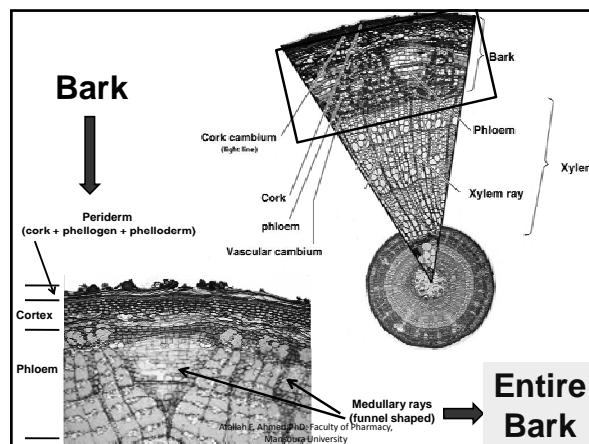
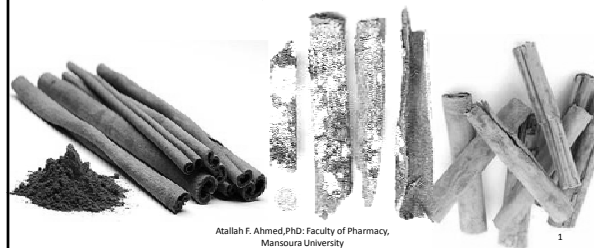


Medicinal Barks (2)

Atallah F. Ahmed, PhD



Microscopical Characters (Bark Structure)

Classification of Barks

1. Entire (Typical):

It consists of:

a- Periderm (cork + phellogen + phelloderm)

b- Cortex

c- Pericycle

d- phloem (1ry & 2ry)

e- Medullary rays.

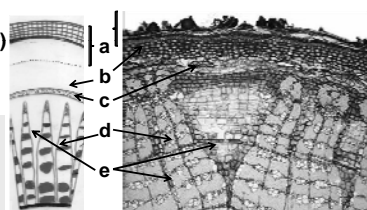
f. Other structures

Examples:

Cassia Bark

Cinchona Bark

Pomegranate Bark

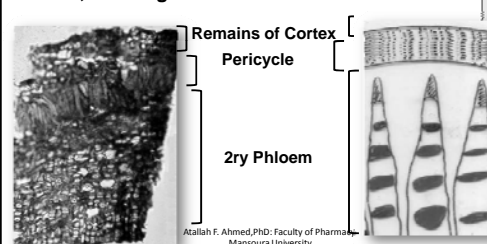


2. Decorticated Bark (needs human interference):

A bark deprived of its most cortex.

During preparation of some commercial barks, a part or whole of the tissues lying outside the 2ry phloem may be removed (decortication) as they are lacking a medicinal value or containing undesirable constituents such as tannins, coloring matters.

Example:
Cinnamon Bark



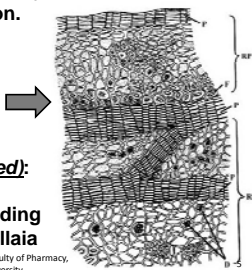
3. OuterBark = Rhytidome = Shell or Scale Bark =

Botanist's Bark (naturally produced):

■ It is composed of alternative layers of dead periderm and other collapsed tissues of cortex or phloem, being formed after the formation of internal phellogen.

■ It has no commercial value e.g. Rhytidome removed from Quillaia or Oak during preparation.

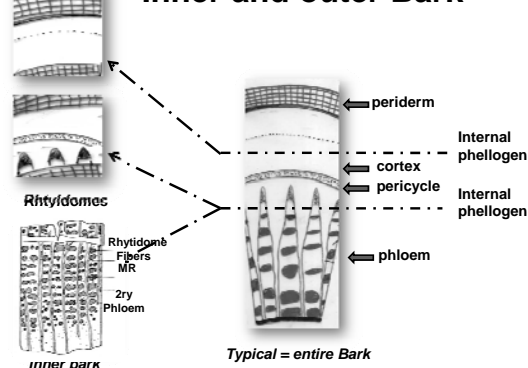
P = periderm
RP = remains of 1ry phloem
RS = remains of 2ry phloem
F = fibers
D = calcium oxalate clusters
Oak Rhytidome



4. Inner Bark (naturally produced):

It is composed mostly of 2ry phloem and remained after shedding or removal of rhytidome e.g. Quillaia Bark.

