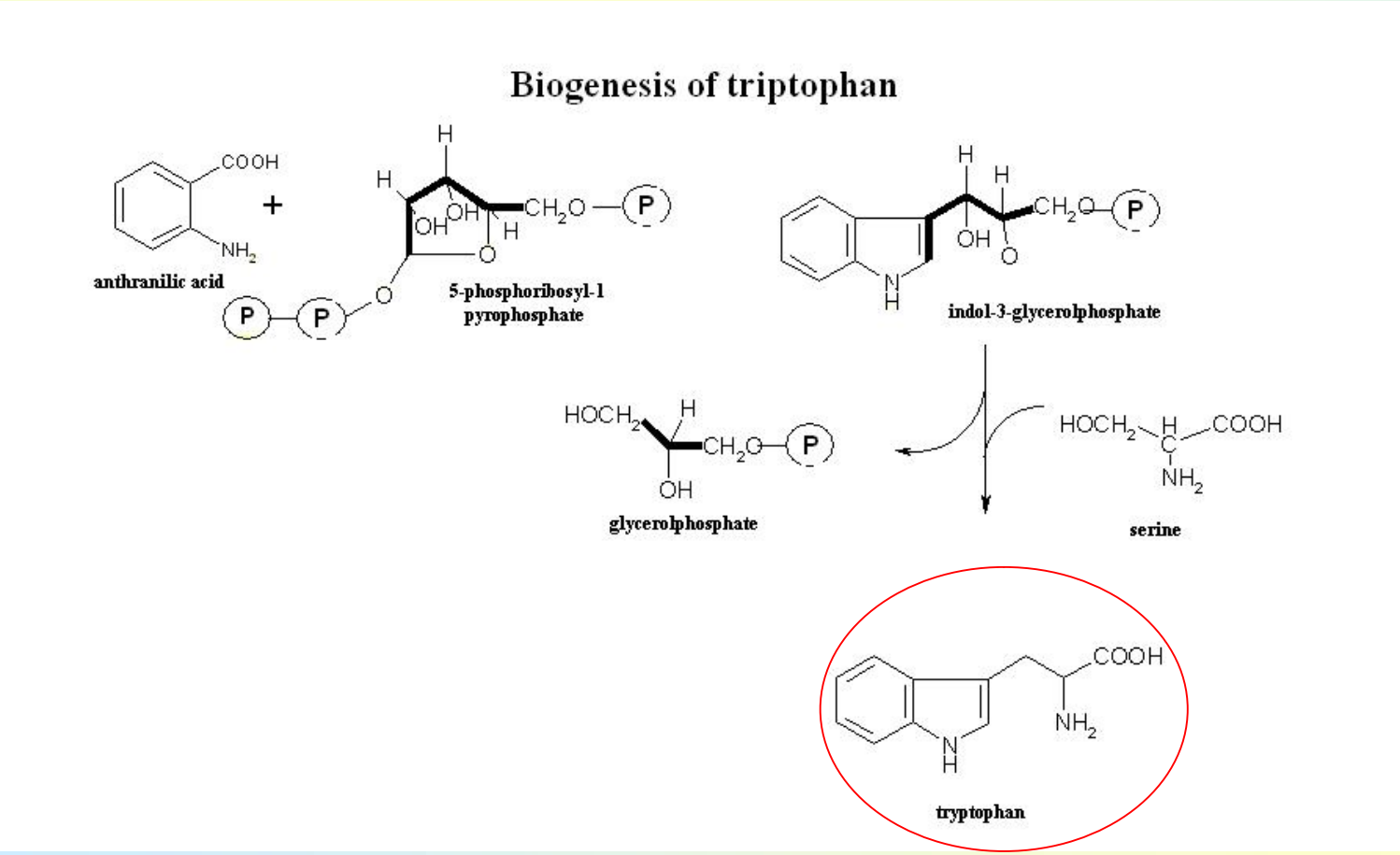
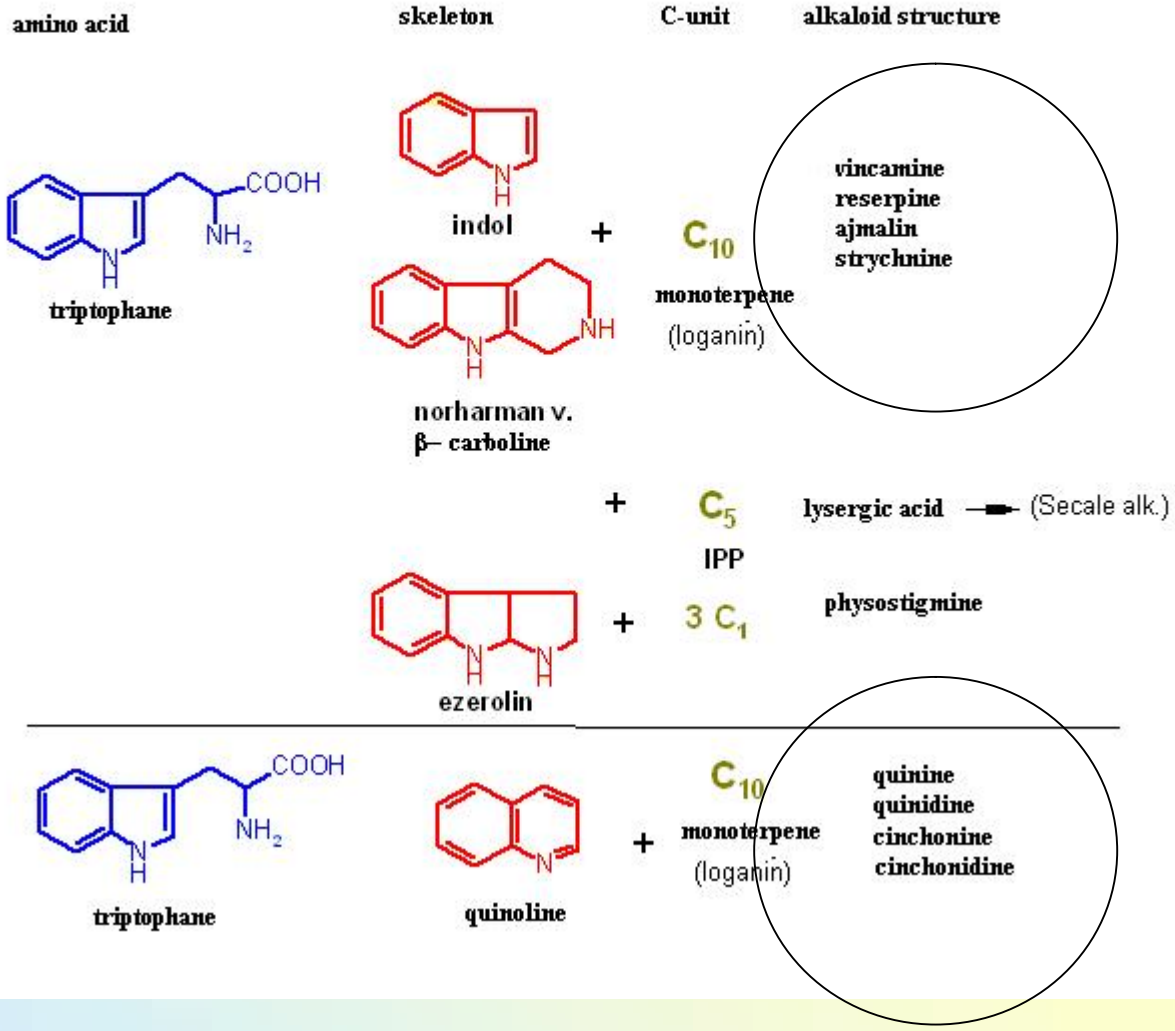
# Alkaloids

# Alkaloids derived from anthranilic acid

**Anthranilic acid is found to be a key intermediate in the biosynthesis of L-tryptophan. Therefore, it has been established that this biotransformation is solely responsible to the elaboration of the indole alkaloids.**



# Indol and quinoline alkaloids derived from triptophane

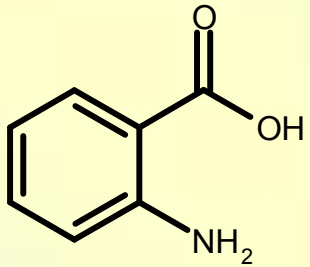


# Alkaloids derived from anthranilic acid

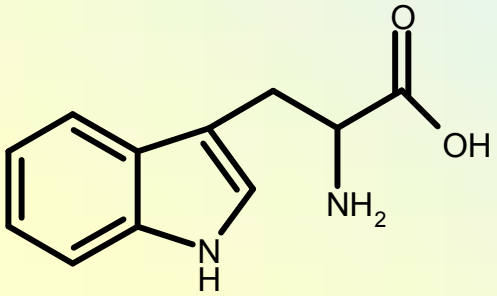
**A number of these alkaloids, mostly found in the Rutaceae and the citrus family.**

**The alkaloids derived from anthranilic acid may be classified into three major categories, namely:**

1. **Quinazoline alkaloids**
2. **Quinoline alkaloids**
3. **Acridine alkaloids**



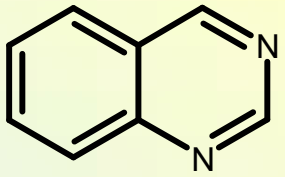
anthranilic acid



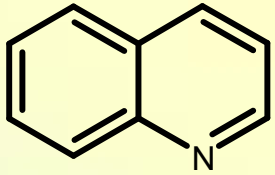
L-tryptophan

**Other alkaloids**

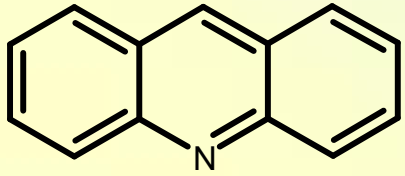
- **Pyrroloquinazolines**
- **Quinazolinocarbolines**
- **Furanoquinolines**
- **Acridone alkaloids**
- **Anthranilic acid proto-alkaloids (e.g. damascenin)**



quinazoline

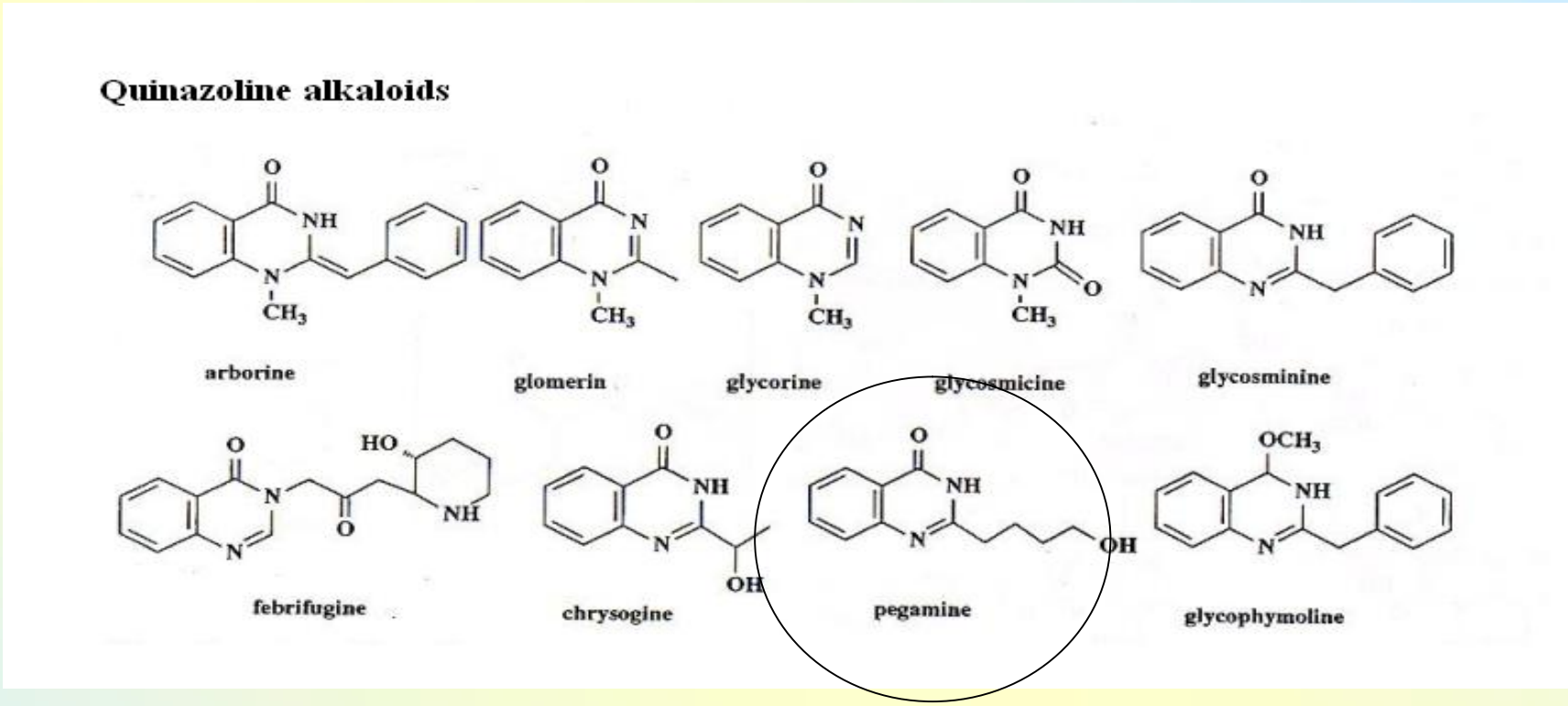


quinoline



acridine

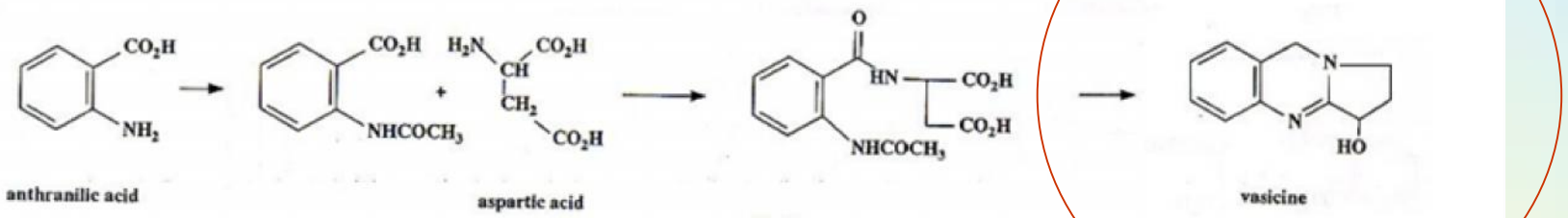
# Quinazoline alkaloids

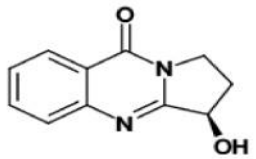



**The antibacterial activity of different parts of *Peganum harmala*, including seed, root, flower, leaf and stem has been investigated and compared. Among the evaluated different parts of P. harmala, the seed and root extracts showed the best antibacterial activity against Gram positive bacterial species, including *Bacillus anthracis, Bacillus cereus, Bacillus pumilus, Staphylococcus aureus, Staphylococcus epidermidis, Listeria monocytogenes* and *Streptococcus pyogenes* and Gram negative bacterial species, including *Pseudomonas aeruginosa, Brucella melitensis, Proteus mirabilis, Salmonella typhi, Escherichia coli* and *Klebsiella pneumonia* (Darabpour et al., 2011.)**

# Other alkaloids derived from anthranilic acid

**Pyrroloquinazoline alkaloids**



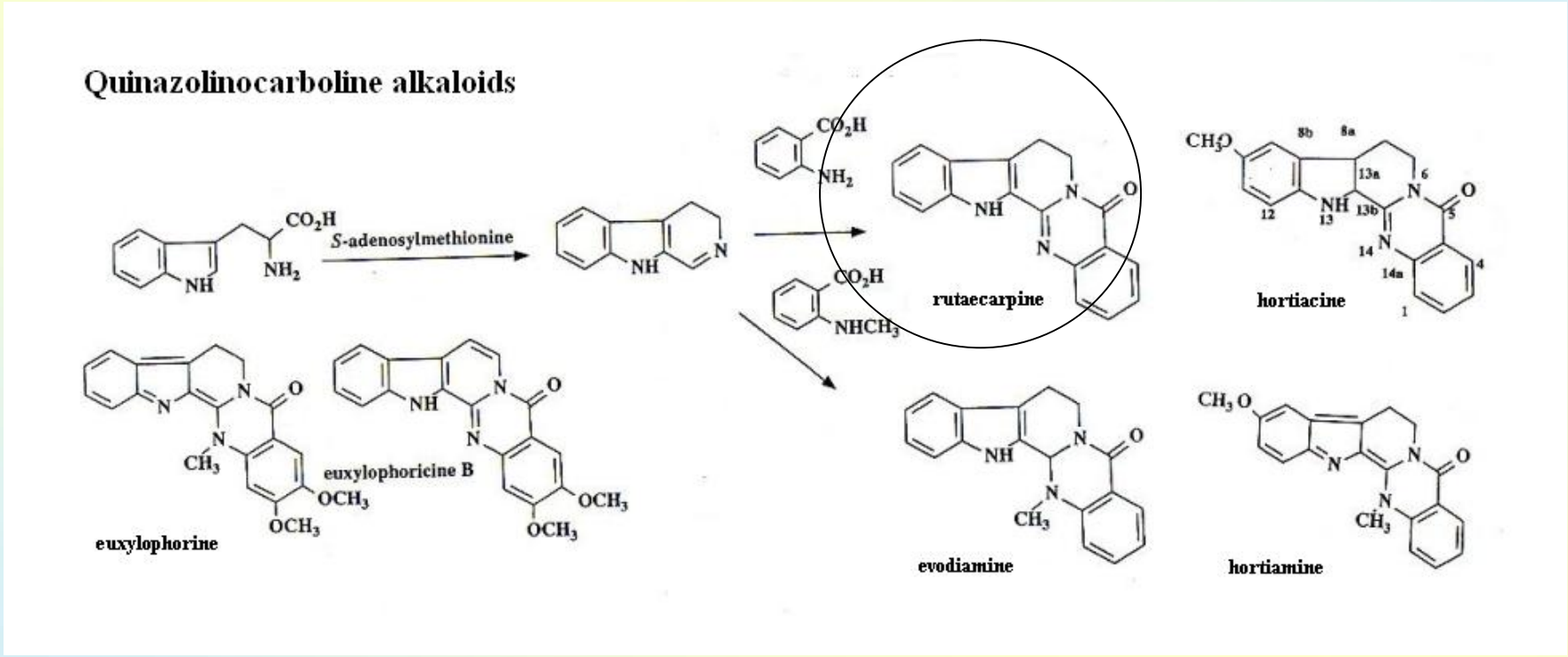




vasicione

## Vasicine

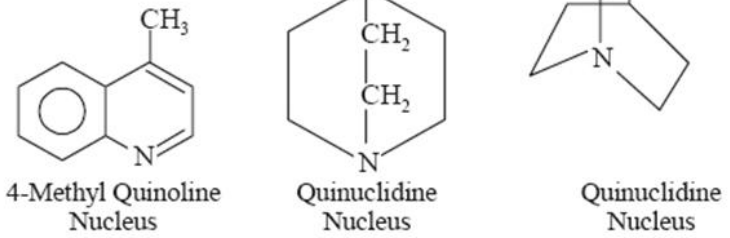
**It is mostly used as an expectorant and bronchodilator.**
**Vasicine also shows abortifacient action which is due to the release of prostaglandins.**

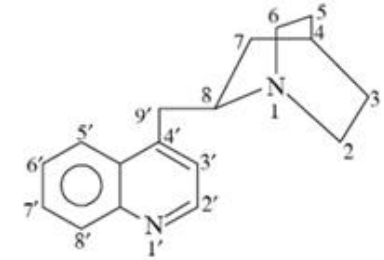
# Other alkaloids derived from anthranilic acid

