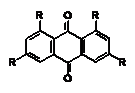
**Quinones** are oxygen-containing compounds, which are essentially oxidized homologs of aromatic derivatives. In naturally occurring quinones, the dione is conjugated to an aromatic nucleus (benzoquinones), or conjugated to a condensed polycyclic aromatic system: naphthalene (naphthoquinones), anthracene (anthraquinoues).

Main groups of quinones are benzoquinones (C6), naphtoquinones (C10) and anthraquinones(C14).

                      Shape

Description automatically generated with medium confidence           

benzoquinones (C6)     naphtoquinones (C10)              anthraquinones(C14)

Derivatives of 1,4-benzoquinone are oxidizers, which reversebly are reduced to hydroquinones. Ubiquinone Q10 is involved in human cell respiration.

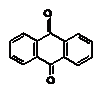
                                    Shape

Description automatically generated with medium confidence

1,2-benzoquinone       1,4-benzoquinone        structure of ubiquinones

Anthracene-derivatives yield nucleus of various degree of oxidation, type of linkage and condensation of monomeric structures.

Text

Description automatically generated                          

                                                        anthracene                                     anthraquinone

**Naphtoquinones** mainly abundant in *Juglandaceae, Plumbaginaceae* and *Droseraceae* Vitamin K is a term that refers to 2-methyl-1,4-naphthoquinone and derivatives of this compound which exhibit an antihaemorrhage activity. Phytonadione (vitamin K1) occurs in green leafy vegetables, naphtoquinone is combined with phytole that is also a component of chlorophyll. Vitamin K is necessary for normal clotting of blood. Juglone, plumbagone and droserone are derivatives of 1,4-benzoquinone.

                 Shape

Description automatically generated with medium confidence                      Shape

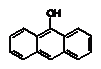
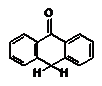
Description automatically generated with low confidence

           juglone                                plumbagone                                         droserone

**The botanical distribution** of the species containing l,8-dihydroxyanthraquinone glycosides is rather limited: *Fabaceae*(sennas), *Polygonaceae*(rhubarbs), *Rhamnaceae*(buckthorn, cascara), *Rubiaceae*, *Asphodelaceae*(aloe) and some other. Reduced forms of hydtoxyanthraquinones (anthranols, anthrones and oxyanthrones) occur naturally less frequently.

**Classification**

Monomeric anthracene derivatives. According to degree of oxidation, anthracene derivatives are classified as reduced forms (derivatives of anthranole, anthrone and oxyanthrone) and oxidized forms (anthraquinones). In anthrones (i.e., 10-H-anthracen-9-ones), carbon 10 is a methylene carbon.

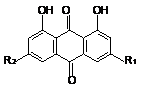
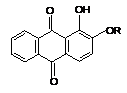
                    A picture containing text

Description automatically generated

                        anthranol                            anthrone                         oxyanthrone

Depending onthe pH, these anthrones can occur alongside with their tautomeric forms, the anthranols. In practice, anthrones and anthranols are often designated by the term "reduced forms", and anthraquinones by that of "oxidized forms". No matter what their degree of oxidation, these molecules have in common a double hydroxylation at C-l and C-8.

In dependence of position of hydroxylation in a molecule, these compounds are divided on derivatives of emodin (1,8-dihydroxyanthraquinones) and alizarine (1,2-dihydroxyanthraquinones).

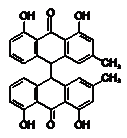
  

  R1=CH3, R2=OH – emodin                                 R=H – alizarine

The first class is representedby emodin, chrysophanol,rhein, aloe-emodin. These compounds have OH-groups in tworings and are used as cathartics.

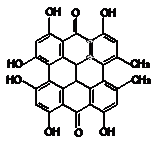
Alizarine derivatives (alizarine, purpurine, lucidine) are hydroxylated within one ring and act as lytolytic agents.

Dimeric compounds in dependence of the conjugation type are engaged with single bond or condensed. There occur both oxidized and reduced forms. The first ones are conjugated into dimers in γ-position (chrysophanol dianthrone), the latters in a- or β-position (cassianine).