Inner and outer Bark



Microscopical Characters (Bark Structure)

Tissues of Barks

Periderm – Cortex – Pericycle – 1ry & 2ry Phloem – MR

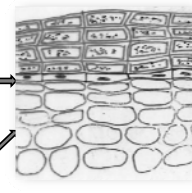
I. Periderm

Cork (Phellum): Outer protective tissue of 2ry origin developed from phellogen.

Cork cells are dead polygonal cells, arranged in compact radial rows - Dark brown in color due to brownish tanniferous pigments – Walls are suberized or lignified (e.g. Cassia, Cascarilla Bark) and varied in thickness.



Phellogen (cork cambium): single row of 2ry meristematic cells → producing suberized cork to outside and unsuberized phelloderm to inside. It may originate in hypodermis (e.g. Cinnamon), cortex, pericycle (e.g. Cinchona calisaya) or phloem (e.g. Quillaia).



Phelloderm (2ry cortex): : developed internally from phellogen - unsuberized and devoid of pigments (c.f. cork), but may contain starch grains. It may be parenchymatous (root bark), collenchymatous (stem bark) or sclerenchymatous (e.g. Canella Bark).

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II. Cortex (1ry cortex):

May be absent due to:

- decortication process (e.g. Cinnamon).
- exfoliation occurred after deep phellogen formation (e.g. Cinchona calisaya).

The term *middle bark* is used to indicate 1ry cortex alone or both 1ry and 2ry cortex (phelloderm).

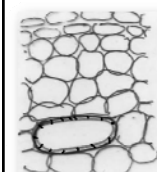
Cortex is parenchymatous in nature, but it may be / contains:

- collenchymatous (e.g. Oak).
- sclereids (e.g. Cassia),
- fibers (e.g. Oak).
- oil cells (e.g. Cascarilla and cassia),
- oil glands (e.g. Cusparia),
- laticiferous ducts (e.g. Cinchona) or
- mucilaginous cells (e.g. Cinnamon, Cassia, Frangula).

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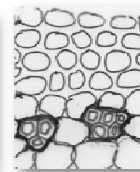
Some peculiarities of cortex



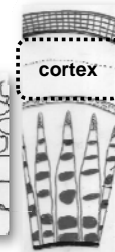
laticiferous ducts
(e.g. Cinchona)



Sclereids
(e.g. cassia)
Oil cells
(e.g. cassia & cascarilla)
Mucilaginous cells
(e.g. cassia)



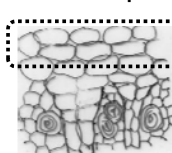
fibers
(e.g. Oak)



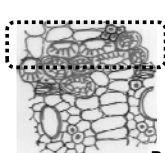
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III. Pericycle: very narrow zone.

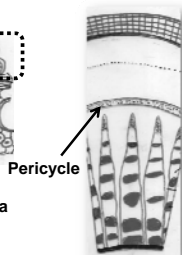
- It may be parenchymatous and undifferentiated from cortex (e.g. Cinchona)
- It may be in the form of interrupted (e.g. Cinnamon) or continuous (e.g. Witch-Hazel) band of sclerenchyma associated with pericyclic fibres.



Pericycle in
Cinchona Bark



Pericycle in
Cinnamon & Cassia
Bark

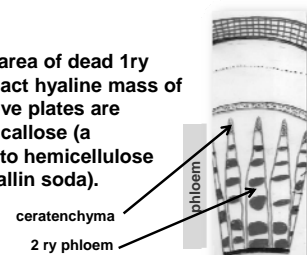


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VI. Phloem (Bast): The commercial bark (mainly 2ry phloem consists of sieve tubes + companion cells + phloem parenchyma + medullary rays, MR) and usually associated with phloem fibers, sclereids and secretory cells .

- **Ceratenchyma:** It is an area of dead 1ry phloem (collapsed compact hyaline mass of sieve tubes) in which sieve plates are permanently blocked by callose (a polysaccharides related to hemicellulose and stained red with corallin soda).



ceratenchyma
2 ry phloem

Phloem parenchyma may contain:
Starch, calcium oxalate crystals which may form crystal sheath around groups of phloem fibers e.g. Cascara, Frangula and Hamamelis.