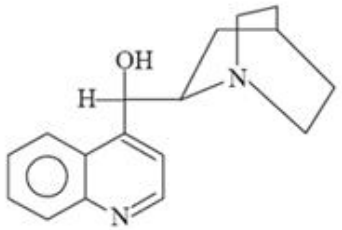


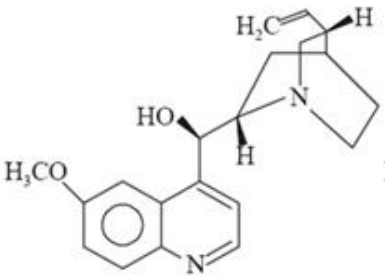

**How does rutaecarpine? - Selective COX2 inhibitor.**

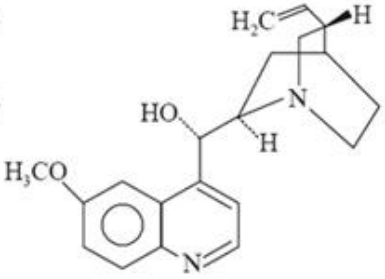
# Quinoline alkaloids

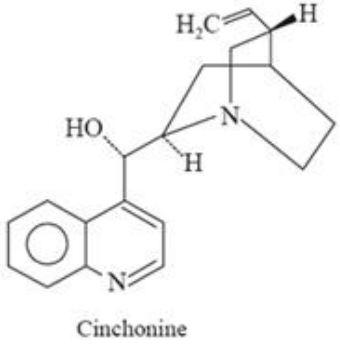


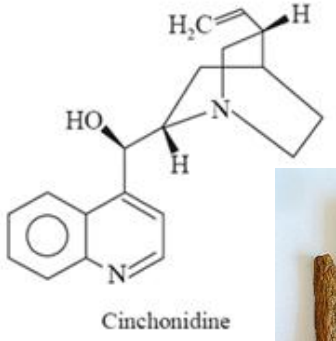




**In general, the alkaloids containing essentially the 'quinoline' nucleus include a series of alkaloids obtained exclusively from the Cinchona bark, the major members of this particular group are, namely: quinine, quinidine, cinchonine and cinchonidine.**

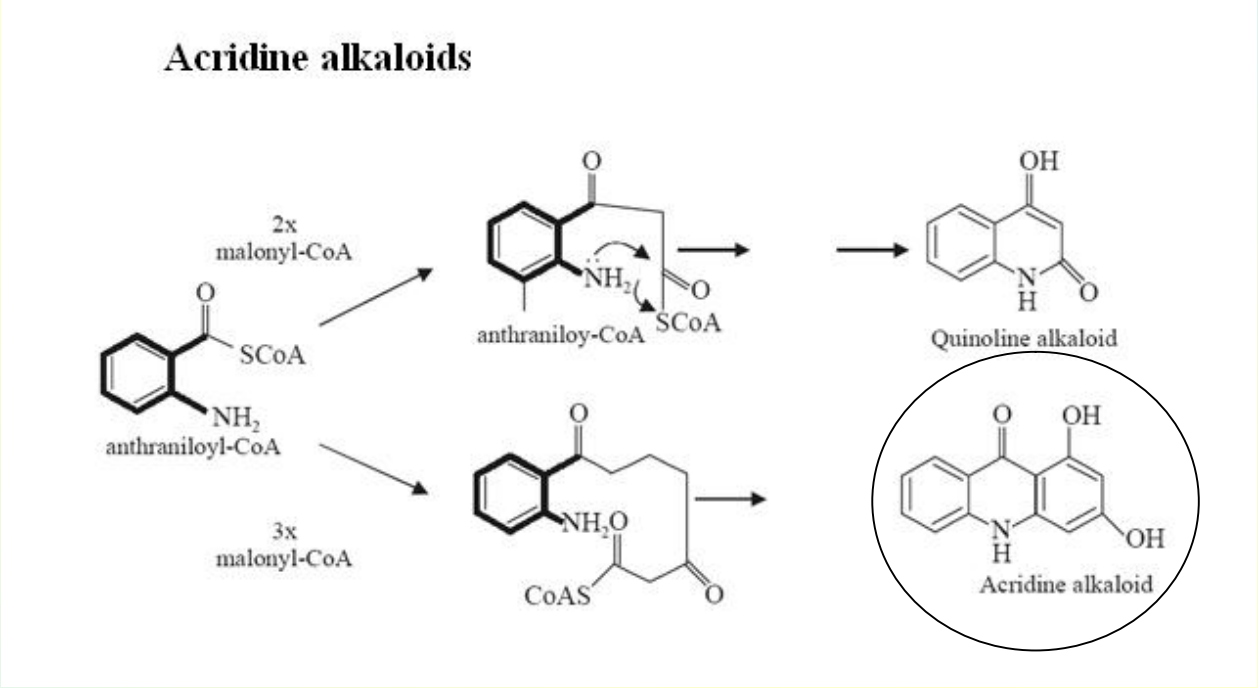
**Uses**

**1. It is used as a flavour in carbonated beverages.**

**2. It is widely used as an antimalarial agent in tropical countries.**

**3. It is employed as a skeletal muscle relaxant.**

# Acridine alkaloids

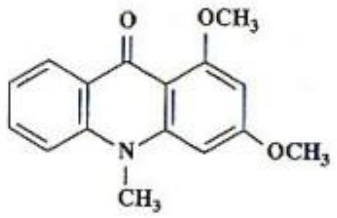



## Uses

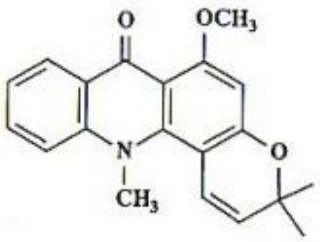
1. In Chinese medicine rue is considered as an emmenagogue, intestinal antispasmodic, sedative, uterine stimulant, vermifuge, rheumatism, cold and fever.
2. In Poland, it is used as an aphrodisiac and choleretic.
3. The herb is used medicinally as a bitters, an aromatic stimulant, ecbolic and in suppression of the menses.

# Other alkaloids derived from anthranilic acid

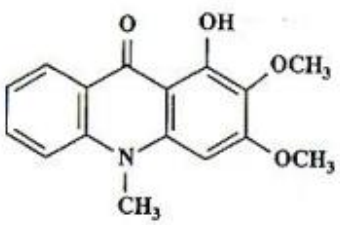
**Acridone alkaloids**



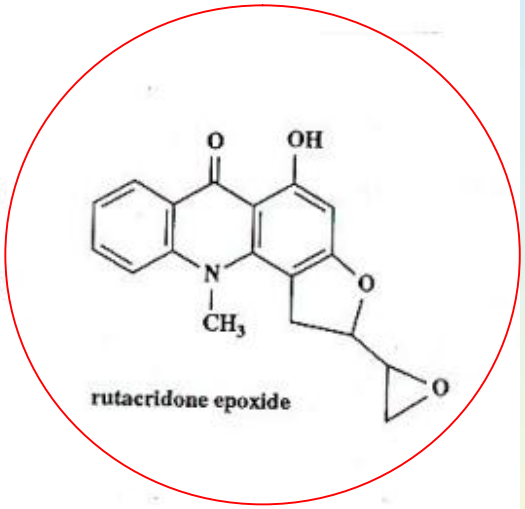

1,3-dimethoxy-*N*-methylacridone




acronycine




arborinine

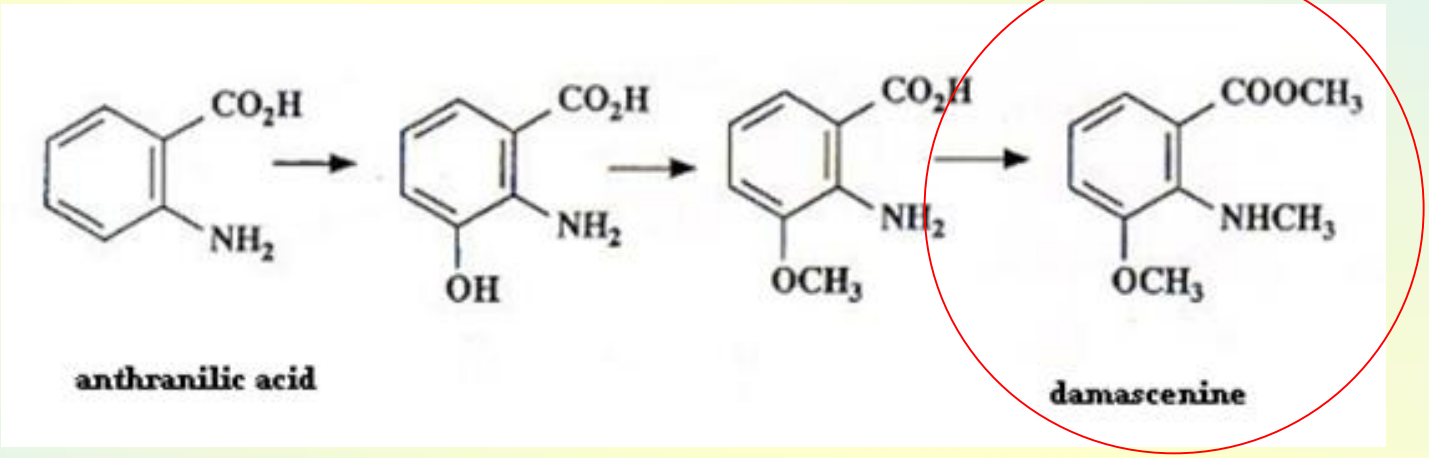



rutacridone epoxide

**In *Ruta graveolens* L.: Rutacridone epoxide was found to be a direct acting mutagen in *Salmonella typhimurium strains* (TA98, TA100 and TA1538). Evidence is presented that rutacridone is metabolized by rat liver enzymes to the corresponding epoxide as the ultimate mutagen.**

## Other alkaloids derived from anthranilic acid

**protoalkaloid**




**Active substances of *Nigella sativa* are anthranilic derivatives damascenin, metildamascenin, nigellin, damascinin, fatty oils, low saponin.**

**Application: in case of gastro-enteritis, carminativum, diureticum, galactogogum.**

**Pepper-like spice.**
**Homeopathy**

## Plants with anthranilic acid derived alkaloids

***Peganum harmala*, Zygophyllaceae, drugs are the flower and fruit**

***Skimmia japonica*, Rutaceae, drug is the fruit**

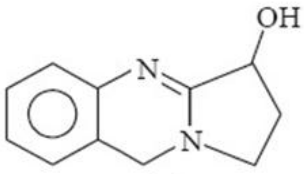
***Ptelea trifoliata*, wafer ash, Rutaceae, branch with fruit**

***Nigella damascena*, Ranunculaceae, drug is the flower**

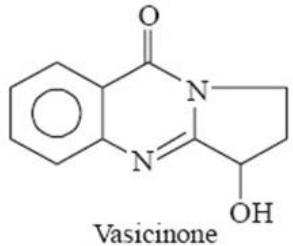
## *Peganum harmala*
## *Zygophyllaceae*

***Peganum harmala*** **is of Asian Origin, commonly called e.g. esfand, wild rue, Syrian rue.**

**The plant has remained a popular tool in both folk medicine and spiritual practices for so long that some historians believe the plant may be the ancient „soma" - a Vedic ritual drink - a medicinal aid that is mentioned in a variety of ancient Indo Iranian texts.**



Vasicine



Vasicinone

**It is a perennial plant which can grow to about 0.8 m tall, but normally it is about 0.3 m tall. The roots of the plant can reach a depth of up to 6.1 m, if the soil where it is growing is very dry. It blossoms between June and August in the Northen Hemisphere. The flowers are white and are about 2.5–3.8 cm in diameter. The round seed capsules measure about 1–1.5 cm in diameter, have three chambers and carry more than 50 seeds.**
**It has spread invasively to America. "**


*Peganum harmala* fruit

*Peganum harmala* branch with fruit have been used to treat pain and to treat skin inflammations, including skin and other cancers.

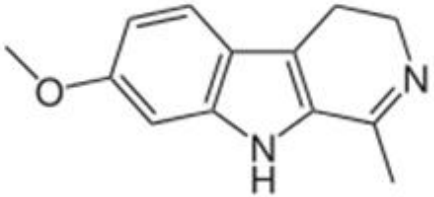
*Peganum harmala* has been used as an emmenagogue and abortifacient agent. The "root is applied to kill lice" inhibit the reproduction of the *Tribolium castaneum* beetle.

*Tribolium castaneum*

It is also used as an anthelmintic. In large quantities, it can reduce spermatogenesis and male fertility in rats.

For sale at a market in Kazakhstan

Some alkaloids of harmal seeds are monoamine oxidase A inhibitors, e.g. harmaline.

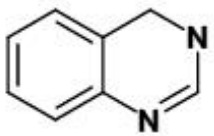



Harmaline

luminescence

It is the "Turkey red„ - from the seeds is often used in western Asia to dye carpets and wool.

The stems, roots and seeds can be used to make inks, stains and tattoos.



quinazoline

*Peganum harmala*
*Zygophyllaceae*

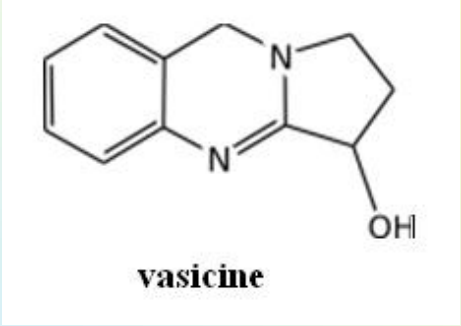
## Vasicine (peganine!)

**It also shows oxytocic properties very similar to those exhibited by oxytocin and methyl ergometrine.**
**Vasicine also shows abortifacient action which is due to the release of prostaglandins.**

## Vasicinone

**It is used mainly as an expectorant which action is solely due to stimulation of the bronchial glands.**

## Pyrroloquinazoline alkaloids

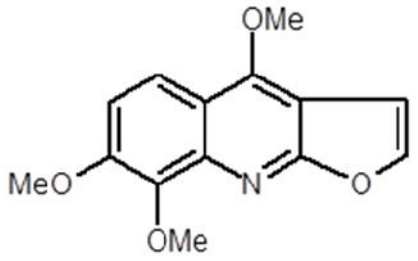


vasicine

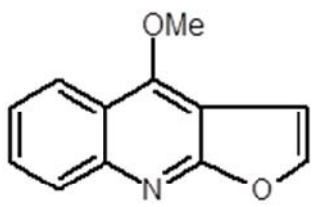
vasicinone

*Skimmia japonica*
**Rutaceae**

**Skimmia japonica, the Japanese skimmia, is a species of flowering plant in the family Rutaceae, native to Japan, China and south east Asia.**
**Growing to 6 m tall and wide, it is a rounded evergreen shrub with glossy, leathery leaves widely cultivated as an ornamental plant in gardens and parks.**
**Its fragrant flowers can be cream-yellow to white, followed on female plants by small round, red fruits.**
**Its characteristic alkaloids are skimmianine and dictamnine furanoquinolines.**




**skimmianine**




**dictamnine**

**Some furoquinoline alkaloids have been found to have in vivo pharmacological properties such as antimicrobial, antiviral, mutagenic and cytotoxic activities.**

**Dictamnine has the property of causing smooth muscle contraction.**
**Skimmianine shows acetylcholinesterase inhibition.**

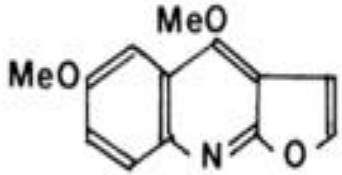
## *Ptelea trifoliata*
## Rutaceae

***Ptelea trifoliata*** **(branch with fruit), the common hoptree, native to North and Central America (Mississippi River Valley). It is a deciduous shrub or tree, growing to 6-8 m tall by 4 m wide.**

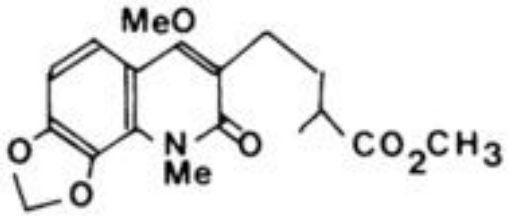
**The plant has thick fleshy roots, flourishes in rich, rather moist soil. Its juices are acrid and bitter and the bark possesses tonic properties.**

**Important alkaloids from *Ptelea trifoliata***

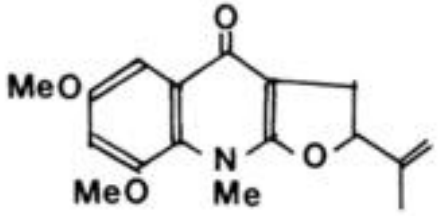
**pteleine, simple furoquinoline base**



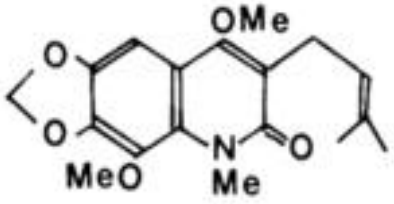

**pteleoline, quinolone alkaloid**




**ptelefoline, fluroquinolone alkaloid**




**ptelecortin, quinoline alkaloid**



**Nigella damascena** is an annual garden flowering plant, belonging to the buttercup family **Ranunculaceae.**

**Nigella damascena** is an easily grown plant and widely cultivated throughout the temperate world, and numerous cultivars have been developed for garden use.

It is native to southern Europe, north Africa and southwest Asia, where it is found on neglected, damp patches of land.

It grows to **20–50 cm tall**, **with pinnately divided, thread-like, alternate leaves.**

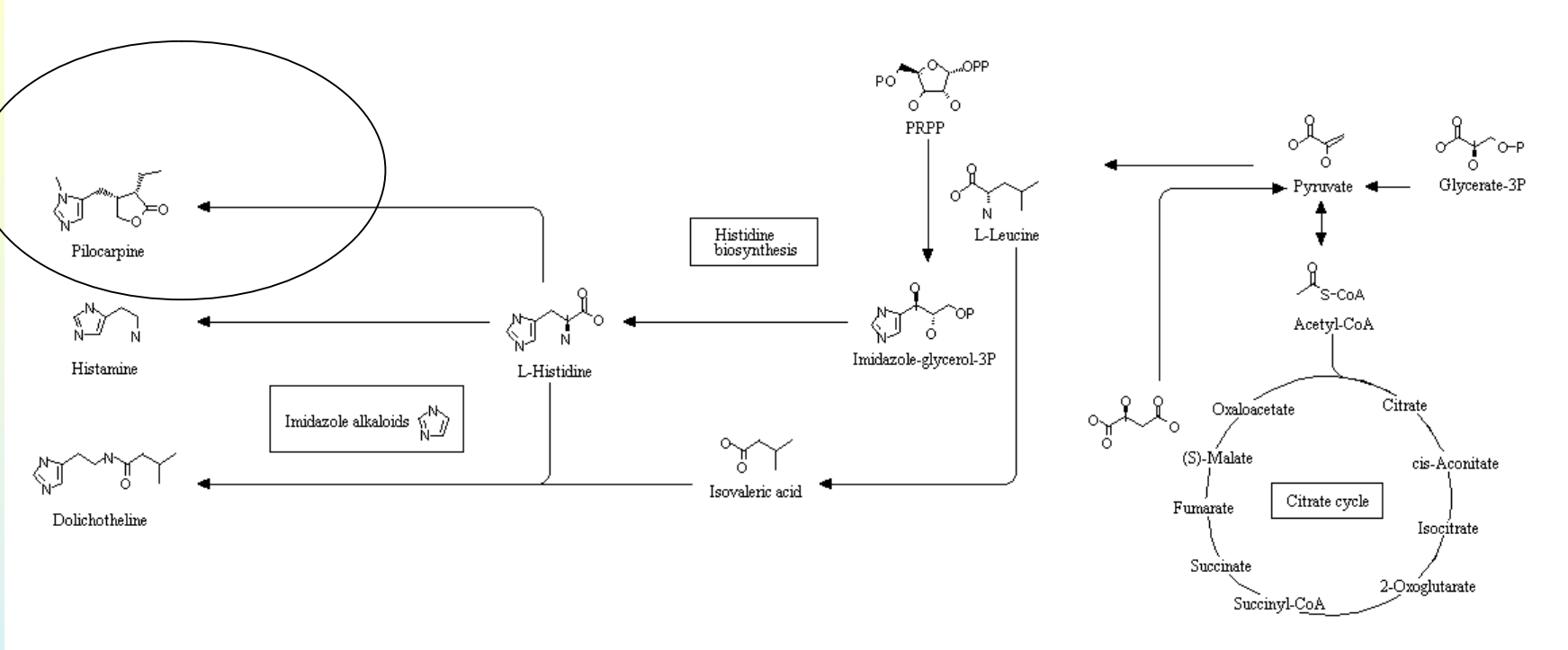
The flowers, blooming in early summer, are most commonly different shades of blue, but can be white, pink, or pale purple, **with 5 to 25 sepals.**

The **fruit is a large** and **inflated capsule**, growing from a **compound ovary**, and is composed of several **united follicles, each containing numerous seeds.**