                                                               chrysophanol dianthrone

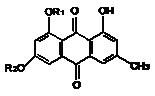
Condensed dimers of anthracene derivatives (hypericine) differ from other types of dimeric compounds by the presence of simultaneously two single and one double bonds between monomeric skeletons.



                                                                      hypericine

Glycosidesare compounds that yield at least onesugar among theproducts ofhydrolysis. Most frequently occurring sugars inthe structure of anthraquinones are glucose, rhamnose, xylose, arabinose, and biosides (primverose, rutinose, gentiobiose). Anthraglycosides mostly occur as 0-glycosides. C-glycosides occur rarely *(Aloe spp.)*

The glycosides, upon hydrolysis, yield aglycones that are di-, tri-, or tetrahydroxyanthraquinones or modifications of these compounds. A typical example isfrangulin A, which hydrolyzes to form emodin (l,6,8-trihydroxy-3-methylanthraquinone) and rhamnose.



 R1=Н, R2=rhamnose – frangulin A

Glycosides of anthranols, dianthrones, and oxanthrones (reduced derivatives of anthraquinones) also occur in the plant materials, and they make significant contributions to the therapeutic action of these natural products.

These glycosides contain an aglycone group that is a derivative of [anthraquinone](http://en.wikipedia.org/wiki/Anthraquinone). They are present in [senna](http://en.wikipedia.org/wiki/Senna_%28herb%29), [rhubarb](http://en.wikipedia.org/wiki/Rhubarb) and [aloes](http://en.wikipedia.org/wiki/Aloe); they have a [laxative](http://en.wikipedia.org/wiki/Laxative) effect. They are mainly found in dicot plant exept Liliaceae family of monocot plant. Antron and anthranol are reduce forms of anthraquinon.

**Physical and chemical properties,**

Anthraquinones are coloured, orangy-red compounds, sparingly soluble in coldwater, and soluble in organic solvents and alcohols. The carboxylic aglycones can be extracted with an aqueous sodium bicarbonate solution. The glycosides are soluble in water and hydroalcoholic solutions. Glycoside extraction is achieved with water or with rather dilute hydroalcoholic solutions.

Free quinones are practically insoluble in water, can be extracted by the common organic solvents (ether, chloroform, benzene), and their separation requires the common chromatographic techniques.

Both aglycones and glycosides are soluble in aqueous solutions of alkali, due to formation of phenolic salts.  -OH-groups form molecular hydroxylic bonds with neighbouring carbonilic group. Therefore, hydroxymethylanthraquinones without -OH-groupare insoluble inammonia andbicarbonate solutions, thosewith -OH-group in alkaline solutions produce salts with solutions of ammonia, bicarbonate and alkali

**İdentification**

Various colour reactions can be used to characterize quinones. The main one is Borntrager’s reaction, carried out by dissolving the quinone in alkaline aqueous medium; the solution develops a vivid colour, which ranges, depending on the structure and the substituents of the quinone, from orangy-red to purplish-violet. This reaction is only positive with the free anthraquinone forms: to characterize glycosides with this reaction, preliminary hydrolysis is required, and if anthrones serve as the aglycones, they must first be oxidised to anthraquinones. This reaction is also used to visualize TLC plates.

Another colour reaction, specific to 1,8-dihydroxyanthraquinones, utilizes magnesium acetate in methanol. The resulting red colour is more intense and more stable to light than that from the simple reaction with potassium hydroxide. Consequently, it lends itself better to quantitation. Like the Borntrager’s reaction, this one is positive only with the oxidized andfree forms.

The identification of the glycosides and aglycones is typically doneby TLC visualization under UV light and by the Borntrager’s reaction, directly or after oxidation, right on the TLC plate, of anthrones to anthraquinones.

Anthraquinones may be detected by reactions with lead acetate, Tchirch's and microsubliniation reactions.

In the result of reaction of microsublimation precipitated yellow crystals with alcoholic sodium hydroxide solution give red or violet colour.