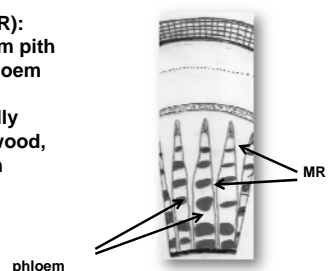
Phloem (Bast) fibers:

1. Usually are fusiform (e.g. Cinnamon) in shape but may be tortuous and irregular (e.g. Quillaia).
2. Walls are thick lignified, sometimes stratified (e.g. Cinchona), rarely cellulosic (e.g. Elm).
3. Occur singly or in groups (e.g. Cinnamon).
4. Their dimensions are good tool in identification and differentiation of closely related barks (e.g. Cinnamon & Cassia).

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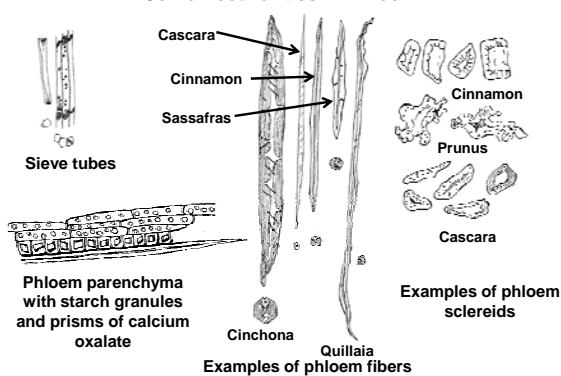
Medullary rays (MR):
 They originate from pith and traversing phloem from xylem.
 MR cells are usually cellulosic (c.f. in wood, lignified) except in Quillaia Bark.



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Some Peculiarities in Phloem



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Selected Barks

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CINNAMON BARK

قشر الدارسيني

Cortex Cinnamomi ceylanici
Ceylon Cinnamon



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CINNAMON BARK

■ It is the dried bark of shoots of coppiced trees of *Cinnamomum zeylanicum* (Lauraceae), deprived of most of its cortex (decorticated bark) and known as Ceylon Cinnamon.

■ It yields not less than 0.7% v/w of volatile oil.

■ It is cultivated in Ceylon (Sri Lanka) and Seychelles.



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Preparation of Cinnamon Bark

Cinnamon is now almost obtained from cultivated plants (cinnamon plantation).

Collected stems are allowed to ferment for 24 h to loosen the outer layers. Cork and cortex are removed by scrapping with curved knife (*decortication process*), barks are then stripped off, dried and packed inside each other and dried in shade then in sun to give compound quills.



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Macroscopical Characters

Dried decorticated bark

Color: light brown

Odor: fragrant

Taste: sweet aromatic and slightly pungent

Shape: long, flexible sticks of single or double, closely packed compound quills.

Size: up to L. 2 m, D. 1 cm, 0.5 mm thick.

Outer surface: smooth with fine pale longitudinal undulating lines and occasional scars or holes.

Cork, rhytidome, cracks or furrows are absent.

Inner surface: darker in color with fine longitudinal striations.

Texture: brittle.

Fracture: short and splintery



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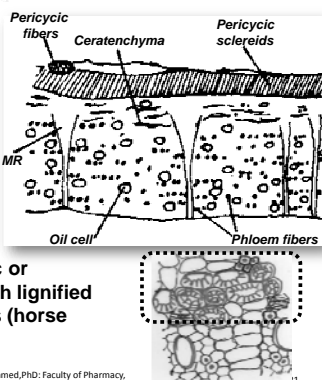
Microscopical Characters

I. Cork & Cortex: absent

II. Pericycle: (a **fibro-sclereidal type**)

A tangential band of sclerides, associated with external small groups of lignified fibres.

Sclereids are isodiametric or tangentially elongated with lignified unequally thickened walls (horse shoe-like thickening).



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III. Phloem:

■ 1ry phloem = collapsed sieve tubes (**Ceratenchyma**).

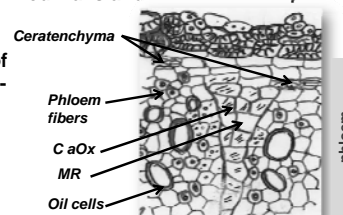
■ 2ry phloem is the widest tissue = sieve tubes + companion cells + phloem parenchyma with **starch granules** ($D < 10 \mu$).