## *Nigella damascena*
## Ranunculaceae
## flower

**Its characteristic alkaloid is damascenin - as a panaceae.**

# Alkaloids derived from histidine

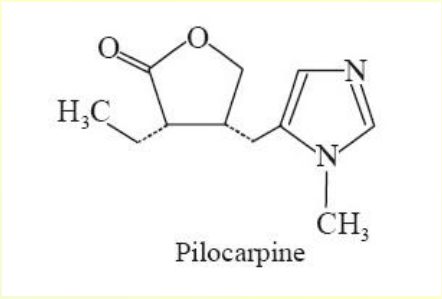



**The amino acid L-histidine containing the heterocyclic imidazole ring, is considered to be the right precursor of alkaloids that essentially comprise of this ring-system.**

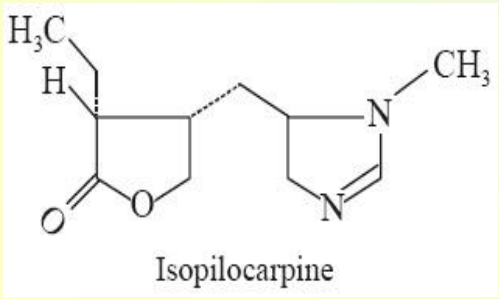
## *Pilocarpus jaborandi*
## Rutaceae

***Pilocarpus species*, belonging to family *Rutaceae*, found to contain a lot of alkaloids with an *imidazole ring*, namely: pilocarpine, isopilocarpine, and pilosene.**

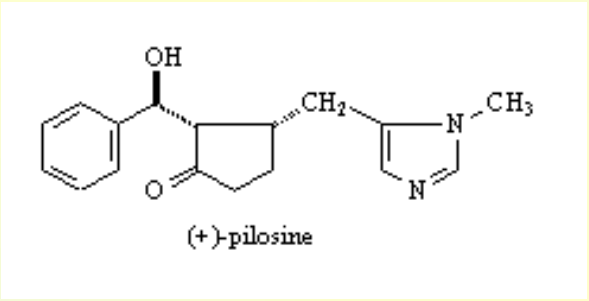
**Alkaloids are located mostly in the upper epidermal part of the leaves.**



Pilocarpine



Isopilocarpine



(+)-pilosine

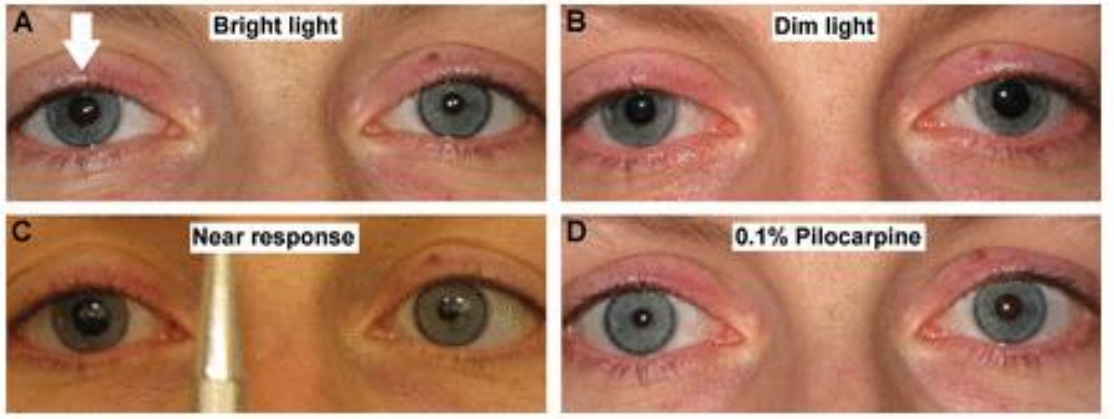
**It has been observed that the alkaloids in these species invariably reside in the leaves.**
**Pilocarpine constitutes 0.5-1.0% of the dried leaf material.**
**Isopilocarpine appears to vary significantly within a range from 5 to 7.5% of the total alkaloids.**

glaucoma

## Therapy with pilocarpine

**When photophobia from a dilated pupil is a problem, topical dilute pilocarpine (0.1%) may be helpful.**






**In glaucoma therapy pilocarpine can be used.**

**Glaucoma is the condition in which pressure builds up inside the eye. It often affects only one eye. Warning signs are blurred vision or haloes around lights, particularly at night. Untreated condition may cause blindness.**

**Together with pilocarpine treatment, the drug acetazolamide may be used to reduce the formation of aqueous humour, the fluid inside the eye, reduce the intra-ocular pressure in glaucoma patients.**

**Pilocarpine possesses miotic and diaphoretic actions.**

**Pilocarpine nitrate is used extensively as an ophthalmic drug having cholinergic action.**

# Terpene derived pseudoalkaloids

**Compounds not derived from amino acids, the amino acid's N-atom is a new part of a heterocycle.**

**The species are taxonomically diverse and differ from each other considerably.**

# Pseudoalkaloids

**diterpene alkaloids:** *Aconitum species*

*Taxus species*

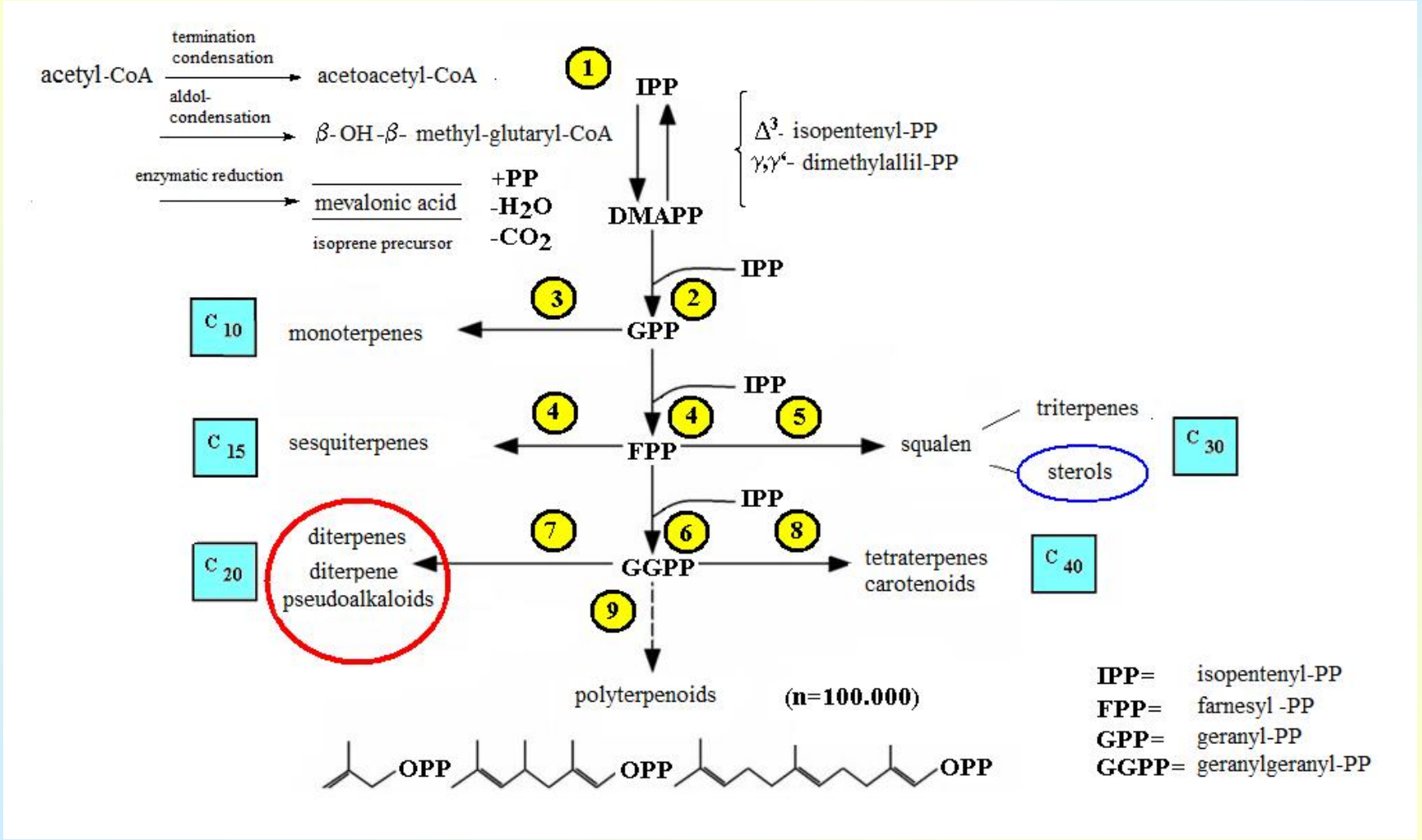
**steroid alkaloids :** *Solanum species*

**C-nor-D-homosteroid-alkaloids:**

*Veratrum species*

*Sabadille species*

# Biosynthesis of terpenoids



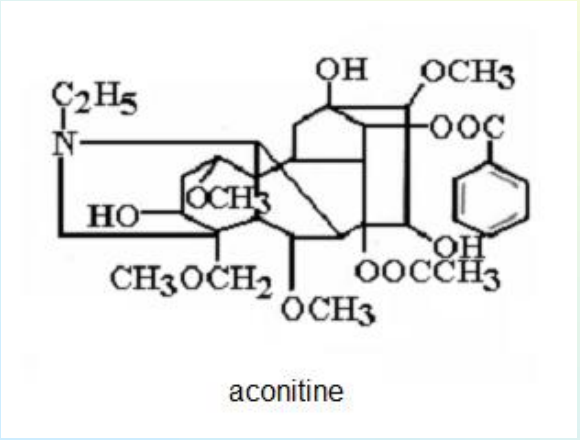

subalpine flower

# *Aconitum napellus* L.

## Ranunculaceae

## Aconiti tuber

## monkshood




aconitine

**The *Aconitum napellus* is native perennial plant in Southern Europe and Asia's high mountains. It is grown in the US and Canada as an ornamental plant.**

**The plant is 0.5-1.5 m high. Its dark green leaves are digitate. Its flowers are blue raceme. The plant has two tubers. The drug is the tuber, which is dark brown across the top and along the length is wrinkles.**

## Content

**0.2-3% diterpenoid alkaloids**

**the principal alkaloid: aconitine (diester)**

**hypaconitine**

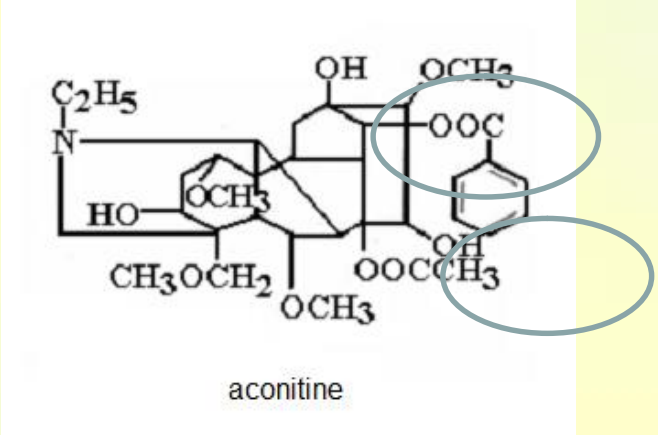
**mezaconite**

**neopelline**

**napelline**

**neoline**

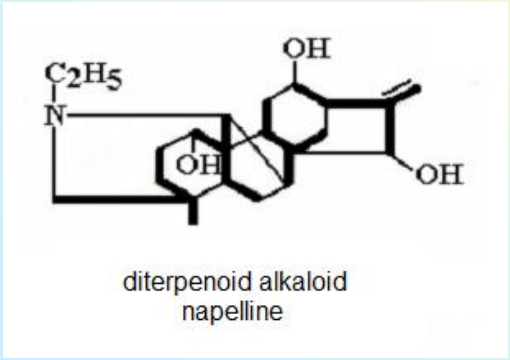
**sembusin A**



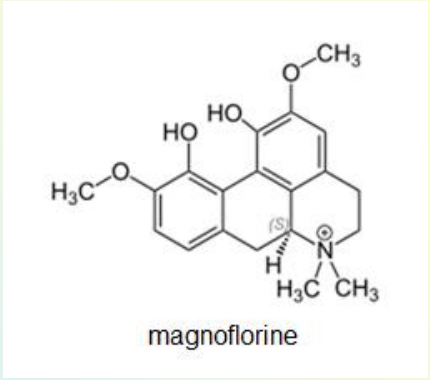
aconitine

**phenylalanine alkaloid magnoflorine**

**inosite, sugars, resin, plant acids.**



diterpenoid alkaloid
napelline



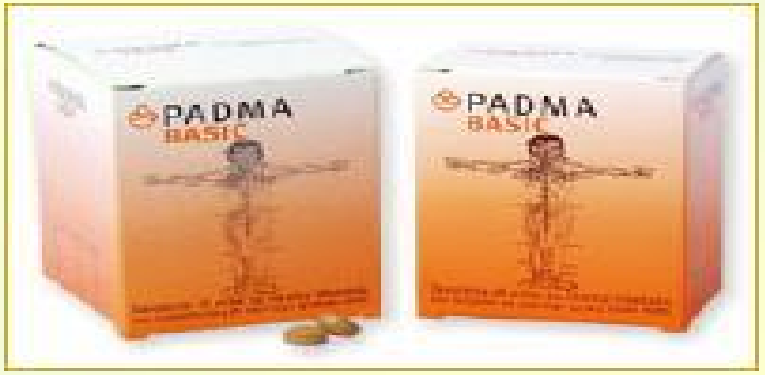
magnoflorine

## Aconiti tuber

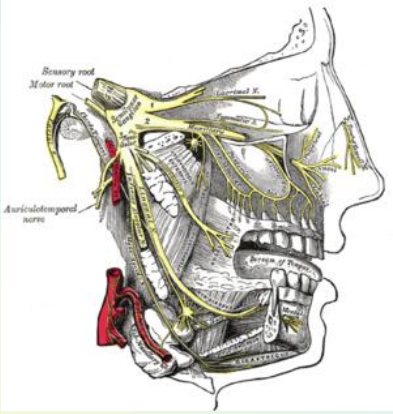
**Lethal dose of aconitine in mice: $LD_{50}$: 0.12 mg/kg**

**In adults 1-2 g bulb causes fatal poisoning.**

## Product



# Aconiti tuber



**Therapeutic uses:** **in chronic arthritis**

**in intercostal and trigeminal neuralgia**

**Poisoning**

**The aconitine is very strong poison. Lethal dose is 1.5-1.6 mg in humans. The drug itself is not being used because of the risk of poisoning.**

**Smaller doses of aconitine cause bradycardia, hypotension, respiratory paralysis, later cardiac arrest.**

**Aconite has long been used in traditional Chinese medicine and Ayurveda (Hindu traditional medicine). Aconite was also described in Greek and Roman medicine by Theophrastus, Dioscorides.**

**Nowadays the Chinese and Ayurvedic medicine like to use the aconite preparations, which can be toxic.**

**Some honeys contain pollen-aconiti and aconitine can be detected.**

## Symptoms:

**Toxic effect occurs during 10-20 minutes.**

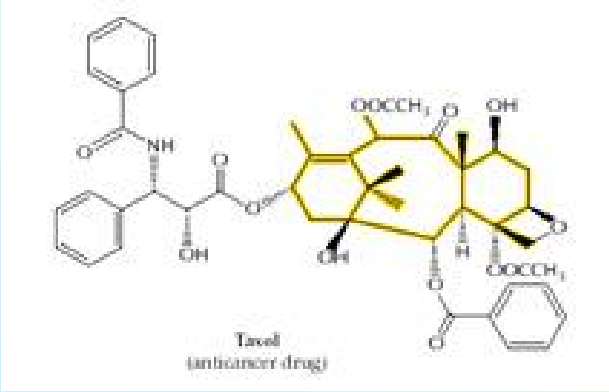
**Burning feeling in the mouth, tingling in the limb fingers, which spreads to the entire body. Insensitivity occurs againts pain. Body temperature diminishes and shivering occurs.**

**Nausea, vomiting, diarrhea, and high urination frequency are characteristic. Tachycardia arrhythmia, impaired vision will be. After six hours cardiac and respiratory arrest can be observed.**

**Treatment of poisoning is mainly supportive. All patients require close monitoring of blood pressure and cardiac rhyrthm. Gastrointestinal decontamination with activated charcoal can be used if given within one hour of ingestion.**

**Evergreen dioecious, strongly branched tree.**

## *Taxus baccata* L.
## Taxaceae
## Taxi bracteae folium




**The tree is spread in Western Europe's parks, gardens.**
**approx. 15 m tall coniferous trees.**
**pine-neddle: 2 mm wide, 35 mm long**
**color: shiny, dark green**
**flip side: light green, matt (stomata)**
**seeds: dark brown, juicy, sweet taste and slimy**
**the seeds are surrounded with scarlet aril**

# Taxus baccata L.
# (Taxaceae)
# "Tree of Death"

***Taxus baccata*** **is a conifer native to western, central and southern Europe, northwest Africa, northern Iran and southwest Asia.**

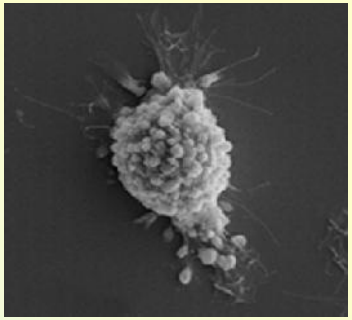
**It is the tree originally known as yew.**

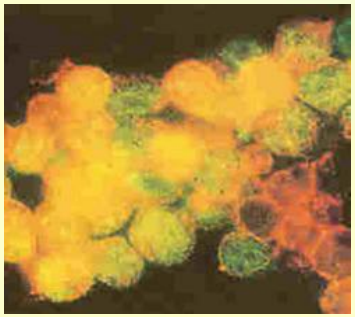
**All parts of a yew plant are toxic to humans with the exception of the yew red arillus.**

**Taxanes are widely used as chemotherapy agents.**

**Taxol and semisynthetic Taxotere have anticancerous properties:**

1. **kill the cancerous cells**
2. **inhibit the cell proliferation**





# Taxus baccata L.
# (Taxaceae)
# yew

**Toxic molecules can be found in the seeds and leaves.**

**molecules of the yew:**

**Diterpenes (= ester alkaloids) with N atom:**

**taxin A, taxin B, taxol A, taxol B**

**biflavonoids:**

**sciadopitizin, ginkgetin, sekojaflavon**

**other phenols:**

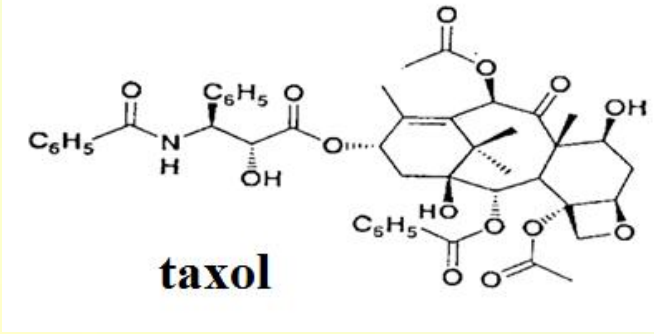
**catechin, betuloside, taxikatin**

**sterane-type compounds:**

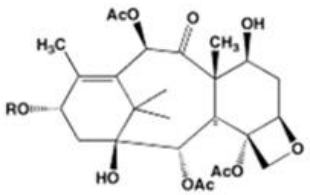
**ecdysteron**

**Cyanogen glycosides**

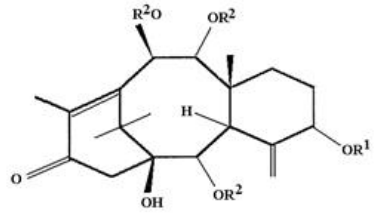
**(Polysaccharides, lipids, sterols)**




**taxol**




**taxane**




**taxin B**

## Products and applying

## Taxus baccata L. (Taxaceae)

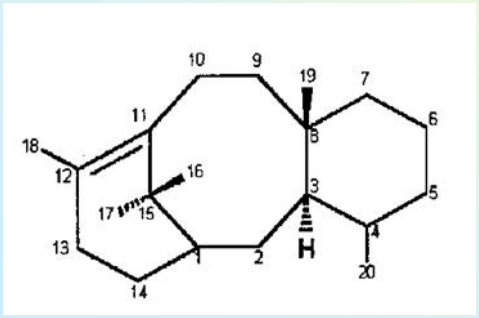
**50-100 g pine-neddle are lethal dose for an adult.**