Tchirch's reaction: at the presence of alcoholic sodium hydroxide solution emodins and chrysophane acid develop cherrish-red colour, alizarines – violet. Chloroform extraction allows distinguishing types of anthraquinones alter reaction with alcoholic NaOH: cherrish-redcolour characterize emodins, blue - alizarine, stable colour indicates chrysophane acid presence.

Reaction with lead acetate Pb(CH3COO)2, added to chloroform extract and methanol: If extracted compounds have OH-groups in **-position, then red colour, if -orange, **-, - then blue or violet colours are produced.

|  |  |  |
| --- | --- | --- |
| **Analysis of materials containing anthracene derivatives** |  |  |

|  |
| --- |
| * 1. 1. Для обнаружения антраценпроизводных чаще используют щелочи. To detect anthracene derivatives increasingly using alkali. Реакции со щелочами проводят в нескольких вариантах. Reaction with alkali is carried out in several ways. А). A). Непосредственно на сырье наносят раствор щелочи. Directly on the raw material solution is applied alkali. При наличии окисленных форм наступает красно-вишневое окрашивание. In the presence of oxidized forms comes the red-cherry color. Б). B). Раствор щелочи добавляют к водному извлечению из сырья. Alkaline solution is added to the aqueous extract of raw materials. Образуется вишневое (окисленные формы) или слабо-оранжевое или желтое (восстановленные формы) окрашивание. Formed cherry (oxidized form) or poorly-orange or yellow (reduced forms) staining. Диантроны дают буроватое или фиолетовое окрашивание. Diantrons give brownish or violet color. 1 и 2 методы не позволяют однозначно судить о присутствии антраценпроизводных, так как другие фенольные соединения маскируют окраску. 1 and 2 methods do not allow us to judge unambiguously the presence of anthracene derivatives, as other phenolic compounds mask the color. Обычно эти методы используют в полевых условиях (экспресс-методы). Typically, these methods are used in the field (rapid tests). В). * C). В лабораторных условиях широко используют реакцию Борнтрегера, основанную на способности антрагликозидов подвергаться щелочному гидролизу с образованием свободных агликонов. Under laboratory conditions, are widely used reaction Borntreger based on the ability antraglikozids subjected to alkaline hydrolysis with the formation of free aglycones. Одновременно происходит окисление антрон- и антранол-производных до антрахинона. Simultaneously, the oxidation of anthrone and anthranol derivatives to anthraquinone. После подкисления гидролизата агликоны извлекают органическим растворителем (диэтиловым эфиром или хлороформом). After acidification of the hydrolyzate aglycones extracted with organic solvent (diethyl ether or chloroform). При встряхивании органического слоя с аммиаком они переходят в аммиачный слой и окрашивают его в вишнево-красный (1,8-дигидроксиантрахиноны) или фиолетовый (1,2-дигидрокси-антрахиноны) цвета, причем в аммиачный слой переходят антрахиноны, имеющие b-ОН-группу. By shaking the organic layer with ammonia, they turn into ammonia layer and paint it cherry red (1,8-digidroksiantrahinony) or purple (1,2-dihydroxy-anthraquinone) colors, and an ammonia layer pass anthraquinones having a b-OH group. В случае хризофанола органический слой остается окрашенным в желтый цвет. In the case of hrizofanola organic layer is colored in yellow. 2. 2. Для обнаружения антрахинонов, имеющих хотя бы одну ОН-группу в a-положении, можно использовать реакцию с 1%-ным метанольным раствором ацетата магния: 1,2-дигидроксипроизводные дают фиолетовое окрашивание; 1,4-дигидроксипроизводные - пурпурное; 1,6- и 1,8-дигидроксипроизводные - оранжево-красное. For the detection of anthraquinones, with at least one OH group in a-position, you can use a reaction with 1% methanolic magnesium acetate: 1,2-digidroksiproizvodnye give violet color; 1,4-digidroksiproizvodnye - purple, 1,6 - and 1,8-digidroksiproizvodnye - orange-red. * 3. 3. Антраценпроизводные можно также обнаружить методом сублимации: порошок сырья нагревают в сухой пробирке на спиртовке, сублимат конденсируется на стенках пробирки в виде желтых капель или кристаллов. anthracene derivatives can also be found by sublimation: a powder feedstock is heated in a dry test tube to the stove sublimate condensed on the walls of the tube as a yellow droplets or crystals. Откапли щелочи антраценпроизводные в составе сублимата окрашиваются в красный цвет. One drop alkali anthracene derivatives in the sublimate are colored red. Для количественного определения антраценпроизводных в растительном сырье используют чаще всего оптические методы: фотоколориметрические и спектрофотометрические. To quantify anthracene derivatives in plant raw material is used more often than optical methods: fotokolorimetricheskie and spectrophotometry.   Из других методов используются хроматоспектрофотометрические, денсифлюориметрические, объемные, весовые и др. |

