 1. Natal aloe -

- Derived from A. candelabrum
- Opaque
- Colour – dull greenish black to brownish
- Odour resembles to cape aloe
- c.c. – nataloin, homonataloin, resin
- Borax test – negative
- Distinguishing test – nitric acid test – vapors of nitric acid blown over natal aloe powder mixed with $H_2SO_4$ – deep blue colour

## 2. Mocha aloes:

- Black, brittle & glassy appearance
- Comes from Mumbai

## 3. Jafferabad aloe

- Black
- Comes from Jafferabad  to Mumbai

4. Also adulterated with black catechu, iron pieces.

Alcoholic extract of aloe in UV light – deep brown colour while black catechu – black colour

# BITTER GLYCOSIDES

- Imp role in digestive process
- Used as stomachic, febrifuges, bitter tonics & in digestive disturbances
- Bitter glycosides are characteristics of species of Gentianaceae.
- According to Korte, gentiopicrin is characteristic glycoside of Gentianaceae.

- Taste of bitter foods stimulate the appetite & triggers the **secretion of digestive juices** in stomach, which in turn improves break down of food.
- Bitters triggers off reflex nerve action which **increase flow of saliva & stomach enzymes.**
- At same time, **gastrin** secreted by walls of stomach. This improves digestive process, by improving passage of food from stomach to intestine.

Bitters

- also **improve immune disorders** resulting from food intolerance or dietary antigen leakage,
- **Protect gut tissue** (by increasing the tone of gastro-esophageal sphincter thereby preventing reflux of corrosive stomach contents into esophagus in heart burn or esophageal inflammation),
- **Promote bile flow** (thereby providing for increased ability of liver to remove toxic load from incomplete digestion & also provide better digestion in duodenum & small intestine),
- **Enhance pancreatic function** (normalizing hormone secretions to moderate excessive swings in blood sugar levels).

- Bitter drugs or their preparations should be taken before or during meal, otherwise they cause digestive disturbances like diarrhoea, vomiting & pain in stomach
- Examples – Gentian, Barberry bark, Dandelion, Hops flowers, Yellow dock, Goldenseal

- Gentian
- Picrorrhiza
- Chirata
- Kalmegh
- quassia

# CHIRATA

**Synonyms** – Chiretta, Chirayita, bitter stick, Ophelia Chirata, Indian gentian, Indian balmony

**B.S.** – Dried entire herb of Swertia chirata

**Family –** Gentianaceae

**G.S.** – India (from Kashmir to Bhutan & Meghalaya, Himachal Pradesh, U.P.)

**Cultivation:**

- Chirata not obtained from cultivated plants but obtained from wild plants
- Annual herb with quadrangular stem
- Attains height of 1 m.

- Plant flowers in month of July to October
- Entire plant collected at stage of flowering when capsules are fully formed.
- Cut off from base.

**Characteristics:**

- Stem – round & purplish at base but quadrangular & yellowish towards the apex
- Upper part of stem contains opposite leaves.
- Leaves – sessile, ovate, lanceolate, entire, glabrous
- Fruits - ovoid

- Odour – none
- Taste – extremely bitter

## Microscopy:

**Stem -**

- Single layered **epidermis** – externally covered with thick striated cuticle present in young stem
- **Endodermis** – showing anticlinal or periclinal walls
- Single layered **pericycle** consisting of thin walled cells
- **Cambium** between xylem & phloem
- **Xylem** – continuous & composed mostly tracheids, a few xylem vessels present, vessels & fiber tracheids have simple & bordered pits
- Medullary rays – absent
- **Pith** – rounded & isodiametric cells with prominent intracellular spaces, acicular crystals, oil droplets & brown pigments present.

## Chemical constituents:

- Bitter glycosides – amarogentin (0.04%) & amaroswerin (0.03%)
- Two extremely bitter principles – chiratin & ophelic acid
- Xanthone dvt – chiratol, mangiferin, swertianin, chiratanin, chiratenol
- Secoirridioid - swertiamarin, gentiopicroside, gentianine & gentiocrucine

## Uses:

- Bitter tonic & stomachic in India
- Also used as antimalarial in certain parts of India
- Antimalarial activity due to gentiopicrin
- Important ingerdient in ayurvedic preparations (Mahasudarshan & sudarshan churna) – used in chronic fever.