**Taxanes accelerate the assembly of microtubules from tubulin dimers. These are microtubule stabilizers. The fixed structure does not allow dynamic microtubule remodeling required for the proliferation process.**

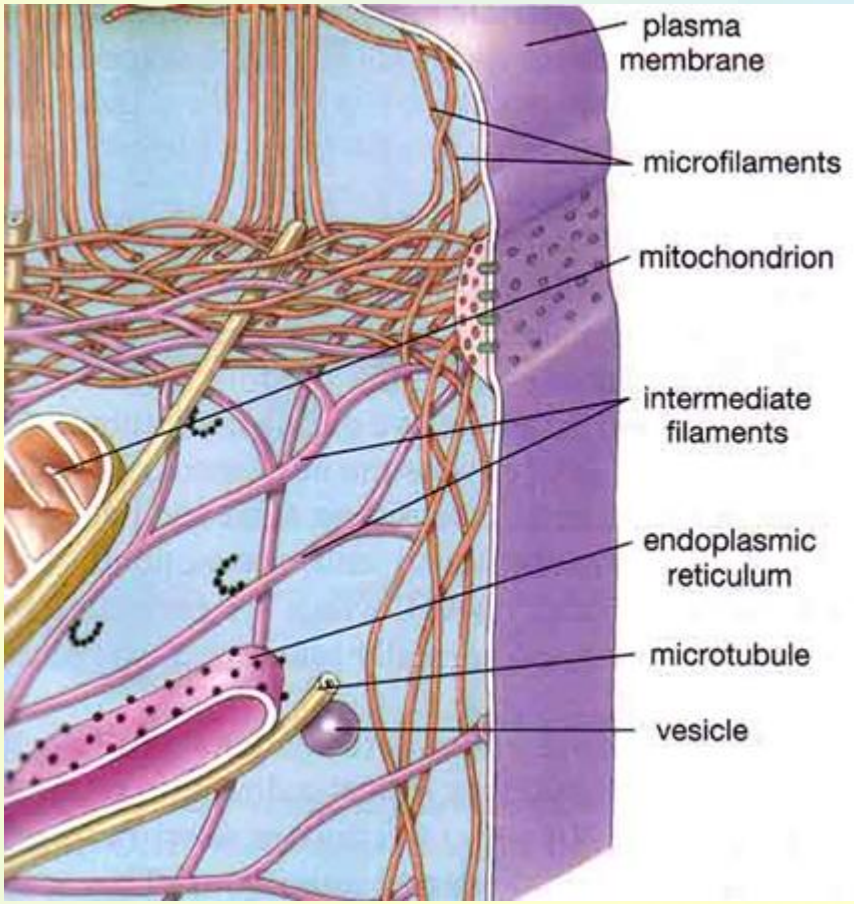
**Antihistamine pretreatment and steroid therapy are necessary before taxane treatment in ovarian carcinoma!**

**Taxotere (docetaxel) is applied in mamma carcinoma.**

**Taxotere is prepared from the baccatin III (by semi-synthetic mode)**



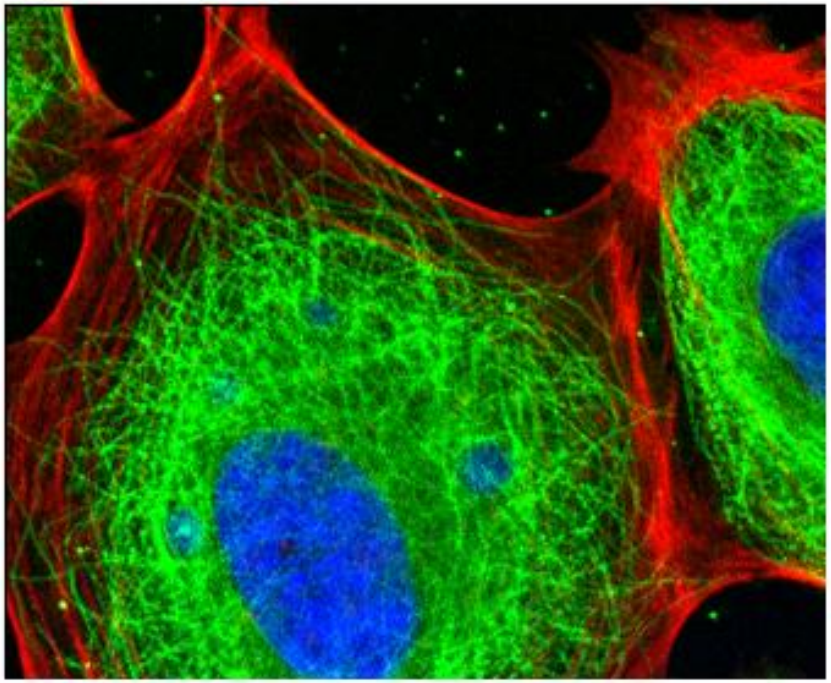

**baccatin III**



- Cytoskeleton is involved in many cell signalling pathways,
- in the uptake of extracellular material (endocytosis),
- segregates chromosomes during cellular division,
- is involved in cytokinesis (the division of a mother cell into two daughter cells),
- provides a scaffold to organize the contents of the cell in space and for intracellular transport (for example, the movement of vesicles and organelles within the cell);
- and can be a template for the construction of a cell wall.

Intermediate filaments are responsible for the three-dimensional structure.

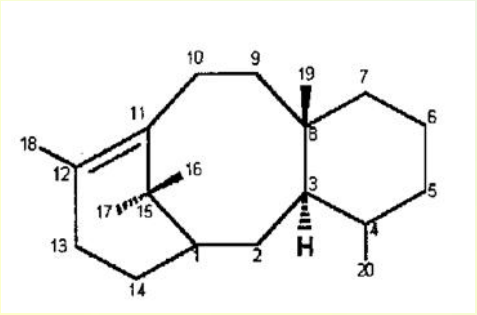
In addition, they are also involved in the formation of junction.



## Taxus baccata L.
## (Taxaceae)

**The drug is used in folk medicine as:**

**anthelmintic**
**expectoration,**
**epilepsy,**
**againts menstruation pain**
**against diphtheria,**
**tonsillitis,**
**wound healing (externally)**




**baccatin III.**

**Seeds of *Taxus baccata***

**India is used as a control of fertility.**
**Direct use is dangerous!**
**The LD50 of taxine B 4.5 mg/kg iv. in rats.**

## Symptoms of poisoning of Taxus-toxine:

**The Taxaceae extracts stimulate the smooth muscle and striated muscle.**
**Its effect causes paralysis of cadiac muscle.**
**The compound irritates the respiratory center, and late paralyzes.**
**The compounds are strongly irritate the gastro-intestinal mucosa, kidney and uterus.**
**The cause of death is cardio-respiratory arrest.**
**The pupils dilate during the poisoning.**

**Activated charcoal may be detoxified successfully several hours after the poisoning!**

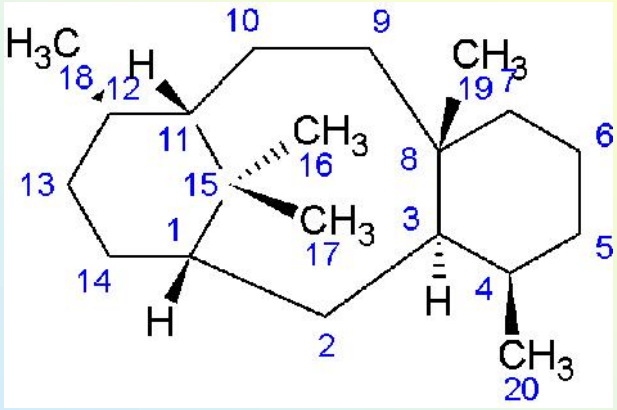
## *Taxus brevifolia*

**is Pacific evergreen. The taxol is isolated from the bark.**

**Taxol is poorly absorbed parenterally, causes allergenic or other serious side effects.**

**Paclitaxel is a semi-synthetic product of taxol**

## pharmaceutical forms



**The semi-synthetic product derived from Taxus baccata (yew) is docetaxel. Both products build up from taxane ring (6-8-6) and phenylisoserine.**

## Side effects:

**- hypersensitivity reactions in 20% of patients**

**- dyspnoe, hypertension, chest pain, fatigue, muscle pain**

**- This should be treated immediately (dexamethasone in advance, and then histamine H2 antagonist).**

**- peripheral neuropathy, alopecia, nausea**

**Sterane skeleton**

**(cyclopentane perhydro phenanthrene)**

**pseudoalkaloids**

**Steroid alkaloids**

# Steroid alkaloids

**Steroid alkaloids have a fairly complex nitrogen containing nucleus.**

**Two important classes of steroid alkaloids are**
**the *Solanum* type - one example is solanidine.**
**  *Veratrum* type - there are more than 50 *Veratrum* alkaloids, examples are veratramine, jervine**

**This steroid alkaloid is the nucleus (i.e. aglycone) for two important glycoalkaloids, solanine and chaconine, found in potatoes.**

**Other plants in the *Solanum* family including various nightshades, Jerusalem cherries, and tomatoes also contain solanum-type glycoalkaloids.**

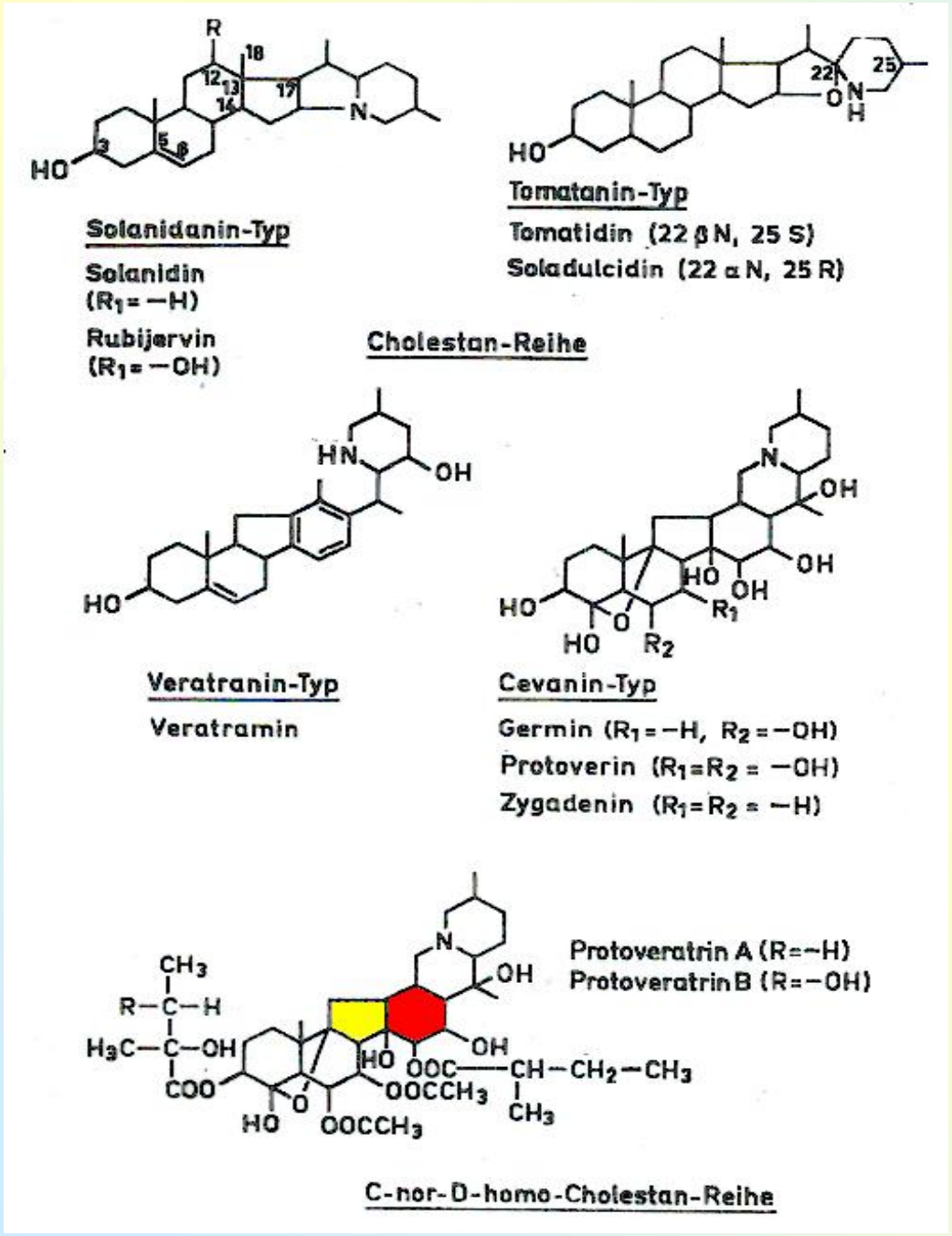
**Glycoalkaloids are glycosides of alkaloids.**

## Where poisons are found?

**Production of solanum-type glycoalkaloids is favored by the same conditions that promote the development of chlorphyll. Therefore, the concentration of these glycoalkaloids is highest in potato sprouts and green potato skins, and tomato vines and green tomatoes.**

**Care should be taken to prevent the exposure of potatoes to sunlight.**

**These alkaloids are not destroyed by cooking or drying at high temperatures.**




**Solanum-type alkaloids** are found in plants in the form of glycosides of alkaloids.

Solanine and chaconine cause poisoning in potatoes.

They have the same aglycone, solanidine, but the structure of their carbohydrate sidechains is different.

Tomatine is a glycoalkaloid found in tomatoes. Its aglycone is tomatidine.

# *Solanum dulcamara* L.
# Solanaceae


**Woody Nightshade**
**very common species**

***Solanum dulcamara*, also known as bittersweet or climbing nightshade, is a species of vine in the potato genus Solanum, family Solanaceae.**
**It is native to Europe and Asia, and widely naturalised, including North America, where it is an invasive problem weed.**

**Bittersweet is a semi-woody herbaceous perennial vine, which scrambles over other plants, capable of reaching a height of 4 m where suitable support is available, but more often 1–2 m high.**

**The flowers have prominent tube-like stamens, five purple petals with a yellow mark at the base. Small red berries are gathered in bunches.**
**The leaves are 4–12 cm long, roughly arrowhead-shaped, and often lobed at the base.**
**The herbaceous plant has dimorphic leaves.**
**They are entire or trilobate depending on their position on the stem.**

**The fruit is an ovoid red berry about 1 cm long, soft and juicy, with the aspect and odor of a tiny tomato, and edible for some birds, which disperse the seeds widely.**

**The berry is poisonous to humans and livestock, and the berry's attractive and familiar look make it dangerous for children.**

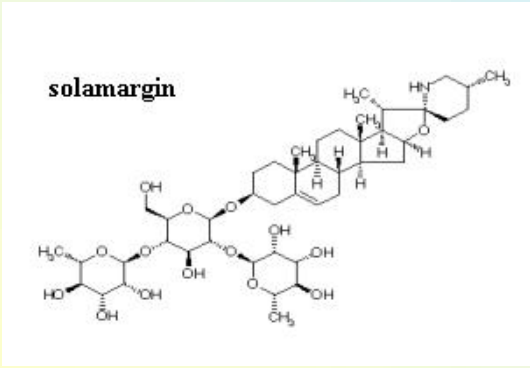
## Biological activity

**The stems are used external as supportive therapy in chronic eczema.**

**The alkaloids, solanine (from unripe fruits), solasodine (from flowers) and beta-solamarine (from roots) inhibited the growth of bacteria eg. E. coli and S. aureus.**

**Solanine and solasodine show antidermatophytic activity against Chrysosporium, Trichophyton, thus it may cure ringworm.**


# *Solanum dulcamara* L.
## Solanaceae
## nightshade




**Content:**

**steroid-glykoalkaloids**

**steroid saponins by their aglycons:**

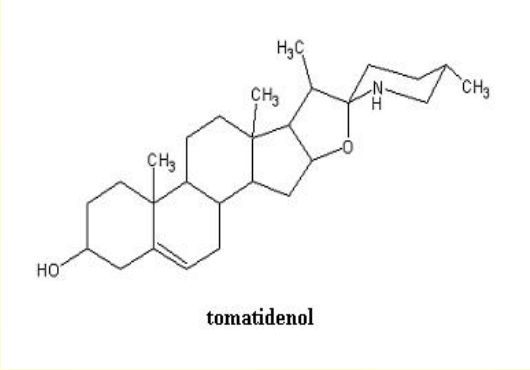
**tomatidenol, soladulcidine, solasodin**

**saponins**

**Medical application: rheumatism, arthritis, cervical lymph node swelling, skin diseases, eczema, psoriasis, herpes**

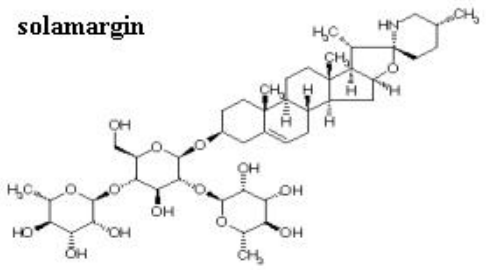
**Dose:**

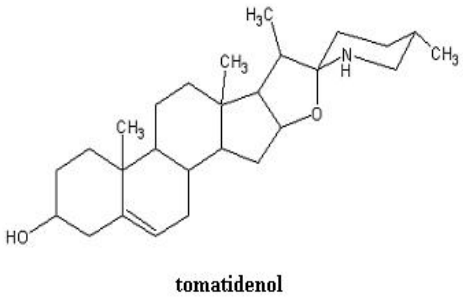
**1g single dose - daily dose is 1-3 g (infusion)**




**The molecules have characteristic properties of steroid saponins.**

solamargin





tomatidenol

***Solanum dulcamara* L.**
**Solanaceae**
**nightshade**

**Tomatidenol is anti-carcinoid type molecule.**

**Components of glycosides are 1 mol D-glucose and 2 mol L-ramnose in solamargin**

**1 mol D-glucose, 1 mol D-galactose and 1 mol L-ramnose in solasonin**

**Industrial sprout has glycoalkaloid. Content varies between 0.7 to 2.2%.**

***Solanum dulcamara* is industrial raw material for the production of steroid hormones, anti-inflammatory drugs. (e.g. pregnadienolone acetate)**

## *Solanum laciniatum*
## Solanaceae

***Solanum laciniatum*** **occurs in temperate regions of New South Wales, the Australian Capital Territory, Victoria, South Australia, Tasmania, New Zealand and associated islands on a range of soil types.**

**It forms a large shrub 4 m high by 5 m wide.**

***Solanum laciniatum*** **produces two types of foliage: large lance-shaped or irregularly lobed juvenile leaves 300 mm long by 250 mm wide and smaller generally entire lance-shaped adult leaves 150 mm long by about 30-50 mm wide.**

**Both types of leaf are a rich dark green on the upper surface, and a lighter green underneath, with conspicuous veins.**

**They are held on dark green succulent stems, which turn black, then a rough light-brown, with age.**

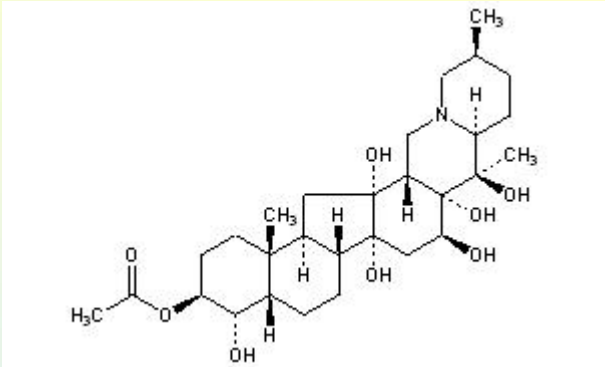

# *Schoenocaulon officinale Schlecht.*
# Liliaceae
# Sabadillae semen

***Schoenocaulon officinale** have narrow* **fibrous foliage and simple raceme.**
**Drug is the wide core with 5-8 mm long and 1-2 mm size.**
**Odorless bitter, pungent.**
**The endosperm can be found in oil-rich seed, which comprises 1-5% of the alkaloids.**

***Schoenocaulon*** **is a North American genus of perennial herbaceous flowering plants, ranging from the southern United States to Peru. It is also cultivated.**