■ Phloem shows numerous **large oval cells** containing volatile oil or mucilage, and **idioblasts** with acicular crystals of CaOx.

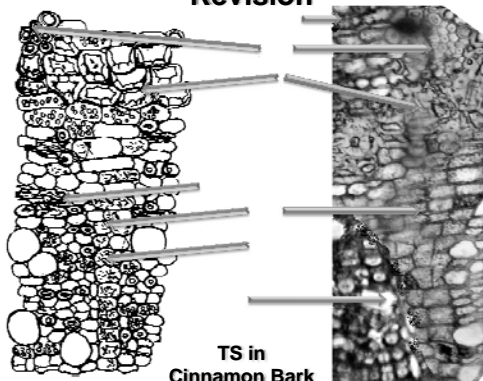
■ Phloem fibers occur isolated or in tangential rows ($W < 30 \mu$). (having thickened lignified walls and narrow lumens).

IV. MR

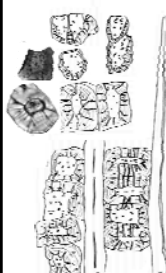
Biseriate, composed of radially elongated thin-walled cells, widened toward the pericycle and contain acicular crystals of CaOx.



Revision



Cinnamon Powder



Starch granules (small: simple or compound = 2-4 components with point or slit-shaped hilum).

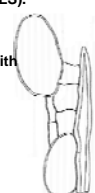


MR cells with acicular crystals of ca. ox., usually accompanied with phloem parenchyma and fibers (Tangential LS).



Lignified pericyclic sclereids isolated or mostly in small groups (thick isodiametric with striated walls or rectangular in shape with unequally thickened walls). May be associated with pericyclic fibers.

Isolated phloem fibers with thick lignified walls or associated with oil cells, phloem parenchyma



Active Constituents

1. Volatile Oil (0.5-1%)

Cinnamaldehyde 65%

Eugenol 5-10%

2. Condensed (Catechol) Tannins
e.g. Cinnamtannin B1

Other contents: mucilage

Note: *Cassia oil* does not contain eugenol, *Cinnamon leaf oil* contains >70 % eugenol (How to test eugenol?)

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Uses and Bioactivity

1. Flavoring agent in Pharmaceuticals, Drinks, and Cookery.
2. Cinnamon oil has carminative property and antimicrobial activity (which can aid preservation of certain food).
3. Mild astringent, being used in treatment of diarrhoea and other problems of the digestive system.
4. Recent researches showed that cinnamtannin B1 is effective in type II diabetes.
5. Cinnamon has high antioxidant activity.

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CASSIA BARK

قشر القرفة

Chinese Cinnamon

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■ It is the dried bark of *Cinnamomum cassia* (*Lauraceae*).

■ It is cultivated in China.

Macroscopical Characters

Odor & Taste: Less aromatic and more astringent and mucilagenous in taste than cinnamon bark.

Shape: channelled, single quills, or broken and more thicker (1-3 mm).

Outer surface: dark earthy brown color, smooth, but with grayish patches of uncleaned cork.

Fracture: short in the outer part (phelloderm & cortex) and splintery in the inner part (pericycle and phloem).

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Microscopical Characters

Histologically, Cassia bark is very close to Cinnamon except in:

- Presence of cork and cortex, externally to the pericyclic sclereids.
- Larger dimensions of fibers ($W > 30\mu$) and starch granules ($D > 10\mu$).

Cork: 2-3 rows of thin suberized cells followed by 2-3 rows of thick-walled lignified cells, and an innermost layer of strongly thickened outer walls.

Cortex: parenchymatous with dispersed isolated or small groups of sclereids.