## Adulterants:

- S. Angustifolia
- S. Alata
- S. Trichotoma
- Kalmegh (Andrographis paniculata)
- Root of Rubia cordifolia

**Japanese Chirata** – S. chinensis

- Much smaller plant
- Length – 10-35 cm & thickness – 1-2 mm
- Colour – brown or purplish brown
- Root is straight
- More bitter than S. chirata
- Contain crystalline glycoside – swertiamarin, yielding by hydrolysis with emulsin erythrocentaurin & glucose
- Also contain crystalline tasteless swertic acid

# GENTIAN

**Synonyms** – Yellow gentian root

**B.S.** – Dried unfermented rhizomes & roots of Gentiana lutea

**Family –** Gentianaceae

**G.S.** – mountainous regions of central & south Europe, India (from Kashmir to Bhutan & Meghalaya, Himachal Pradesh, U.P.)

Morphology:

General appearance : Cylindrical pieces of roots & rhizomes

Size: L – 10-20 cm, D – 2.5 cm (root), 6 cm (rhizome)

Shape – cylindrical. At apex of rhizome conical buds present

Surface – root – longitudinal wrinkled

rhizome – transversely wrinkle, leaf scra & root scars found in rhizome

Fracture – short & shows nucleus & oil drops in cells

Colour – yellowish brown

Taste – first sweet & then bitter

Chemical constituents:

Bitter glycosides – gentiopicrin & amarogentin – irridoid monoterpene dvts.

Fresh or carefully fermented & carefully dried gentian contains 2% gentiopicrin

Amarogentin – 0.04%

Gentiamarin – amorphous glycoside – to be formed during fermentation or drying from gentiopicrin

Genttin – bitter crystalline glycoside – mixture of gentiopicrin & coloring substance gentisin or gentianic acid

Also contain gentisin, isogentisin & their dvts. – xanthone dvts.

- Gentisin – insoluble in water & alcohol but with 5% KOH forms yellow colored substance & nitro dvt
- Bitter trisaccharide – gentianose – hydrolysis give 2 mole glucose & 1 mole glucose
- Oily matter – cholesterol
- Pectin & ca. oxalate crystals
- Can  be distinguished by alkaloid gentianin & obtained by reaction with ammonia on gentiopicrin, gentianose & gentisin

# COUMARINS GLYCOSIDES

- Psoralea
- Ammi majus
- Ammi visnaga

- Coumarin glycosdies are benzo-α-pyrone derivaties.
- Alcoholic solutions when made alkaline – give blue or green fluoresence.
- Glycosides – Umbelliferone, Aesculetin, scopoletin.

1. **Umbelliferone** – 7-OH coumarin, present in free state in galbanum & in combined state in Asafoetida.
2. **Aesculetin** – 6:7 – dihydroxy coumarin

- Aesculetin & its glycoside present in species of Rosaceae including Crategus oxyacantha
- Aesculetin similar to rutin, has vit. P like activity &official in French Pharmacopoeia.

3. **Scopoletin** – 6 – methoxy,7 – hydroxy coumarin

- Scopoletin & its glycoside scopolin or methyl aesculetin present in belladonna, datura, wild cherry bark & jalap.

- Coumarins have flavouring property but they cause damage to liver & also cause drug interactions with many other drugs & possess carcinogenic properties. So in U.S.A. as flavouring agents is banned.
- Umbelliferone & Aesculetin added in sun tan preparations – they absorb rays of wavelength 280-315 nm which responsible for erythema formation.

**Furanocoumairns –** furan ring joined at 6:7 or 7:8 to coumarins.

- Found in Rutaceae, Umbelliferae & Leguminosae.
- Have prominent photosensibilising property & uaed in treatment of leucoderma
- Glycoside – Psoralen, xanthotoxin, bergapten, imperatorin
- **Psoralen** - Bavchi
- **Xanthotoxin** – 8-methoxy psoralen, Ammi majus
- **Bergapten** - 5-methoxy psoralen, bergamot (Citrus bergmia)
- **Imperatorin** - 8-dimethylallyloxy psoralen
- **Marmelosin** – similar to Imperatorin, Aegle marmelos
- Furanocoumairns absorb rays 315-400 nm at which pigmentation occurs.

# PSORALEA

**Synonyms** – Bavchi

**B.S.** – Dried ripe fruits of Psoralea corylifolia

**Family –** Leguminoseae

**G.S.** – India (Rajasthan, Punjab, U.P.)

**Cultivation:**

- Annual plant
- Seeds sown in March-April.
- Plant flowers during rains & seeds mature in November.
- When fruits start drying & attain dark brownish black colour, fruits are collected by stripping off
- Fruits separated by winnowing.