**Merck (1891) isolated two new alkaloids from cevadilla, which he names sabadine and sabadinine respectively.**

**sabadine**



*Schoenocaulon officinale Schlecht.*

**Liliaceae**

**Sabadille semen**

**Content:** **1-5% alkaloids (cevane type)**
**dominant alkalods are cevadin, veratridin**

**others:** **sabadillin**
**sabadin**
**sabadinin**
**veratrum- with tiglin-, kelidon-acids**


**9-17% fatty oil**
**fitosterine**
**resin, wax**

**Effect:** **antihypertensive**
**abnoral heart rhythm balancing effect**

**Application:**
**neuralgia,**
**against parasites**
**allergy**
**Veratridine is an insecticide.**

*Schoenocaulon officinale Schlecht.*

Liliaceae

Sabadillae semen

## Medicinal action and uses:

**Sabadilla, or cevadilla is an acrid, drastic emeto-cathartic, in overdoses capable of producing fatal results.**

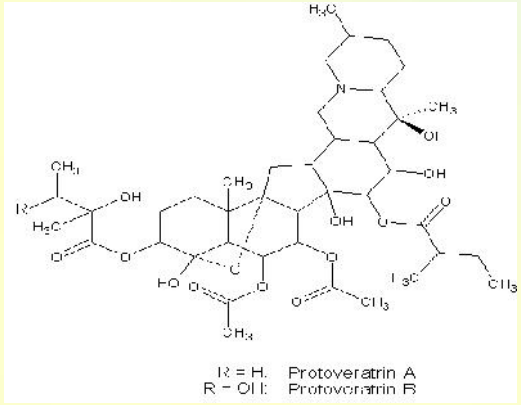
**Cevine was found to be less poisonous than cevadine, though producing similar symptoms.**

**The powdered seeds have been used as a vermifuge, and to destroy vermin in the hair, being the principal ingredient of the pulvis capucinorum used in Europe.**

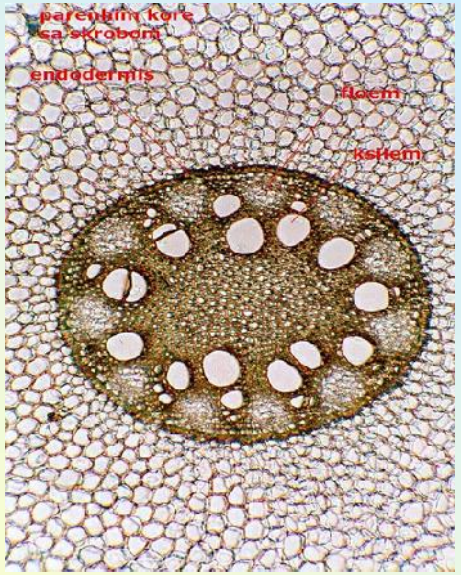
**Cevadilla was formerly used internally as an anthelmintic, and in rheumatic and neuralgic affections.**

**The highly poisonous veratria, which is derived from it, has been given in minute doses internally in acute rheumatism and gout, and in some inflammatory diseases, but it must be used with caution.**

# Veratrum album L.
# Liliaceae
# Veratri rhizoma
# White Hellebore




monocot root




**Drugs:** rhizomes and roots

**The plant is a perennial herb with a stout vertical rhisome covered with remnants of old leaf sheaths. The stout, simple stems are 50 to 175 cm tall.**

**Resveratrol has been isolated from the plant.**

**Veratrum lives in peaty and boggy areas of Europe and Asia.**

**The root is very poisonous, with a paralyzing effect on the nervous system.**

**Plant causes mucous membrane irritation.**

# Veratrum album L.
# Liliaceae
# Veratri rhizoma

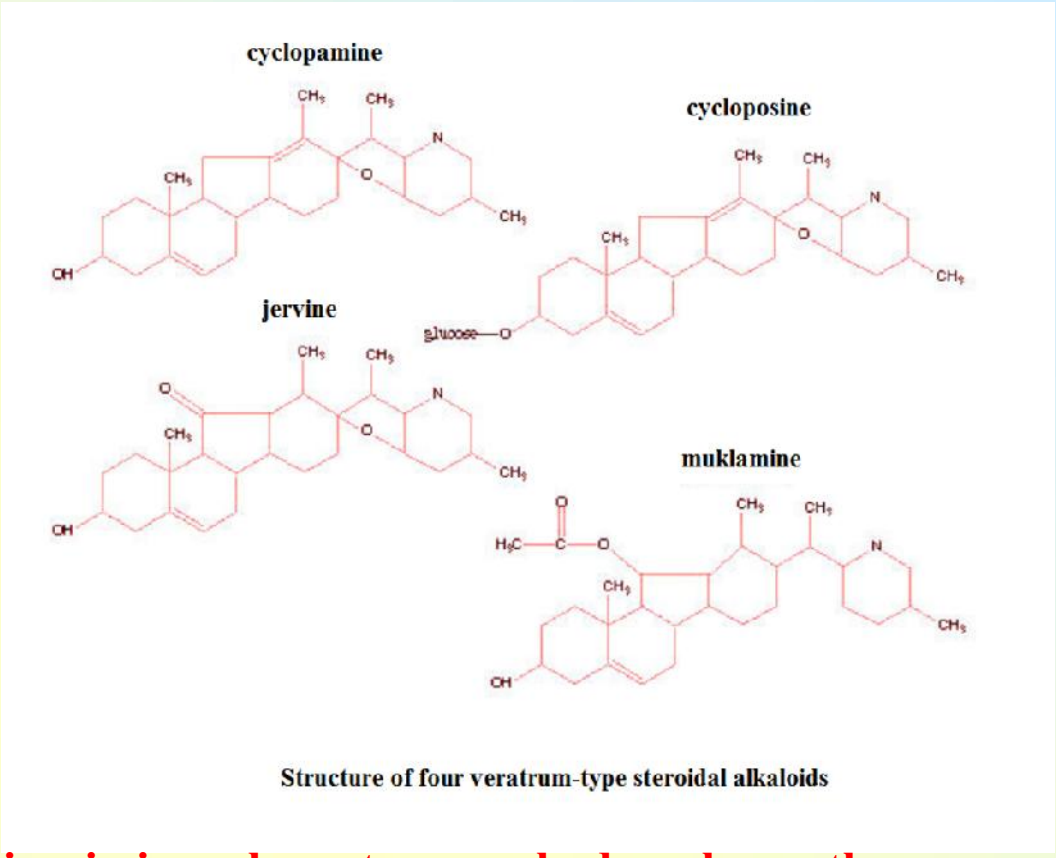
**Large numbers of roots grow at the bottom of the rhizomes; tufts and stout, 3-4 mm thick, and the color is bright yellow.**


**Ca-oxalate rafids in the rhizomes of the drug can be easily recognizable by microscopic examination.**

# Veratri rhizoma

**Content:**

**1,5-1,6 % alkaloids**
**ester and non ester alkaloids (glycoalkaloids)**
**fatty oils**
**resin**
**acetic-, butyric-, angelic-, tiglic- acids**




Structure of four veratrum-type steroidal alkaloids

**The structure of rubijervin and jervin is cyclopentano-perhydro-phenanthrene.**

## Veratri rhizoma

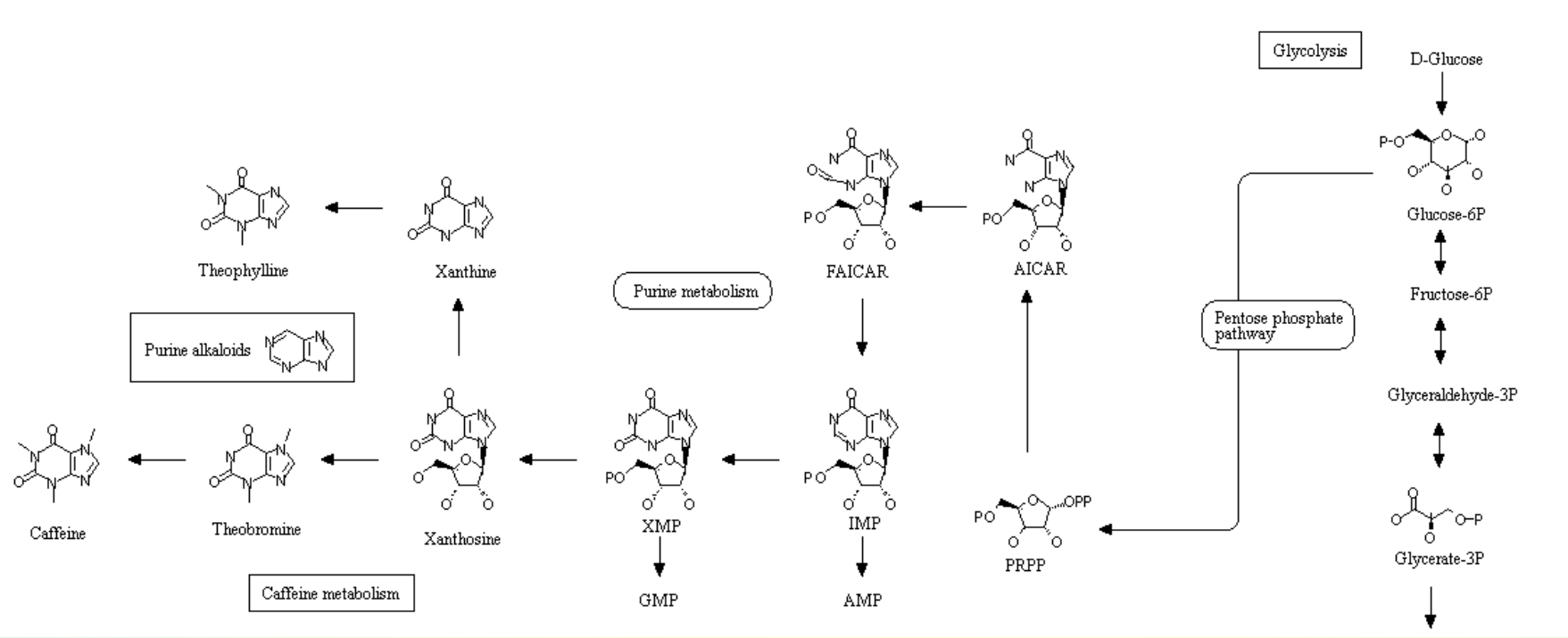
**Physiological effect:**

- antihypertensive (alkaminesters)
- protoveratrine A and B are used in cases of acute hypertension
- alkamine glycosides are less effective
- A and B are effective in protoverin

**The drug is used mainly in veterinary medicine:**

- stomachicum in ruminants
- emetic in pigs

# Alkaloids derived from purine




## Drugs with alkaloids derived from purine

| | |
|---|---|
| Coffeae semen | Rubiaceae |
| Colae semen | Sterculiaceae |
| Cocoa semen | Sterculiaceae |
| Theae folium | Camelliaceae |
| Mate folium | Aguifoliaceae |
| Paullinia sorbilis | Sapindaceae |

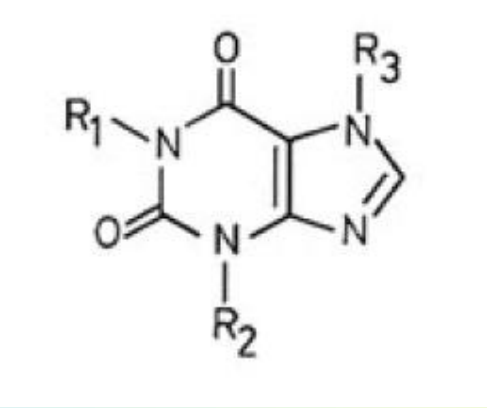
**They bioactive xanthine type alkaloids have marked physiological effects.**

## What is caffeine?

**Caffeine is a drug that is naturally produced in the leaves and seeds of many plants.**

**Caffeine is a xanthine alkaloid, found in the bean of coffee plant, the leaves of tea bush and in Cola spp. as well as Mate leaves.**

**It's also produced artificially and added to certain foods.**




| | $R_1$ | $R_2$ | $R_3$ |
|---|---|---|---|
| Coffeine | $CH_3$ | $CH_3$ | $CH_3$ |
| Theobromine | H | $CH_3$ | $CH_3$ |
| Theophylline | $CH_3$ | $CH_3$ | H |
| Xanthine | H | H | H |

**Purine is a heterocyclic, aromatic, organic compound, consisting of a pyrimidine ring fused to an imidazole ring.**

# Biological effects of caffeine

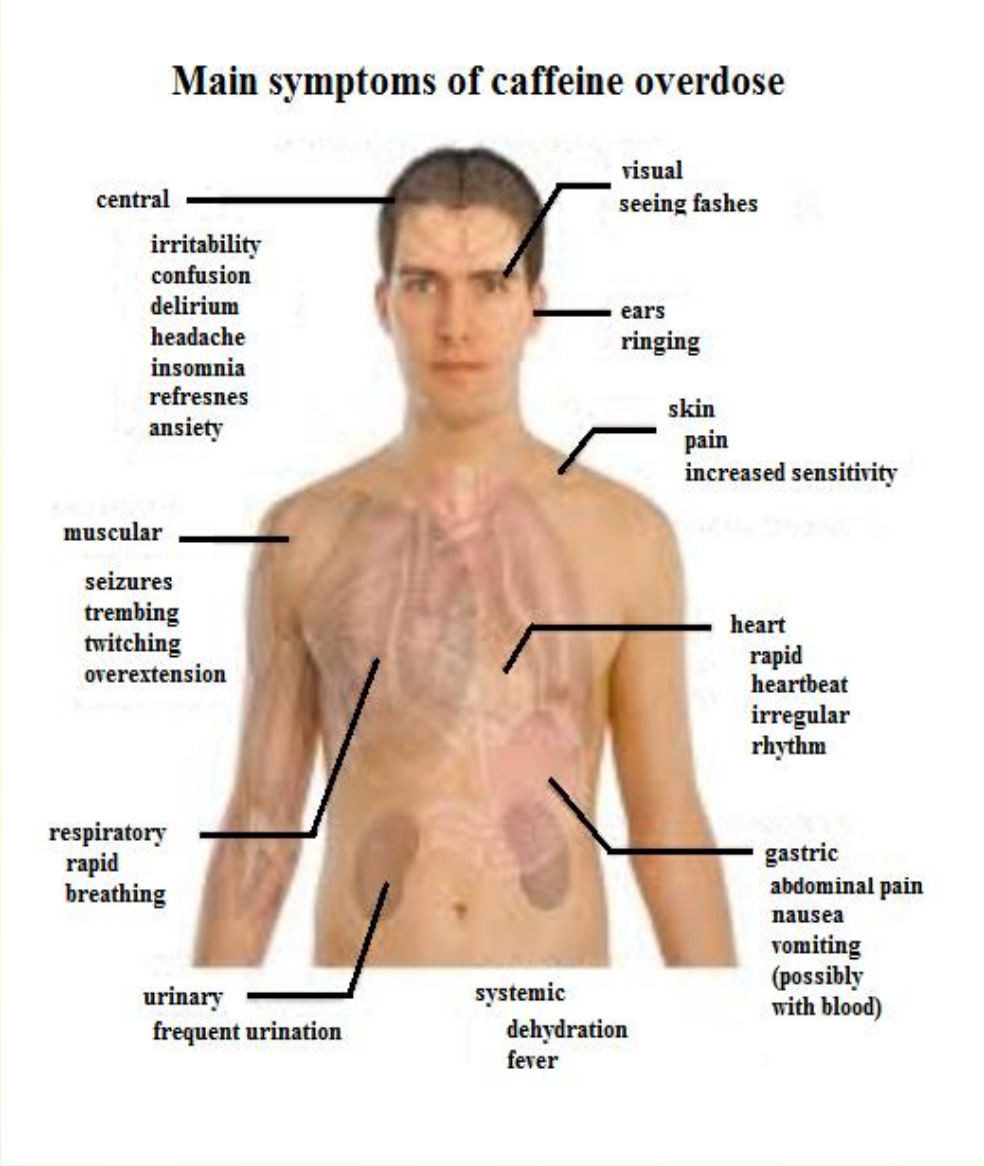
In its natural form, caffeine tastes very bitter, therefore it induces bile secretion.

Caffeine is not stored in the body, and its effects for up to 6 hours.

Caffeine is defined as a drug because it stimulates the central nervous system, causing increased alertness.

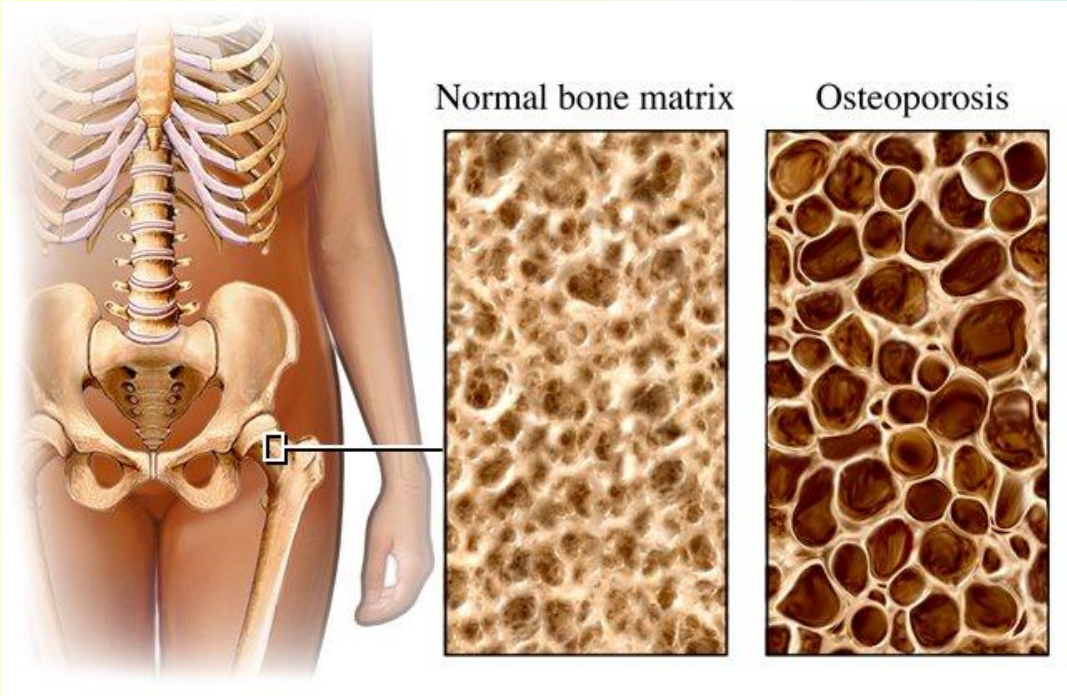
Caffeine gives most people a temporary energy boost and elevates mood.

Caffeine is in tea, coffee, chocolate, many soft drinks, and pain relievers and other over-the-counter medications.