**Quantitative determination**

Quinone quantitation is often done by spectrophotometry, and based on one of the colour reactions described above. The spectrophotometric quantitation takes advantage of the colour obtained with magnesium acetate, or possibly, with potassium hydroxide. Since the free anthraquinone forms have no marked pharmacological activity, they are generally notincluded in thequantitation.

The quantitation of the total combined forms generally includes an extraction, an oxidizing hydrolysis to obtain free aglycones, a colour reaction, and a spectrophotometric determination. The drug is powdered and extracted with hydroalcoholic solution (70%) or alcoholic (95%) solution, the aqueous phase isextracted with an apolar organic solvent*.*which eliminates thefree anthraquinone formspotentially present*.*Next, thisaqueous solution is oxidized and hydrolyzed (hydrochloric acid); the resulting anthraquinones are extracted with an apolar organic solvent. The solvent is evaporated, and the residue redissolved in a methanolic solution of magnesium acetate, whose absorbance is measured.

To divide a total anthraquinone content on individual compounds are used alkali and their salts. Anthraquinones with COOH-group are soluble in aqueous bicarbonate solutions and other alkaline solutions. Anthraquinones with -OH-group do not result in phenolic salts with bicarbonate sodium, but they react with solutions of bicarbonates and alkali. If anthraquinone nucleus has in its structure just -OH-group, phenolic salts are formed in solutions of alkali only.

Authergoff’s method (photoelectrocolourimetry) is used as Pharmacopoeial forquantitative determination of anthraquinones in medicinal plant materials. At the presence of acetic acid, extraction with chloroform, later with sodium hydroxide and ammonia is carried out. Acidic hydrolysis allows obtaining free aglycones, destroying phenolic salts. After extraction of aglycones with diethylether, adding of ammonia allows to distinguish types of analized anthraquinones, due to produced red or violet or constant yellow colour.

Spectrophotometry is also widely used for identification of particular substances after extraction of coloured alkaline solution. In chtomatospectrophotometry compounds are separated by TLCor paper chromatography.

**Pharmacological Properties**

Laxative, or cathartic, drugs, such as senna, aloe, rhubarb, cascara sagrada, and frangula, contain anthraquinone glycosides (1,8-dihydroxyanthraquinone, or emodine, derivatives). Alizarine derivatives of*Rubia tinctoria*are spasmolytic, diuretic and nephrolytic. Hypericine is a psychoactive agent. Reduced forms of emodin monomerspossess anti-inflammatory action. Condensed anthraquinones (antibiotics anthracyclines) are potent antitumour agents. Many naphthoquinones are antibacterial and fungicidal. The anthraquinone and related glycosides are stimulant cathartics and exert their action by increasing the tone of the smooth muscle in the wall of the colon and stimulate the secretion of water and electrolytes into the large intestine. Depending on the dose administered, 1,8-anthraquinone derivatives exert a more or less violent laxative or purgativeactivity. At therapeutic dosesthey are stimulant laxatives.