Lignified cork cells

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Periderm

Cortex

Pericycle

Phloem

MR MR

Lignified cork

Thickened lignified basal cells

Cortical sclereids

Mucilage cells & oil cells

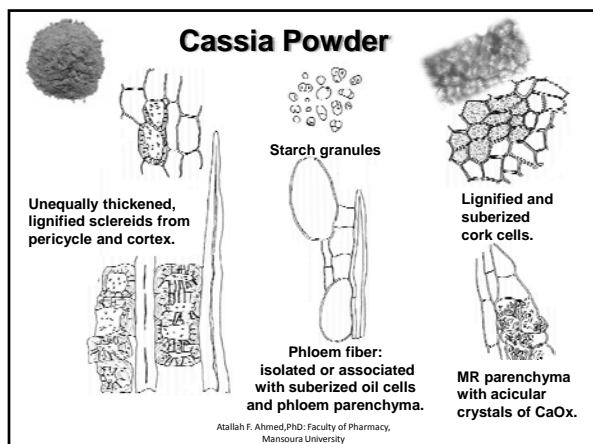
Pericyclic sclereids

Oil cells

Phloem fibers

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Active Constituents

- Volatile oil (1-2%)
It contains 75% cinnamaldehyde and no eugenol.
- Condensed Tannins.
- Other constituents: Mucilage.

Uses and Bioactivity

- Flavoring agent.
- Carminative.
- Mild astringent.

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Test yourself

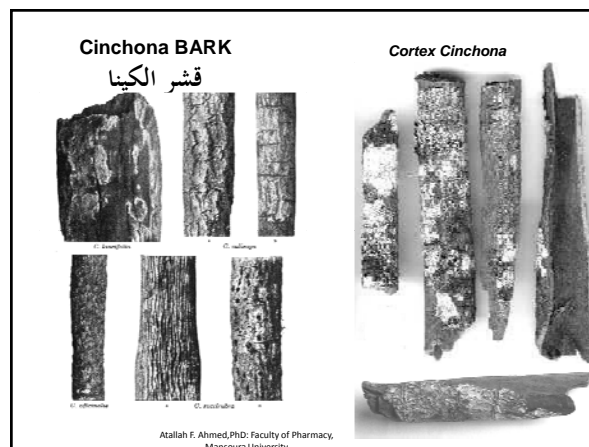
Differentiate between Cinnamon and Cassia Bark in:

- Active constituents.
- Histology.
- Microscopical elements.
- uses

What is the taste of proanthocyanidin and How to chemically test it in cassia and cinnamon?.

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■ Dried stem and root barks of:

1. *Cinchona succirubra* and its hyperids (Red Cinchona)
2. *C. ledgeriana*, *C. calisaya* and their hyperids (Yellow Cinchona)
3. *C. officinalis* (Pale Cinchona) (*Rubiaceae*).

■ Yields not less than 5% of Cinchona alkaloids.

■ Cinchona trees are indigenous to S. America, and grows at an altitude of 5000-7000 ft. Now, they are cultivated in India, Tanzania, Java (supplies 90% of the world's need).



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Collection & Preparation

Mostly, it is collected by *Coppicing method*.
In Java, the *Uprooting method* is adopted.
Bark is collected during the rainy season when it separate most easily.

After removal from the stems, bark is firstly dried by the heat of sun with protection against rain and dew then by artificial heat.

During drying, the inner surface of the bark (pale in color) changes into brown or red color, due to auto-oxidation of tannins by exposing to the air.



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Macroscopical Characters of Stem Bark

Odor: faint characteristic.

Taste: very bitter and astringent.

Shape: quills (single or double), curved (for thick pieces).

Outer surface: grayish-brown with whitish patches of lichens and other epiphytes, rough with longitudinal ridges, and longitudinal and transverse fissures.

Inner surface: brownish-yellow to deep reddish-brown, finely to coarsely longitudinally striated.

Fracture: short in the outer part and fibrous in the inner one (phloem region).

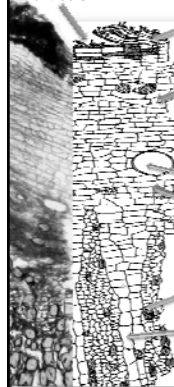


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Microscopical Characters

Lenticels



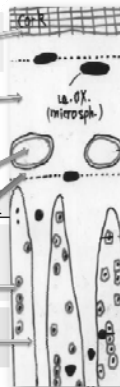
Cork: several layers of thin-walled, rectangular cells, filled with reddish-brown contents.

Cortex: narrow, parenchymatous, containing starch granules and showing scattered idioblasts with microspheoidal crystals of CaOx. Inner part of cortex shows large laticiferous secretory ducts.