# Biological effects of caffeine

**Caffeine can aggravate certain heart problems.**
**It may also interact with some medications or supplements.**
**In stress or anxious, caffeine can make these feelings worse.**

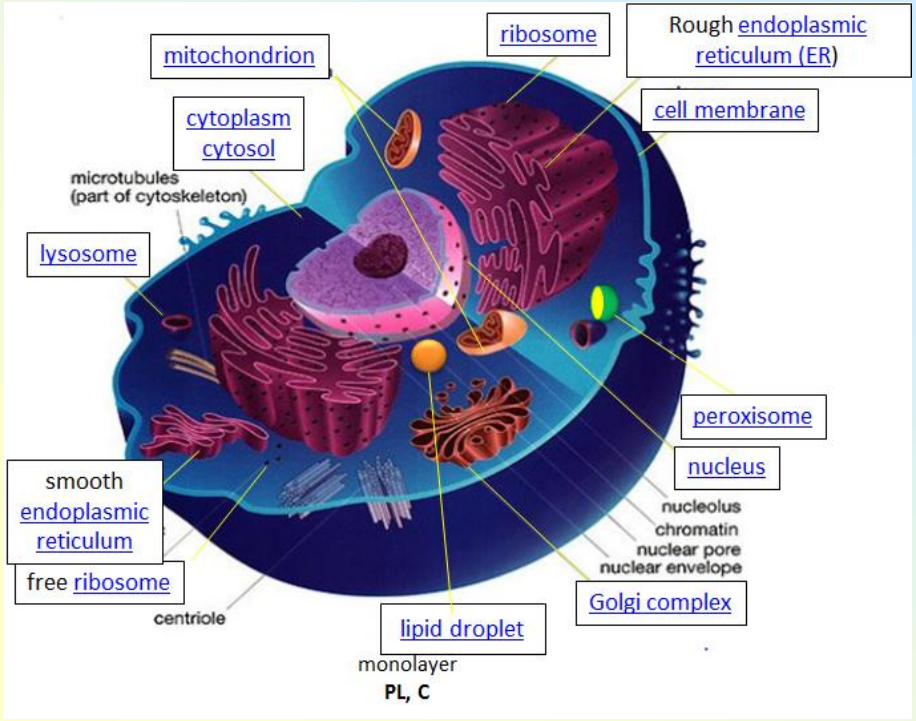


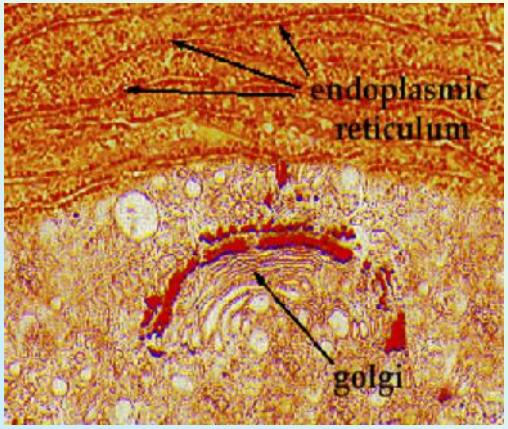

**Caffeine may also cause the body to lose calcium, and that can lead to bone loss over time. Drinking caffeine - containing soft drinks and coffee instead of milk can have an even greater impact on bone density and the risk of developing osteoporosis.**

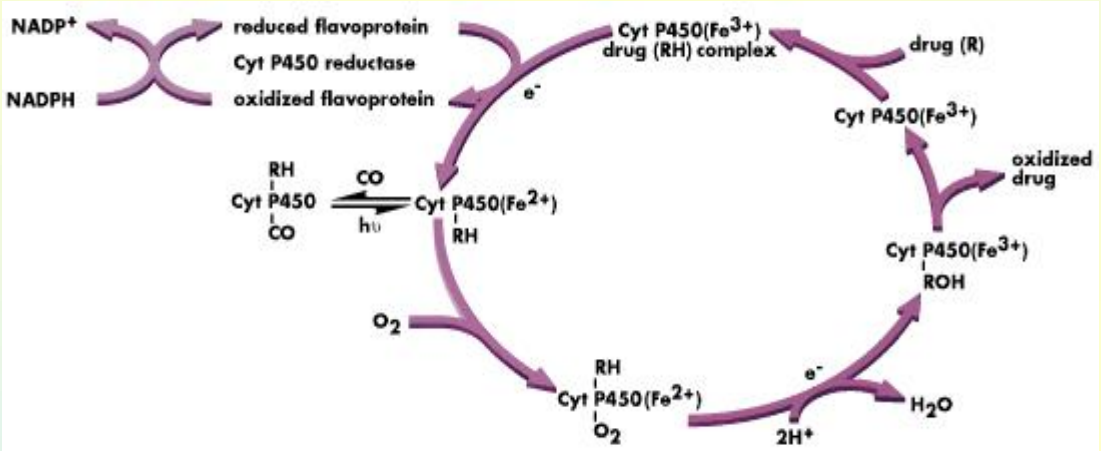
**Methylated xanthines** (methylxanthines), which include e.g. **caffeine, theobromine**, and **theophylline**, affect not only the airways but stimulate heart rate, force of contraction, cardiac arrhythmias at high concentrations.

In high doses they can lead to convulsions that are resistant to anticonvulsants. Methylxanthines induce acid and pepsin secretions in the gastrointestinal tract.

**Methylxanthines are metabolized by cytochrome P450 in the liver.**

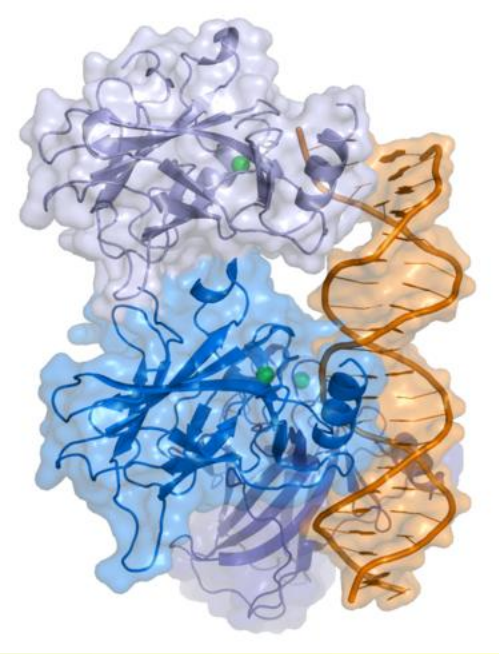


**Chemopreventive properties of caffeine in hairless mice after oral or topical administration: reduced multiplicity, incidence and volume of tumor, elimination of mutant p53 gene, selected apoptosis of tumor cells.**

**Tumor suppressor p53**



**Relationship between caffeine consumption and nonmelanoma skin cancer:**

**prevalence 9.1% in coffee drinkers vs. 10.2% in non-drinkers.**

**Demographic and lifestyle variables that affect NMSC.**

**Women's Health Initiative Study Group (1998)**

# Moderation is the key!

**Caffeine is usually thought to be safe in moderate amounts. Experts consider 200-300 mg of caffeine a day to be a moderate amount for adults.**

**Consuming as little as 100 mg of caffeine a day can lead a person to become "dependent" on caffeine.**

**This means that someone may develop withdrawal symptoms (like tiredness, irritability, and headaches) if he or she quits caffeine suddenly.**

# *Coffea arabica*
# Rubiaceae

***Coffea* is a genus is a member of the Rubiaceae family.**

**They are shrubs or small trees native to tropical and southern Africa and tropical Asia.**

**Flowering branches of *Coffea arabica***

**Coffee is one of the world's most valuable and widely traded commodity crops and is an important export product of several countries.**

**Coffee is a brewed beverage prepared from the roasted seeds of several species of an evergreen shrub of the genus Coffea.**

***Coffea* have xanthine derivated mayor and minor components**

**The tree of *Coffea arabica* will grow fruits after three to five years, and will produce for about 50 to 60 years (although up to 100 years is possible).**

**The white flowers are highly scented.**
**The fruit takes about 9 months to ripen.**

**The trees produce red or purple fruits called "cherries„.**

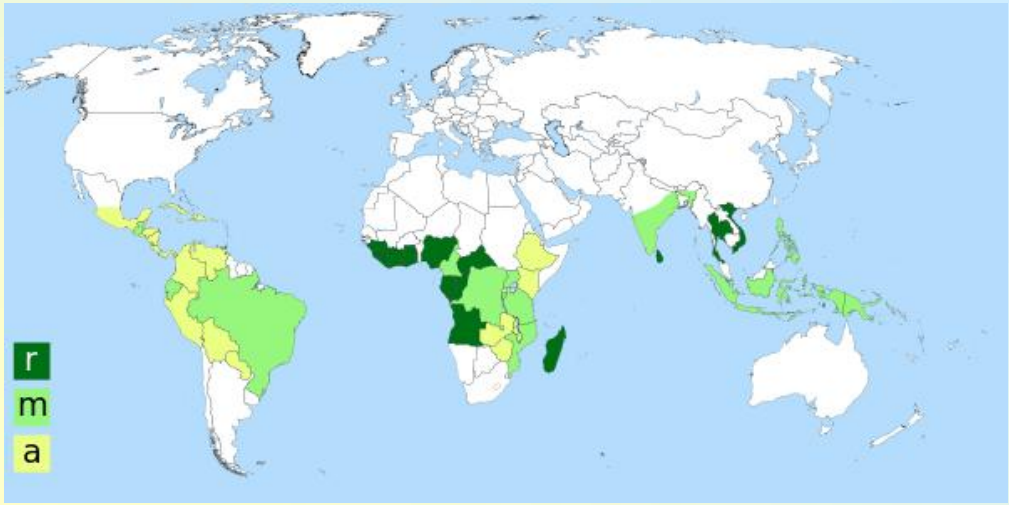
**The cherries contain two seeds, the so-called "coffee beans", which — despite their name — are not true beans.**

**In about 5-10% of any crop of coffee cherries, only a single bean, rather than the usual two, is found.**
**This is called a peaberry, which is smaller and rounder than a normal coffee bean.**


**It is often removed from the yield and either sold separately (as in New Guinea peaberry), or discarded.**

*Coffea arabica*
**Rubiaceae**

**Robusta coffee seeds**



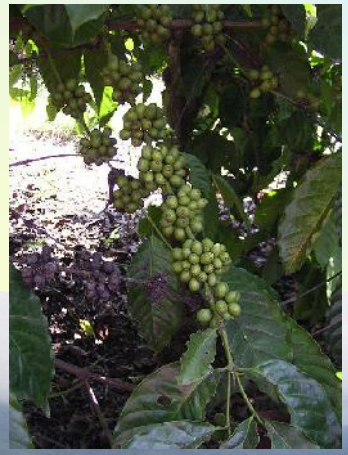

**Map showing areas of coffee cultivation**

**In 2011 Brasil was the world leader in production of green coffee, followed by Vietnam, Indonesia and Colombia. Arabica coffee seeds are cultivated in Latin America, easten Africa, Arabia or Asia.**

**Robusta coffee seeds are grown in western and central Africa, throughout southeast Asia and to some extent in Brazil.**

**Seeds from different countries or regions can usually be distinguished by differences in flavor, aroma, body and acidity (bitter).**

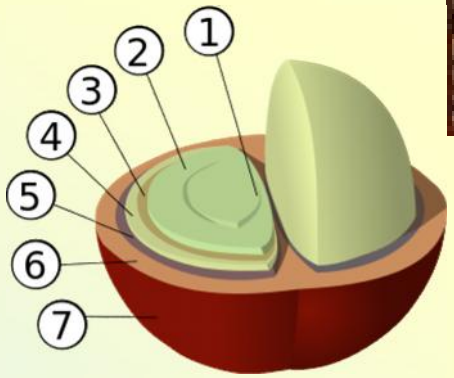
# Landscape of coffea plantation in Brasil



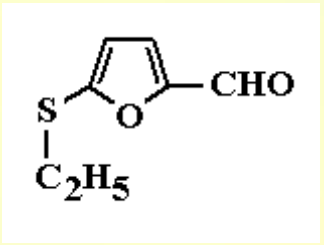
Plum-shaped fruit is drupe.
A crop is two pieces. approx. 2 cm core being.
The drug is the endosperm.

**Structure of coffee berry and beans:**

1: Center cut.
2: Bean (endosperm).
3: Silver skin(testa, epidermis).
4: Parchment coat(hull, endocarp).
5: Pectin layer.
6: Pulp (mesocarp).
7: Outer skin (percarp, exocarp).




After roasting the caffee seeds




alpha furfuryl mercaptan

Eaten after roasting. During roasting the coffee to swell, turn brown, caramelizes the sugars, the flavor (coffee, oil / kaffeol) develop.

# Evergreen shrub of the genus coffea

**When grown in the tropics, coffee is a vigorous bush or small tree that usually grows to a height of 3–3.5 m. Most commonly cultivated coffee species grow best at high elevations, but are nevertheless intolerant of freezing temperatures.**

**Coffee cultivation first took place in southern Arabia.**
**An important export commodity, coffee is the top agricultural export more than twelve countries.**

## *Camellia sinensis* L.

## Camelliaceae
## Theae folium

***Camellia sinensis*** **is the species of plant whose leaves and leaf buds are used to produce the popular beverage tea.**

**White tea, yellow tea, green tea, oolong and black tea are all harvested from this species, but are processed differently to attain different levels of oxidation.**

**There are two major varieties used for tea, Chinese tea, *Camellia sinensis* var. *sinensis*, and Assam tea, *Camellia sinensis* var. *assamica*.**

## *Camellia sinensis* L. Camelliaceae
## Theae folium

var. sinensis

var. assamica

**var. sinensis has lance shaped, 8-10 cm long leaves.**
**var. assamica has larger longitudinal, pointing leaves.**

**Leaves are lance or elliptical shaped coriaceous and naked, with neat serrated edges, the main rib protrudes to the lower surface.**

**When quite young the leaves may be more or less hairly.**

**The drug has a characteristic odour, it has an astringent bitter taste.**

***Camellia sinensis*** **is mainly cultivated in tropical and subtropical climates, in areas with at least 127 cm of rainfall a year.**

**Many high quality teas are grown at high elevations, up to 1500 meters, as the plants grow more slowly and acquire more flavour.**

# Theae folium

**The green tea is official in pharmacopoeia in several Europen countries.**

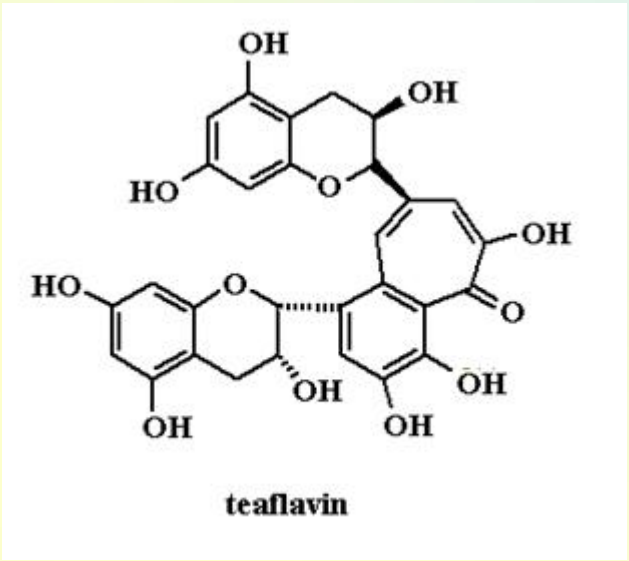

**Flavour formation can be formed.**
**One cap of tea has 20-30 mg coffeine.**

**green tea**

**drying**
**heated in iron pans**
**machines roll**

**black tea**

**gentle heating and drying**
**fermented**
**machines roll**




**teaflavin**

**During fermentation several new molecules are formed, e.g. tea flavins from catechines, seven membered ring is appeared, and B-ring is formed.**

**Contains:**

| | |
|---|---|
| coffeine | (2.5-3.5%) |
| theobromine | (0.1-0.2%) |
| teophylline | (0.02-0.04%) |

**Coffeine can be found with tannin.**

**Other components:**

**kempferol-, quercetin-, miricetin-glycosides, gallic acids, p-cumaric acids, coffeic acid, klorogenic acids, theogallin, p-coumaroyl chinese acid, chinese acid, 0,5-1% volatile oil, triterpene-saponins, carotenoids, lutein, violaxantin, neoxantin, amino acid derivatives, eg. teanin**

**green tea:**

**flavanols (catechins), flavon glycosides, little hydrolyzed tannins, saponins, metal elements (Al-fluoride)**

**black tea:**

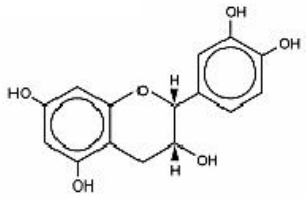
**tannin like materials, oxidation derivates of flavanols, tea-flavins, little flavon glycosides, metal elements (Al-fluoride)**

# *Camellia sinensis* L.

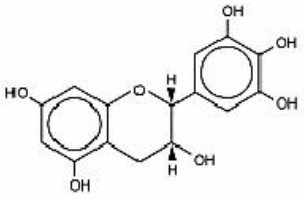
## Camelliaceae
## Theae folium

***Camellia sinensis***

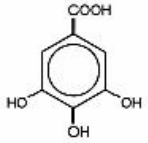
**flavan-3-ol származékok:**



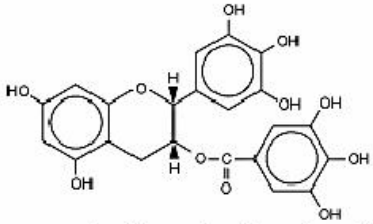
**epikatechin**



**epigallocatechin**

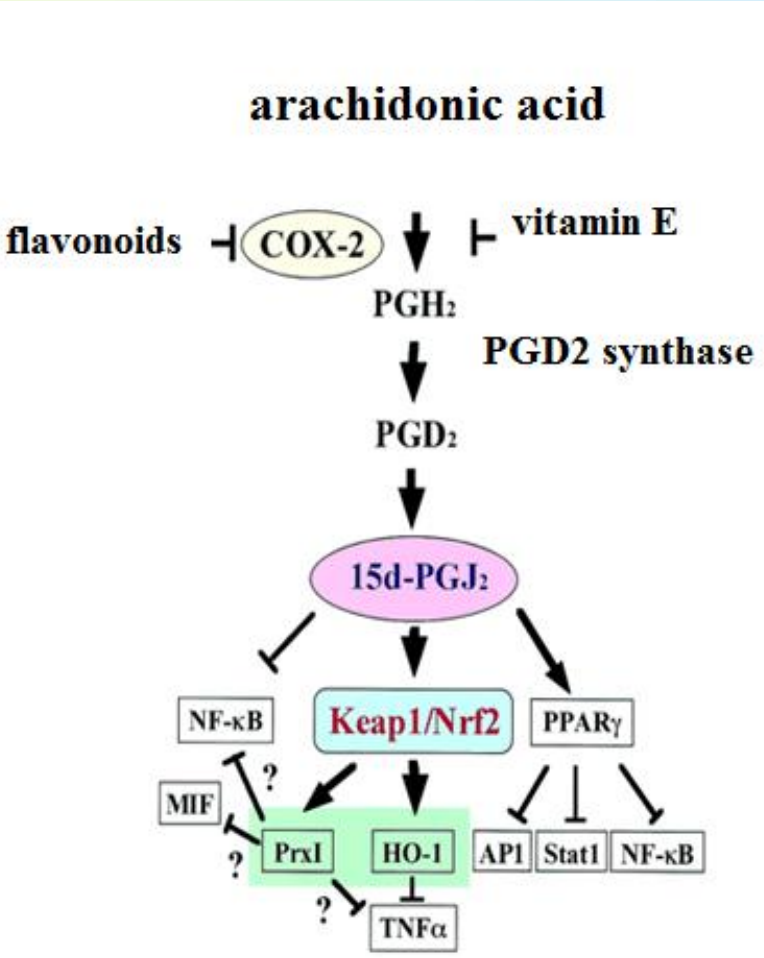


**galluszsav**



**epigallocatechin-3-gallát**

**(40%)**




Wessner et al. 2004.