After oral administration, the anthraquinone glycosides are hydrolyzed in the colon by the enzymes of the microflora to the pharmacologically active free aglycones, which usually produce their action in 8 to 12 hours after administration. These agents are indicated for constipation in patients who do not respond to milder drugs and for bowel evacuation before investigational procedures or surgery. The glycosides of anthraquinone and dianthrones are polar molecules, water-soluble, andhave a high molecular weight so they are not resorbed nor hydrolyzed, in the small intestine. The use of these drugs and their preparations can certainly have adequate justification (preparation for radiology or coloscopy, softening stool prior to anorectal surgical procedures, treatment of occasional constipation linked to drug treatment or to a change in lifestyle), but it must always include caution, and it must always be limited to short periods of time. All of the drugs in the group are contraindicated in case of intestinal occlusion. Except for aloe, they can be used in pregnant women only with a physician's advice (aloe is formally contraindicated inpregnant women). Preliminary medicaladvice is also necessary for breast-feeding women.

                 The activity is linked to the structure of these compounds: the most interesting derivatives are the O-glycosides of dianthrones and anthraqumones, as well as the C-glycosides of anthrones, in other words the group of compounds without a –CH2- in the 10-position. The activity of the glycosides of monomeric anthrones is excessive, which explainswhy the drugs containingthem (for example, buckthorn bark) are only used after prolongedstorage or after the appropriate heat treatment during whichthey are oxidized to anthraquinone glycosides. The free aglycones (anthraquinones) are practically inactive.

|  |  |  |
| --- | --- | --- |
| **The use of raw materials containing anthracenes** |  |  |

|  |
| --- |
| По своему фармакологическому действию антраценпроизводные относятся к слабительным средствам. According to its pharmacological action anthracene derivatives are laxatives. Таким действием обладают производные хризацина, которые способны усиливать перистальтику толстых кишок. Such action have hrizatsina derivatives, which can enhance peristalsis large intestines. Действие наступает через 8-10 часов и проявляется длительно (препараты крушины, жостера, сенны, ревеня). The action comes after 8-10 hours and is manifested for a long time. Применяют препараты при хронических запорах, главным образом в старческом возрасте. Use the drug for chronic constipation, especially in old age. Помимо слабительного действия антраценпроизводные вызывают приток крови к тазовым органам и поэтому противопоказаны при маточных кровотечениях. In addition to act as a laxative anthracene derivatives cause blood flow to the pelvic organs and therefore are contraindicated in uterine bleeding.  Производные ализарина обладают главным образом нефролитическим действием и применяются при лечении почечно-каменной болезни (препараты марены красильной). Alizarin derivatives have mainly nefrolitic action and are used in the treatment of renal stone disease (drugs madder dye).  In addition, some reduced forms, in particular, anthrone and anthranol hrizofanol in combination with other compounds included in the drug "Hrizirobin", is used to treat certain skin diseases, including psoriasis. Condensed anthracene derivatives (hypericin) are responsible for antibacterial activity of Hypericum preparations. |