## Characteristics:

- Size: L-3to4.5mm & 2-3mm breadth
- Fruit consist oily pericarp, hard seed coat & kernel.
- Colour – dark chocolate to black
- Shape – ovate, bean shaped, somewhat compressed & pitted
- Taste – bitter
- Smell – pungent due to volatile oil

## Microscopy:

- Three parts: Epicarp, Mesocarp, Endocarp
- Epidermal layer of Epicarp – thick & covered with resinous coat
- Mesocarp – thin walled parenchyma & vascular bundles
- Endocarp – testa & endosperm
- Testa – thin walled parenchyma within raphe & endosperm
- Endosperm – contain starch grains

## Chemical constituents:

- Furanocoumarin – psoralen – 1-3% (main active constituent), isopsoralen
- Other – psoralidin, corylidin
- Flavone – bawachinin
- Chalcone dvt.
- Seed contain fixed oil & resin acids (21.5%)

## Chemical tests:

- Psoralen dissolved in alcohol & then NaOH is added & observed under UV light – yellow fluorescence observed
- Psoralen dissolved in alcohol & add 3 times of propylene glycol, 5 times of acetic acid & 40 times water & observed under UV light – blue fluorescence observed

## Uses:

- Treatment of leucoderma, leprosy, psoriasis & for inflammatory diseases of skin.
- Psoralen is main responsible for stimulation of skin pigment melanin.
- Drug is applied externally as well as internally
- Bawachinin have marked anti-inflammatory, antipyretic & analgesic properties.

# VISNAGA

**Synonyms –** Khella, pick tooth fruit

**B.S.** – Dried ripe fruits of *Ammi visnaga*

**Family – Umbelliferae**

**G.S.** – Egypt, chile in south America

**Cultivation:**

- Plant – annual herb growing about 1-1.5 m height.
- Propagated by seeds in loamy soil of nursery beds in August.

- After attaining height of 6-7 cm, transplantation done into open fields.
- After 7-8 months, plant bears flowers & harvesting done at stage of ripening of first fertilized flowers.
- Plant cut & preserved in heaps which all fruits ripened.

## Morphology:

- Umbelliferous fruit, very few cremocarps are entire. Otherwise occur as separate mericarps.
- Shape – planoconvex & ovoid lanceolate
- Colour – greenish brown
- Size – l – 2-2.5 mm, width – 0.7-1.2 mm, thick – 0.8-1 mm
- Mericarp shows 5 primary ridges & 4 secondary ridges.

## Microscopy:

- 5 vascular bundles & 4 oil glands.
- Large lacuna present in primary ridge on outer side of vascular bundle.

## Chemical constituents:

- Volatile oil – 1% khellin, 0.1% visnagin & 0.3% khelloside – furanocoumarin dvts
- Khellin – odourless bitter tasting crystals. Soluble in mineral acids & organic solvents except ether.
- Also contain samidine, dihydrosamidine & visnadine

## Uses

- Khellin – smooth muscle relaxant & used as coronary vasodilator in angina pectoris, renal & uterine colic, bronchial asthma & whooping cough.
- samidine , dihydrosamidine & visnadine – strong vasodilators

# AMMI

**B.S.** – Dried ripe fruits of *Ammi majus*

**Family – Umbelliferae**

**G.S.** – Egypt, Europe, Abyssinia, West Africa, India (Jammu & Kashmir)

**Cultivation:**

- Cultivated in North India by some pharmaceutical firms as well as central institute of Aromatic & Medicinal plants
- Propagation done by seeds which mixed with soil & sown at distance of 9o cm.
- Sowing done in October.

- Before sowing, farmyard manure & superphosphate added to soil.
- Harvesting done in April-May, when plant bears immature green fruits.

## Microscopy:

- Resemble to visnaga except they are small & possess 4 prominent secondary ridges.
- No lacuna is present in primary ridges.

**Chemical constituents** – furanocoumarins dvt.

- Xanthotoxin – 0.4-1.9%
- Other – bergapten, isopimplin & imperatorin

**Uses:**

- Xanthotoxin – called methoxalen in USP – used to increase formation of melanin pigments in skin on exposure to UV light.
- used in treatment of idiopathic vitiligo.