## *Ilex paraguariensis* St. Hilaire
## Aquifoliaceae
## Mate folium

Serrated leaves

**Mate also known as yerba mate etc. is a traditional South American caffeine-rich infused drink, particularly in Argentina, where it is defined by law as the "national infusion"**

**Uruguay, Paraguay and the southern states of Brazil and to a lesser degree in south of Chile, the Bolivian Chaco, Syria and Lebanon.**

**It is prepared from steeping dried leaves of yerba mate, known in Portuguese as *erva-mate*) in hot water.**

**Yerba mate, begins as a shrub and then matures to a tree and can grow up to 15 metres (49 ft) tall.**


**The leaves are evergreen, 7–11 cm long and 3–5.5 cm wide, with a serrated margin. The leaves are often called *yerba* (Spanish) or *erva* (Portuguese), both of which mean "herb". They contain mateine and related compounds and are harvested commercially.**

**The flowers are small, greenish-white, with four petals. The fruit is a red drupe 4–6 mm in diameter.**


## *Ilex paraguariensis* St. Hilaire
## Aquifoliaceae
## Mate folium

YERBA MATE

**Mate contain**

- **xanthine alkaloids, 1-2 % caffeine, 0.45-0.9%**
- **theobromine, 0.05% theophylline, tannin-like substances 4-16%**
- **caffeic and chlorogenic acids,**
- **the amines choline and trigonelline,**
- **amino acids,**
- **the flavonoids kempferol, quecertin and rutin, ursolic acid,**
- **vitamin B2, B6, C, niacin and pantothenic acid, and volatile oil.**

**Yerba mate also contains elements such as potassium, magnesium and manganese.**

**Plantation in Misiones, Argentina**

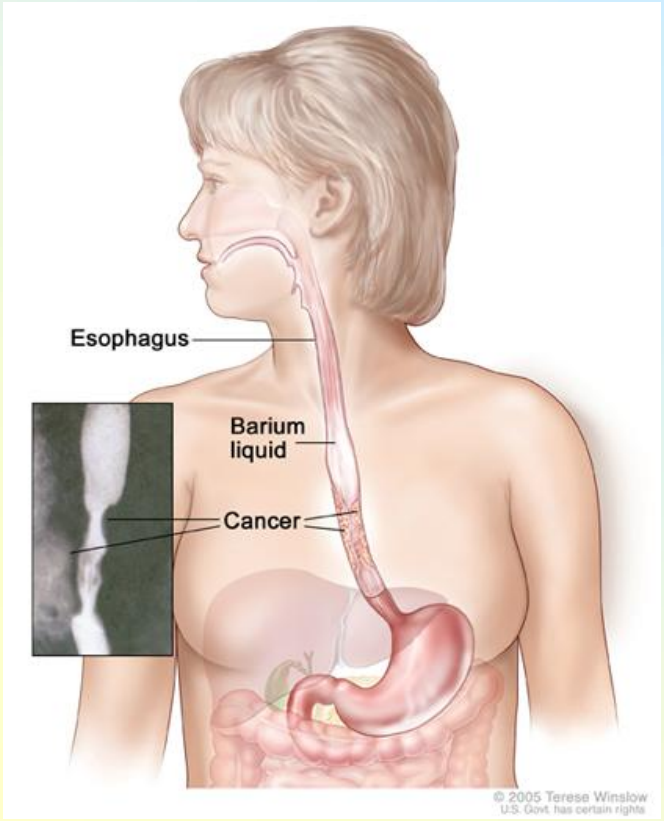
## Problem with hot mate

**Hot tea consumption is associated with oral cancer esophagus cancer, cancer of the larynx and squamous cell of the head and neck.**

**Studies show a correlation between temperature and likelihood of cancer, making it unclear how much a role mate itself plays as a carcinogen.**

**A study by the International Agency for Research on Cancer showed a limited correlation between oral cancer and the drinking of large quantities of "hot mate"**

**Smaller quantities (less than 1 liter daily) were found to increase risk only slightly, though alcohol and tobacco consumption had a synergistic effect on increasing oral, throat, and esophageal cancer.**




## *Theobroma cacao* L.
## Sterculiaceae
## Cacao semen

**The edible properties of *Theobroma cacao* were discovered over 2000 years ago by the local people of Central America living deep in the tropical rainforests.**

**The scientific name *Theobroma cacao* was given to the species by the Swedish botanist Carl Linnaeus in 1753, when he published it in his famous book *Species Plantarum*.**

***Theobroma* means "food of the Gods" in Latin, and *cacao* is derived from the Nahuatl (Aztec language) word xocolatl, from xococ (bitter) and atl (water).**

**In the year 2008-2009 the world cocoa production was 3,515,000 tonnes.**

crop

## *Theobroma cacao* L.
## Sterculiaceae
## Cacao semen

***Theobroma cacao*, cocoa tree, is a small (4–8 m tall) evergreen tree in the family Sterculiaceae native to the deep tropical regions of Central and South America.**

**Leaves are alternate, entire, unlobed, 10–40 cm long and 5–20 cm broad.**

**The flowers are produced in clusters directly on the trunk and older branches; this is known as cauliflory. The flowers are small, 1–2 cm in diameter, with pink calyx.**

**Cacao flowers are pollinated by tiny flies.**

# Cacao semen

**The fruit called a cacao pod, is ovoid, 15–30 cm long and 8–10 cm wide, ripening yellow to orange, and weighs about 500 g when ripe.**
**The pod contains 20 to 60 seeds, usually called "beans", embedded in a white pulp.**
**The seeds are the main ingredient of chocolate, while the pulp is used in some countries to prepare a refreshing juice.**

**Each seed contains a significant amount of fat (40–50%) as cocoa butter. Their most noted active constituent is theobromine.**

**Its seeds are used to make cocoa powder and chocolate.**

# Cacao semen

**Content:**

**1-3% theobromine**
**0.05-0.35% coffeine**
**45-53% fatty oil**
**4-8% tannins**
**8% starch**
**2.5 % sugar**
**volatile oil (linalool)**
**amyl acetate, amyl butirate,**
**esters, acids**

**The seed coat is thin, fragile.**
**The embryo violet-brown color.**
**The embryo with two large cotyledons folded, it forms the drug.**

**Toasted cacao beans produced at the hacienda.**

There is no chocolate flavour in cocoa beans without fermentation.

When the seeds are dried and fermented in the sun they are brownish red, and known as cocoa beans.

Chocolate is considered a delicacy for humans, but cocoa solids contain the alkaloid theobromine, which is toxic to pets such as cats and dogs.
Excessive amounts of chocolate and cocoa may be harmful during pregnancy and breast feeding.

**Harvesting cocoa, breaking ripe pods**

**Starting a fermentation heap**

**Heap ready to Ferment**

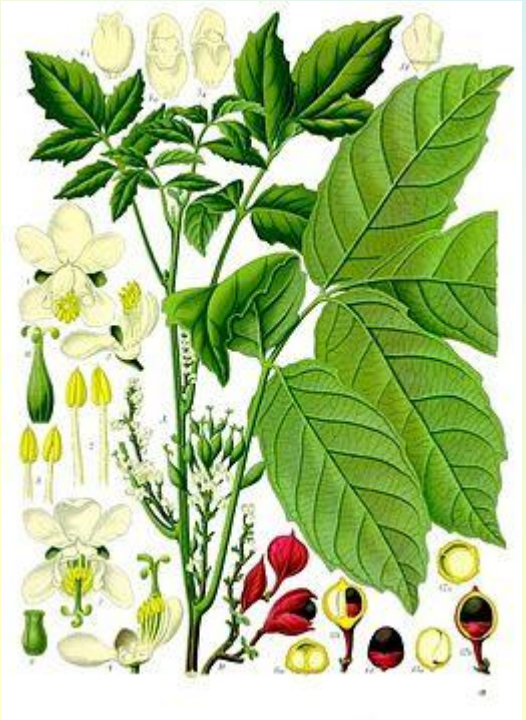
**Fermentation is finished**

## Box fermentation types
## Industrial sized fermentation

Chocolate flavour is extremely complex mixture of more than 500 compounds.

*Paullinia sorbilis*
*(Sapindaceae)*
**Guarana**

**Native climbing shrub in Brazil and Venezuela.**
**It blooms in June.**
**12 mm long boll in it 1-3 seed development.**
**The fruit is red.**
**Fresh crop is red, brown is dried.**
**2 cotyledons are develop.**



| | | |
|---|---|---|
| **Content:** | **caffeine** | **4-8%** |
| | **tannins** | **8% (d-catechin)** |
| | **saponin** | **0,06%** |
| | **fat (3%), resin (7-8%), red colour, starch, mucus, dextrine** | |

**Pasta guarana is official in Ph.Hg III.**

**Guarana is used in sweetened or carbonated soft drinks and energy shots.**
**Generally, South America obtains most of its caffeine from guarana.**

*Paullinia sorbilis*
*(Sapindaceae)*
**Guarana**

**As guarana is rich in caffeine, it is of interest for its potential effects on cognition.**

**Guarana increases the memory retention and physical endurance.**

**In 2007 a human pilot study assessed acute behavioral effects to four doses (37.5 mg, 75 mg, 150 mg and 300 mg) of guarana extract.**

**Memory, alertness and mood were increased by the two lower doses, confirming previous results of cognitive improvement following 75 mg guarana.**

**In the United States, guarana has received the designation of „generally recognized as safe" by the American Food and Drug Administration.**

**Guarana may affect how quickly the body perceives itself to be full.**

**Guarana extract reduced aggregation of platelets and decreased platelet thromboxane formation from arachidonic acid by 78 % below control values. It is not known if such platelet action has any effect on the risk of heart attack or ischemic stroke.**

*Paullinia sorbilis*

*(Sapindaceae)*

**Guarana**


**The seeds gathered from the soaked gvarana crops are roasted, crushed and then mixed with water are rolled into dough-like paste.**

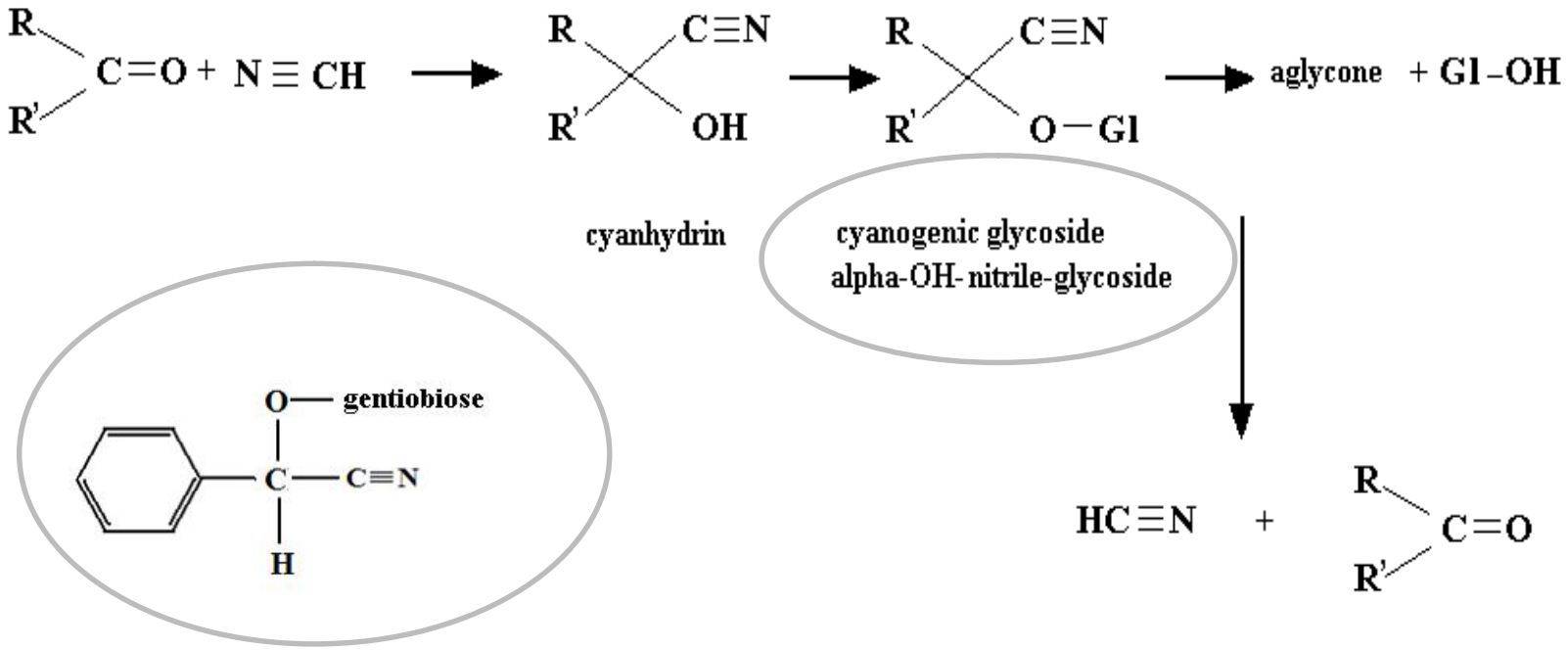
**Often starch is added to the guarana powder. It is formed to rod shape. (10-20 cm long, 3-4 cm wide, 100-500 g weight). The rod shape is the commercial product.**



**Cyanogenic glycosides**
**→ HCN (blue acid)**

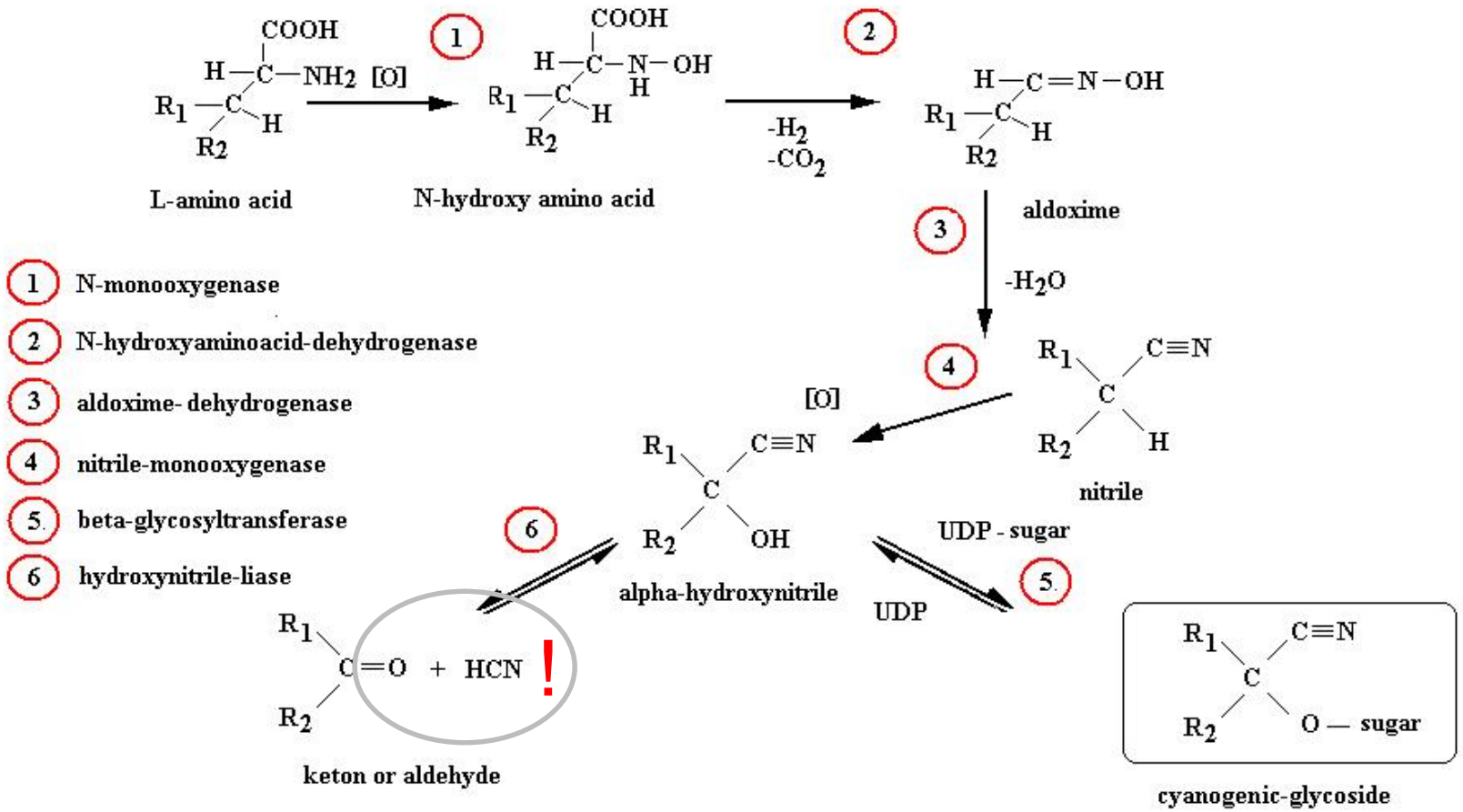
**Mustard oil-glycosides: →  (glucosinolates)**