|  |  |  |  |
| --- | --- | --- | --- |
| **MPM name** | **Source** | **Constituents** | **Action, use** |
| ***Radices Rhei*** | *Rheum palmatum L, var. tanguticum*(Rhubarb),  *Polygonaceae* | chrysophanol, aloe-emodin, emodin and emodin monomethyl ether, or physcion, their glycosides (chrysophanein and glucoaloe-emodin), anthrones, dianthrones; rhein, glucorhein; sennosides A and B, E, F); astringent compounds, mainly hydrolyzable tannins  (up to 12%) | laxative and astrigent |
| ***Cortex Frangulae*** | *Rhamnus frangula L. (Frangula alnus*) (frangula bark, alder buckthorn),  *Rhamnaceae* | The rhamnoside franguloside,or frangulin, consisting of twoisomers, frangulosides A andB, the monosides are frangulin A  (= emodin 6-0--L-rhamnoside) and frangulin B (= emodin 6-O--D-apioside). The fresh bark also contains anthranols and anthrones; emodin-dianthrone, palmidin C, palmidineC-monorhamnoside and emodin-diantharone monorhamnoside,  emodin-8-O-gentiobioside | laxative;  ingredient of laxative and antihaemorhoidal teas |
| ***Fructus Rhamni catharticae*** | *Rhamnus cathartica L*(common buckthorn),  *Rhamnaceae* | chrysophanol, rhamnocatharnin (glucofranguline), rhamnoxanthin (frangulin); frangula-emodin, rhamnicoside, which yields on hydrolysisrhamnicogenol (an anthraquinone derivative), glucose and xylose. Flavonoids and tannins also found | decoction is used as a mild laxative (hemorrhoids, after anal or rectal surgery); ingredient of laxative teas and herbal collections |
| ***Folia Sennae, Fructus Sennae*** | *Cassia senna*L.  *(C . acutifolia*Delile), Alexandrian or Khartoum senna,*Cassia angustifolium*Vahl, (Tinnevelly senna), *Fabaceae* | sennosides, which are glycosides of dianthrone-type aglycones, in other words sennidins. Sennosides A and B are major components. Other dimersfound infair quantities in the dried drugare sennosides C and D, which are the 8,8' diglucosides of sennidin C and D and the isomers of a heterodianthrone, namely rhein aloe-emodin dianthron | laxative; often included into laxative and antihaemorrhoidai teas and herbal collections. The therapeutic indication is the symptomatic treatment of constipation |
| ***Folia Juglandis*** | *Juglans regia L.*(walnut tree), *Juglandaceae* | naphtoquinones : juglone  (5-hydroxy-1,4-naphthoquinone), reduced derivatives (hydrojuglone); hydrolyzable tannins. The leaf also contains a small amount of essential oil, ascorbic acid, flavonoids, carotene and microelements | tincture is astrigent, anti-inflammatory and wound-healing. Walnut oil is antisclerotic |
| ***Herba Hyperici*** | *Hypericum perforatum,*(St.John’s herb), *Hypericaceae* | condensed anthraquinones (0,5%): hypericine, pseudohypericine, dianthranol-derivatives; tannins; flavonoids; resins;volatile oils | astrigent, antimicrobic, antihaemorrhage, anti-inflammatory; antidepressant |
| ***Folia Aloes arborefscentis recens*** | *Aloe arborescens*Mill., (krantz aloe), *Liliaceae* | oxymethylanthraquinone derivatives, aloe-emodin,  C-glycoside aloin (aloe-emodin anthrone + arabinose), nataloin (anthrone+arabinose); also found ferments, polysaccharides, resins, vitamins, organic acids | the fresh leaves are the source of biogenic stimulants (immunomodulating, bactericidic and anti-inflammatory activity); purgative properties |
| ***Rhizomata et radices Rubiae*** | *Rubia tinctorum L, Rubiaceae* | alizarine and its bioside ruberithrinic acid, lucedine and itsbioside lucidinprimverosine, rubiadine with rubiadinprimverosine, purpurine-3-carbonilic acid; also foundpurpurine, xanthopurpurine and methylic ester of alizarine; methylhydroxyanthraquinones | lytolitic (alizarine derivatives dissolve kidney stones), spasmolytic and diuretic |

***Senna***

**The fruits of Senna (Cassia) - Fructus Sennae (Cassiae)**

**Листья** **Leafs** **сенны ( кассии ) - Fructus Senna (Cassiae)** **of Senna (Cassia) - Folia** **Senna ( Cassiae )** **Sennae (Cassiae)**

**Кассия остролистная - Cassia acutifolia Del.** **Cassia acutifolia - Cassia acutifolia Del.**

**Кассия** **Cassia** **узколистная - Cassia angustifolia Vahl.** **angustifolia - Cassia angustifolia Vahl.**

**Семейство бобовые - Fabaceae** **Legume family - Fabaceae**

**Botanical Origin.**—(1) *Cassia acutifolia* Delile (*Cassia senna*L.). (Engl. – Alexandrian, or Khartoum Senna; ) and (2) *Cassia angustifolia*Vahl. (Engl. – Indian, or Tinnevelly Senna; Family –*Fabaceae.*

**Parts Used.**—According to the *EP,****Folia Sennae*** consists of the dried leaflets of *Cassia acutifolia*Delile, or *Cassia angustifolium*Vahl, or a mixture of the two species. ***Fructus Sennae,***or Senna Pods, representing the dried ripe fruits of the *C. acutifolia* and *C. angustifolia, Fabaceae.*