Pericycle: undifferentiated parenchyma.

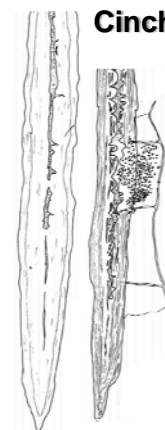
Phloem: shows thick lignified phloem fibers (isolated or in short radial rows). Some phloem parenchyma is filled with microspheoidal crystals of CaOx.

MR: bi- or triseriate, with rectangular or radially elongated moderately thick-walled cells.



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Cinchona Stem Bark Powder



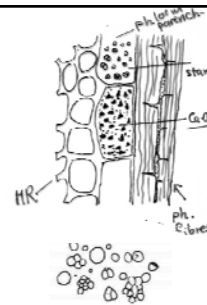
Yellowish phloem fibers (entire or broken), occur singly or in groups of 2-3 cells.

They are fusiform with blunt pointed ends.

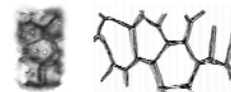
The walls are heavily thickened, lignified, stratified and shows numerous funnel-shaped pits.

They may be associated with phloem parenchyma (containing microspheoidal CaOx) and MR.

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Brown phloem parenchyma, with idioblasts of microspheoidal crystals of CaOx.



Thin-walled lignified cork cells filled with reddish-brown contents.

- Starch granules: small, usually simple, rounded, occasionally compounds with 2-3 components.

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Cinchona Root Bark

It differs from stem bark in the followings:

- Shape: channeled, often twisted pieces.
- The outer surface shows no epiphytes where its color resemble the inner one, being reddish-brown, while the inner surface is striated and frequently fissured.
- It is formed entirely of 2ry phloem.
- Phloem fibres, mostly have forked ends.
- Occasional sclereids, with thick striated, lignified pitted walls are present.
- Secretory ducts are absent.

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Active Constituents

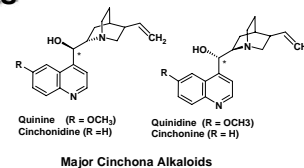
- Total alkaloids 6.5% of which up to 60% are quinine-type:

- quinine (up to 15%)
- quinidine (0.5%)
- cinchonine and cinchonidine.

- They exist in combination with quinic acid and cinchotannic acid.

- Cinchotannic acid is a condensed tannin and it rapidly oxidized to give phlobaphene, known (cinchona red).

- Bitter glycoside: quinovin
- Quinic acid.



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Uses and Bioactivity

The diagram illustrates the life cycle of the malaria parasite (Plasmodium) and the clinical effects of Quinine and Quinidine. It shows the parasite's development in the liver, its invasion of red blood cells, and its rupture of these cells to infect new cells. It also shows the parasite's development in the mosquito. The clinical effects of Quinine and Quinidine are shown as follows:

- Quinine (Antimalarial):**
 - Parasites are released when a mosquito bites.
 - Parasites reach the liver and are ingested by a mosquito when it feeds on blood.
 - Parasites multiply in the liver.
 - Parasites enter the red blood cells.
 - Parasites rupture the red blood cells and approach new parasites.
 - Parasites enter the red blood cells.
 - Parasites rupture the red blood cells and approach new parasites.
- Quinidine (Antiarrhythmias):**
 - Diagram of the heart showing the effect of Quinidine on the atrial fibrillation.
 - ECG traces showing the effect of Quinidine on the heart rate.

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Tests for identity

1. Fluorescence test:

Dry ignition of powder Cinchona in test tube → purplish-red fumes → condense to purplish-red tarry droplets + 50% alcohol (OR dil. oxygenated acids: H_2SO_4 or H_3PO_4) → pale yellow soln. UV. Lamp at 366 nm → blue fluorescence.

2. Thalleiquine test (for quinine & quinidine):

Moisten mixture of Cinchona powder + CaO for few minutes. Extract with alcohol → filter → alc. ext → evaporate to a dry residue. Add dil. H_2SO_4 then filter, neutralize filtrate + Br_2 + ammonia → emerald green color.

3. Immediate copious yellowish white ppt. when the dil. HCl extract treated with Mayer's reagent.

4. Water decoction + 5% $FeCl_3$ → Greenish black color.

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