**Habitat.**—*Cassia acutifolia*is indigenous to tropical Africa and iscultivated inthe Sudan (Kordofan, Sennar). *Cassia angustifolia*is indigenous to Somaliland, Arabia, Sind and the Punjab, and is cultivated in South India (Tinnevelly).



|  |
| --- |
| **Fig.***Cassia acutifolia:*E - Leaf and fruiting branch; F - Leaflet; G - Pod. *Cassia angustifolia:*H - Leaflet; J - Pod |

|  |  |  |
| --- | --- | --- |
| **Plants.**—The senna plants are small shrubs*,*about 1 m in height, with paripinnate compound leaves. The flowers, tetracyclic, pentamerous, and zygomorph, have a quincuncial calyx, a corolla of yellow petals with brown vein, with imbricate ascendent prefloration, and with a partially staminodial androecium. The fruit is a flattened, parchment-like, dehiscent pod, with sixto eight seeds.  *Cassia acutifolia* is a low growing shrub with branched whitish stems, paripinnate, stipulate leaves with pale green leaflets, and large yellow flowers born in axillary racemes. Its fruit is a broadly elliptical, somewhat reniform, flattened, membranous legume containing 6 or 7 seeds.  *Cassia angustifolia* resembles the former species in habit, but its leaflets are yellowish-green, frequently broader, and usually more abruptly pointed; its pods are more narrowly elliptical or reniform and 8 seeded.  **MPM Description.—**According to the *EP, C.* *senna*occurs as greyish-green to brownish-green, thin, fragile leaflets, lanceolate, mucronate, asymmetrical at the base, usually 15 mm to 40 mm long and 5 mm to 13 mm wide, the maximum width being at a point slightly below the centre; the lamina is slightly undulant with both surfaces covered wine fine, short trichomes. Pinnate venation isvisible mainly on the lower surface, with lateral veins leaving the midrib at an angle of about 600  and anastomosing to form a ridge near the margin.  *C. angustifolia*occurs as yellowish-green to brownish-green leaflets, elongated and lanceolate, slightly asymmetrical at the base, usually 20 mm to 50 mm long and 7 mm to 20 mm wide at the centre. Both surfaces are smooth with a very small number of short trichomasand are frequently marked with trasverse oroblique lines.  Alexandrian senna pods occur as flattened reniform pods, green to greenish-brown with brown patches at the positions corresponding to the seeds, usually 40 mm to 50 mm long and at least 20 mm wide. At one end is a stylar point and at the other a short stalk. The pods contain six or seven flattened and obovate seeds, green to pale brown, with a continuous network of prominent ridges on the testa.  **Microscopical Characters.—**According to the *EP,*The leaf powder is light green togreen­ish-yellow. The powder shows the following diagnostic characters: polygonal epidermal cells showing paracytic stomata; unicellular trichomes, conical in shape, with warted walls, isolated or attached to fragments of epidermis; fragments of vascular bundles with a crystal sheath of pris­matic crystals of calcium oxalate; cluster crystals isolated or in  fragments of parenchyma.  Surface sections of both upper and lower epidermis exhibit polygonal epidermal cells amongst which will be noted broadly elliptical stomata, each of which has 2 unequal neighbouring cells parallel to its longer axis; occasionally a third neighbouring cell at the end of the stoma is present. Unicellular papillose, pointed, non-glandular hairs and the rounded scars of the bases of these will also be observed.  Powdered Indian Senna is dusky greenish-yellow to light olive brown. Calcium oxalate in rosette aggregates, from 9 to 20 µm in diameter, and in prisms 12 to 15 µm in length, usually in crystal fibers that adhere to groups of thick-walled sclerenchyma fibers of the pericycle; few unicellular, non-glandu­lar, straight or curved hairs or fragments thereof with thick, papillose walls; fragments of epidermis, some of which show elliptical stomata with two unequal, parallel neighbouring cells or occasionally a third neighbouring cell; spiral, annular and pitted tracheae.  Powdered Alexandria Senna is light green and differs from powdered Indian Senna mainly by showing more numerous hairs and more stomatal apparatuses accompanied by 3 neighbouring cells.           Transverse sections made through thelamina of an Indian Senna leafletoutside of themidrib show the following structural peculiarities:  1. *Upper epidermis* with prominent cuticle possessing broadly elliptical stomata that are sunken below its surface level, and relatively few non-glan­dular, 1-celled, conical, often curved, appressed hairs with papillose walls.  2. *Palisade parenchyma*of a single layer of elongated, narrow, columnar cells containing chloroplastids.  3. *Spongy parenchyma* consisting of rather loosely arranged, rounded cells, some of which contain rosette aggregates or 4- to 6-sided prisms of calcium oxalate, others, chloroplastids. Through this region course the bundles of the smaller veins.  4. *Palisade parenchyma* of a single layer of columnar cells which differ from the upper palisade layer in being shorter and wavy-walled.  5. *Lower epidermis* with prominent cuticle and possessing sunken stomata. Both epidermises show a few outgrowths in the form of one-celled, papillose, straight to slightly curved, non-glandular hairs from 100 to 350 µ in length. Each of these, when observed, has its base wedged between adjacent epidermal cells.  Fragments of Senna show a red coloration when mounted in alkaline solutions.   |  | | --- | | **Fig.** Powdered Alexandrian Senna  *cr.* - Monoclinic prisms of calcium oxalate; *ep2 -* fragments of both epidermises showing stomatal apparatuses with 2 and 3 neigh­bour cells, *h -* unicellular, papil­lose, non-glandular hairs; *cr.fb -* crystal fibers, those on the light adherent to vein *bundle; fb -* portions of pericyclic fibers; *mes -* mesophyll parenchyma contain­ing rosette aggregates of calcium oxalate. *(Drawing by Izso)* | | **Constituents.—**The major components of the dried drug are sennosides, which are glycosides of dianthrone-type aglycones, in other words sennidins. Sennosides A and B are the 8,8'-diglucosides of a symmetrical homodianthropic aglycone, dirhein anthrone, its threo isomers are optically active. (+)-sennidin A and (-)-sennidin Al (= sennidin G); in the erythro series, a plane of symmetry reduces the possibilities to only one meso, optically inactive derivative (sennidin B). Other dimersfound infair quantities inthe dried drugare sennosides C and D, which are the 8,8' - diglucosides of sennidin C and D and the isomers of a heterodianthrone, namely rhein aloe-emodin dianthron.    The dried drug also contains traces of free anthraquinones (< 0.1%), and a small amount of anthraquinone glycosides (aloe-emodin and rhein mono- and diglucosides) and monomeric anthrone glycosides (rhein-anthrone and aloe-emodin-anthrone glucosides). The average levelof the various drugs inhydroxyanthraquinone derivatives ranges from 2 to 5%. In the fruits, they are concentrated to the pericarps.  The dianthrone derivatives do not exist in fresh senna, which mainly contains the 8-glucosides of rhein-anthrone and of aloe-emodin anthrone. It is during the drying process,around 40°C, that the anthrone glycosides are dimerized by an enzymatic process. If drying is conducted at higher temperature, the glycosidic linkage is cleaved, and the anthrones are immediately oxidised to anthraquinones.  Senna also contains the yellow flavanol colouring matters kaempferol, its glucoside (kaempferin) and isorhamnetin; also a sterol, resins, that cause stomach ache.  According to the *EP,* Senna leaf contains not less than 2.5 per cent of hydroxyanthracene glycosides, calculated as sennoside B with reference to the dried drug*.* Alexandrian senna pods consist of the dried fruit of *Cassia senna* L *(C. acutifolia* Delile). They contain not less than 3.4 per cent of hydroxyanthracene glycosides, calculated as sennoside B with reference to the dried drug.  **Pharmacological Action. Uses.—**Senna and its preparations (senna leaf extract in tablets, *Senadexinum, Senade, Glaxena, Kaphyolum. Regulaxum)* are used as laxatives. MPM is often included into laxative and antihaemorrhoidai teas and herbal collections. The therapeutic indication is the symptomatic treatment of constipation. | |