## Chemical structure of cyanogenic glycosides

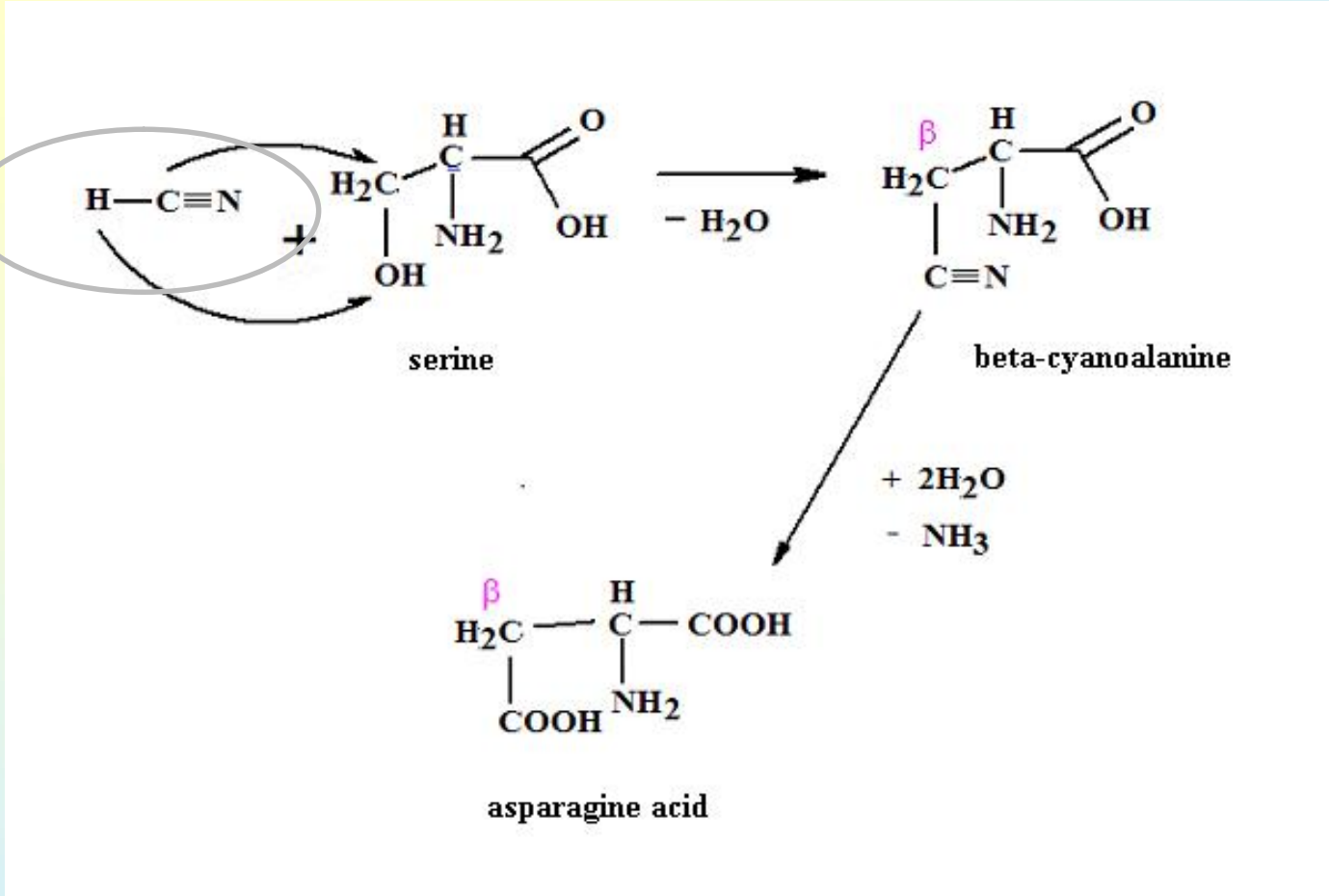



**More than 60 plant families are known to contain cyanogenic glycosides in more than 750 species.**

## Biosynthesis of cyanogenic glycosides



# Route of HCN in plants

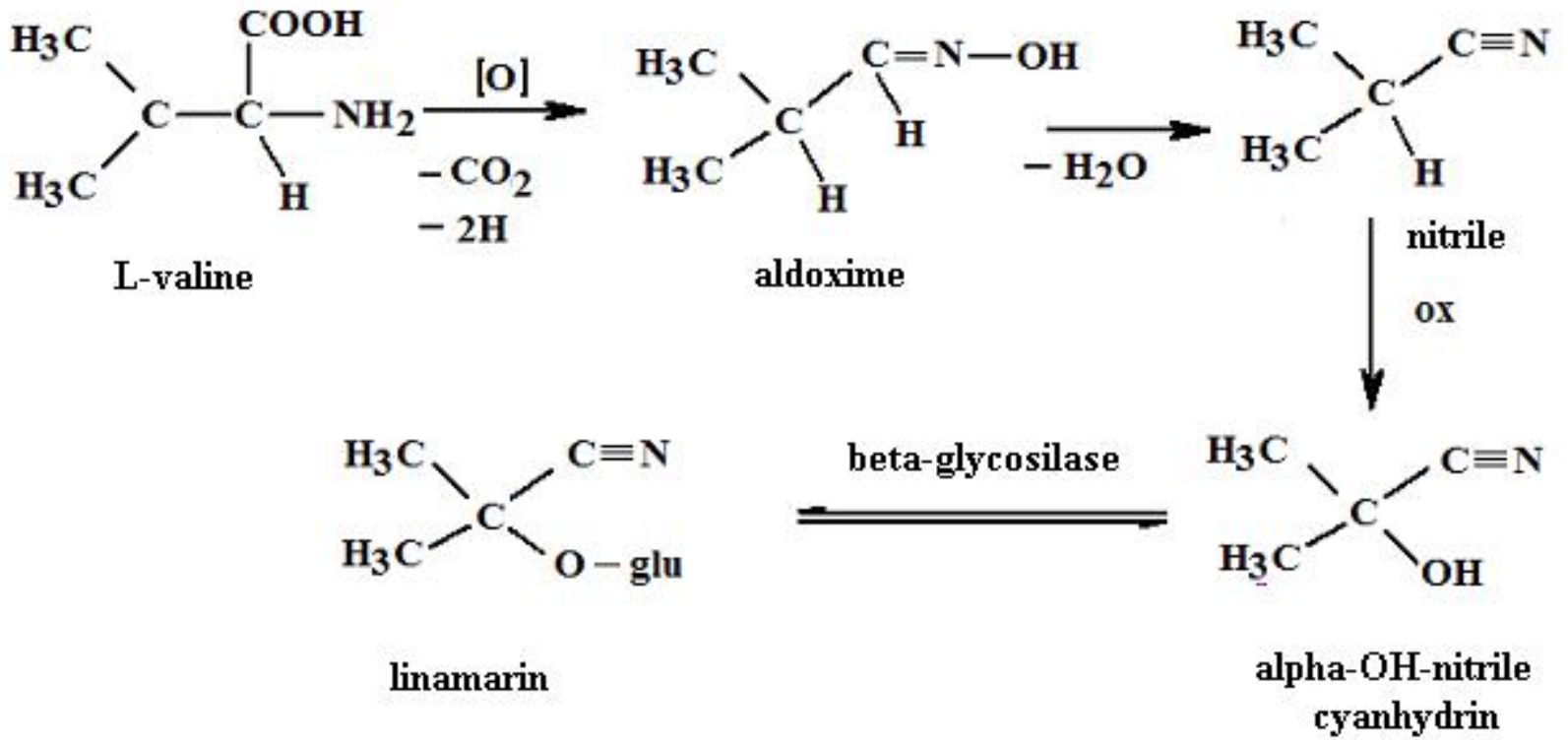



**HCN is not toxic for the plant, because asparagine acid is formed from HCN.**

# Biosynthesis of linamarin

## cyanogenic glycoside

## (Flax seed)

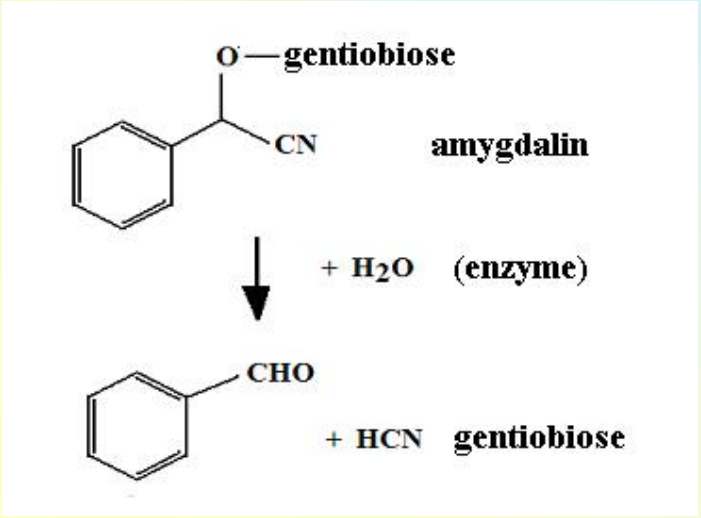


*Prunus amygdalus Batsch.*

*Rosaceae*

*Amygdalae semen*

**Almond seed**




**Prunus amygdalus var. sativa dulce does not contain cyanogenic glycosides**

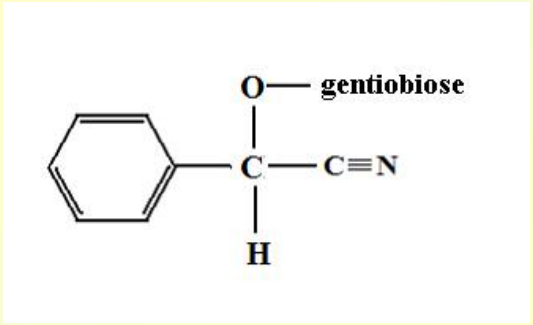
**Prunus amygdalus var. amara contains 3-5 % of amygdalin cyanogenic glycoside, from this quantity 0.2-0.3 % is the hydrocyanic acid.**

**Cyanogenesis is frequent in the plant kingdom**

**50 seeds are lethal for adults, 10 seeds for children!**

*Prunus amygdalus Batsch.*
*Rosaceae*
*Amygdalae semen*

**Almond seed**



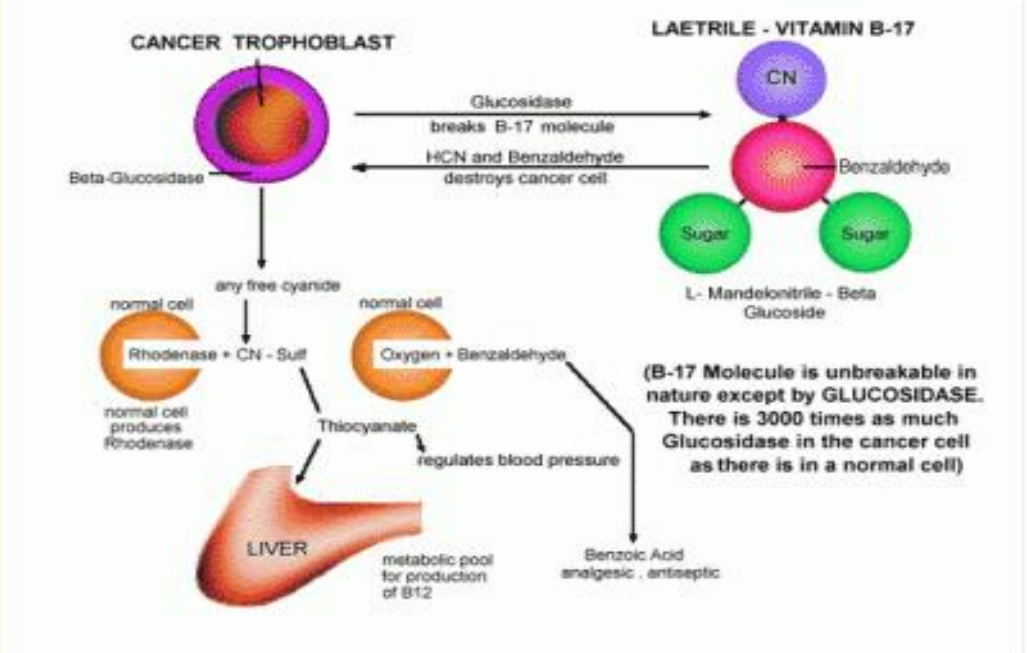
## Products

**Oleum amygdalae**
**Aqua amygdalarum amarum -1% HCN after steam destillation.**
**LAETRILE / vitamin B17 – amygdalin product.**
**Farina amygdalarum – protein rich product seed mass is native substance of cosmetics .**

# Biological activity of vitamin B17

**Laetrile has a dangerous component cyanide locked away inside.** The only way that it can get unlocked and come out is when the laetrile comes into contact with a cancerous cell.

Cancer cells have a **beta-glucosidase enzyme** that unlocks that cyanide, and the cyanide comes out and destroys the cancer cells.


## Explanation

When the cyanide comes out the cancer cells, rhodanase and neutralizing substance also come out from normal cells that prevents the cyanide from harming any nearby healthy cells. Isothyocyanate will be formed.

**Although this is not true!**

The detoxicating processes are connected with the rodanase enzyme in the mammals.

**Detoxication needs a sulphur donor.**

**Intravenously sodiumthiosuphate is the clinical antidots of hydrocyanic acid poisoning.**

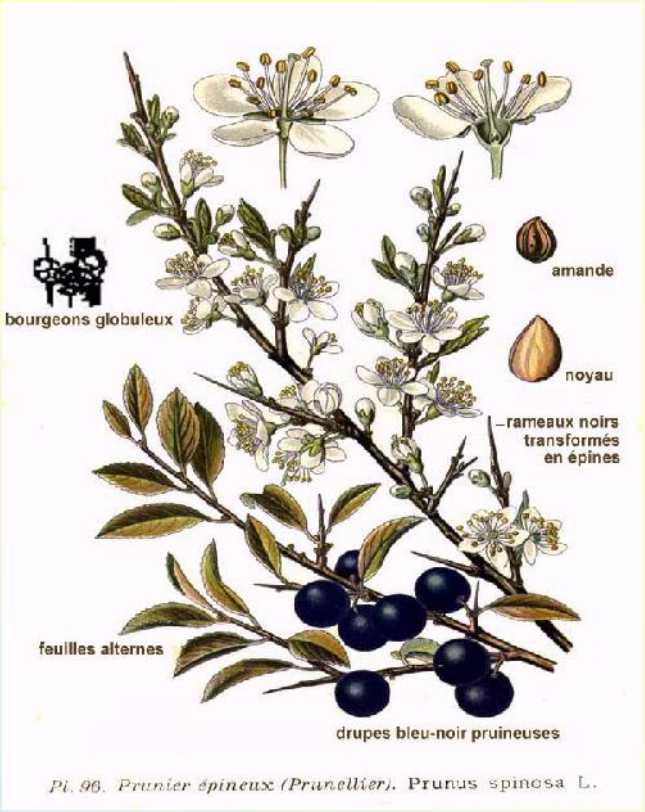
$CN^- + Na_2S_2O_3 = SCN^- + Na_2SO_3$

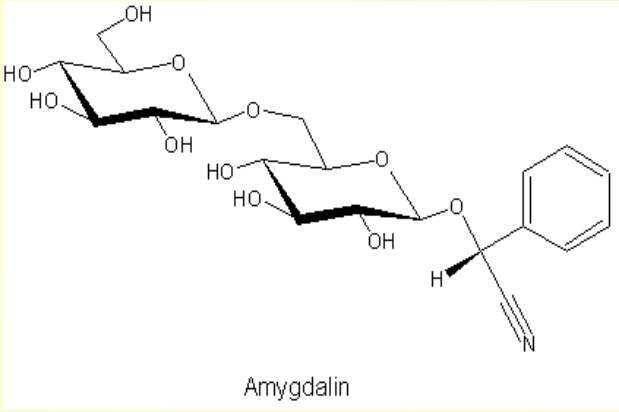
# *Prunus spinosa L.*

## Rosaceae

## Pruni spinosae flos

## blackthorn / wild plum




**The plant is native in European bushy shrubby slopes. It flowers in April-May, before leafing. Fresh flowers have benzaldehyde odor.**

**The white, 1 cm long flowers have free petals and many stamens. Their pistil is in central position.**

*Prunus spinosa L.*

**Rosaceae**

**Pruni spinosae flos**

**blackthorn / wild plum**

**Confusing synonime: Acaciae flos**

**Contains:** **amygdalin cyanogenic glycoside**

**flavonoid:** **kempferol**

**kempferin (glycozide)**

**quercetin,**

**quercitrin,**

**rutin**

**hyperozid**

**It is official in FoNo. IV. as the constituent of Species cynosbati composita. Flowers are applied in blood-purifying tea mixtures as hypotensive and aperient.**

**Products**



**Blackthorn brandy**

# Mustard oil and its glycosides

**Circa 30 species can be found in the plant kingdom.**

| | | |
|---|---|---|
| ***Brassicaceae*** | **Sinapis species** | **mustard** |
| **(Cruciferae)** | **Brassica species** | **black radish** |
| | | **cauliflower** |
| | | **cabbage white and red** |
| | | **kohlrabi** |
| | | **savoy** |
| | | **horse radish** |

***Tropaeolaceae***
***Capparaceae***
***Euphorbiaceae***
***Resedaceae***

# Mustard oil glycosides

**Effects:**

1. **On plant: increases the plant resistance.**

1. **On human body:**

**A / Curative effects**

**appetizer: stomachicum. → spice**
**antibacterial activity: disinfectant**
**skin irritant: rheuma cream**
**hyperaemia: neuralgia → embrocation**

**B / Toxic effects:**

**antithyreoid → goitre / struma**
**pustula → necrosis**

*Brassica nigra L.*

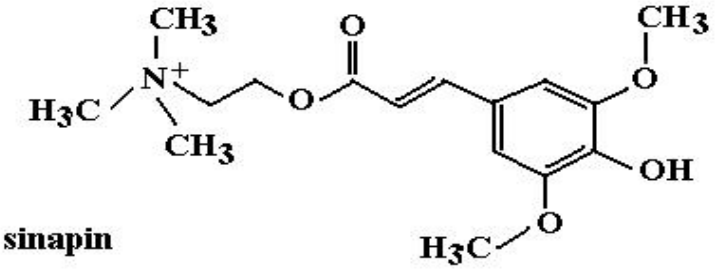
**Brassicaceae**

**Sinapis nigrae semen**

**black mustard**

**Important spice.**

**Drug is the semen.**




**sinapin**

**The plant is native in Europe. Plant is annual, with short breeding season (110-130 days).**

**It has stake-like tap root. Leaves are pinafitid, joined. Petals are vivid yellow, having 4 main stamens.**

**The flowers are good melliferous plut.**

*Brassica nigra L.*

**Brassicaceae**

**Sinapis nigrae semen**

**black mustard**


**Contains:** **7% sinigrin ( glycoside )**

**0.6-1.2% mustard oil /volatile/ from sinigrin-glycosides./**

**20-40% fatty oils /eruca acid, oil acid, linolenic acid/**

**sinapin (sinapin acid-choline ester)**

**sinapin acid (4-oxi-3,5-dimetoxi-cinnamonic acid)**

**myrosinase, mucilage**

**palmitic acid, arachidonic acid**

**Galenus' product:** **Spiritus sinapis – against rheuma -**

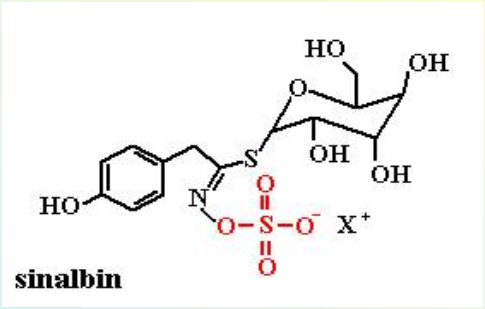
**Charta sinapisata**

**spice – stomachicum**

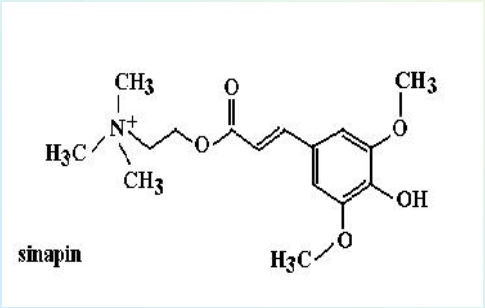
**Cultivation:** ***Sinapis nigra* x *Sinapis rapa* ssp. Campester are crossbreaded**

## Sinapis alba L.
## Brassicaeae

**Sinapis albae semen**
**White mustard seed**

sinalbin



sinapin

**The plant is native in America and India.**

**Seeds contain glycoside sinalbin and myrosin as well as isothiocyanate and sinapine hydrogen sulfate. (English mustard)**

**When the seed is treated with alkaline, the product will be yellow because of sulfur (sinalbin glycoside).**

**X+ = sinapin**

**Sinapis alba L.**
**Brassicaeae**
**Sinapis albae semen**
**White mustard seed**

**Contains:**
**2-5 % sinalbin**
**~ 1% mustard oil (volatile)**
**20-30 % fatty oil**
**myrosinase**
**mucilage, protein**

**Application:**
**stomachicum**
**chreme from white**
**and black mustard seed**

**Effectiveness:**
**increases secretion of saliva**
**increases bowel motility and**
**bile secretion**
**has positive inotropic activity**

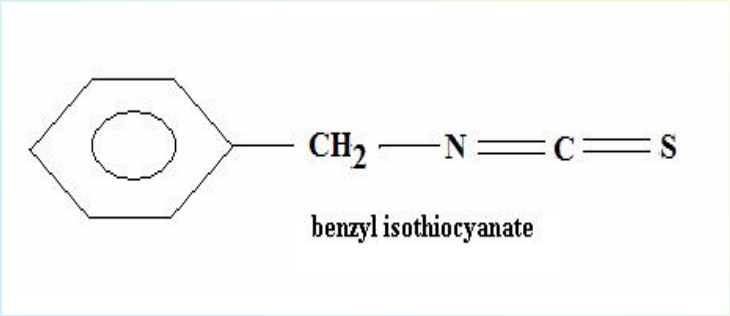
## *Tropeolum majus L.*
## Geraniales

**This plant is native in America. *Tropeolum majus* is an ornamental plant.**

**The plant is also a climber. It has a shell form letters and spurred yellowish-reddish flowers.**

**Contains 0.03 % volatile oils**

**The main active component is: glucotropeolin (glucosinolate), from this benzyl-mustard oil is formed by myrosinase activity.**

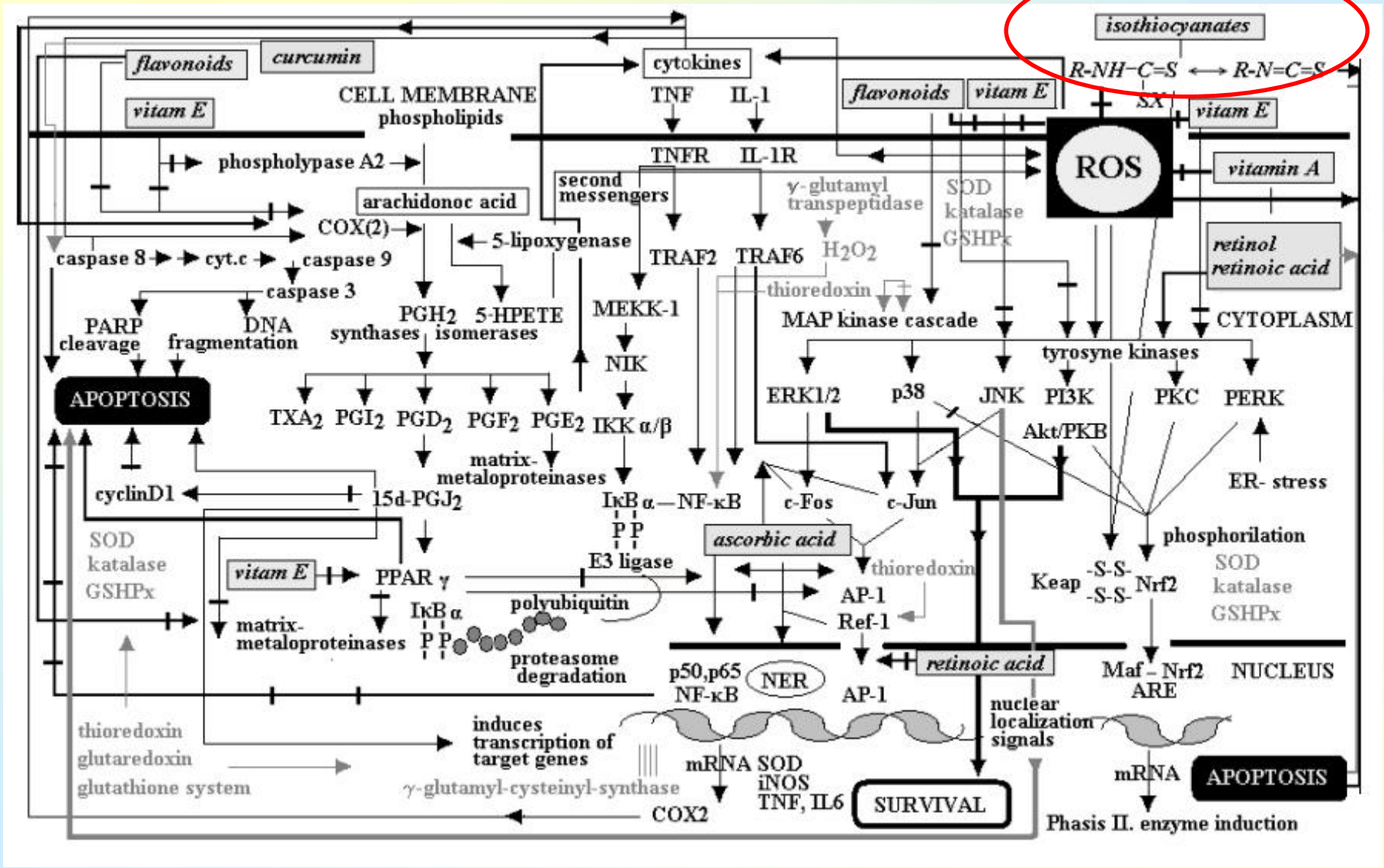


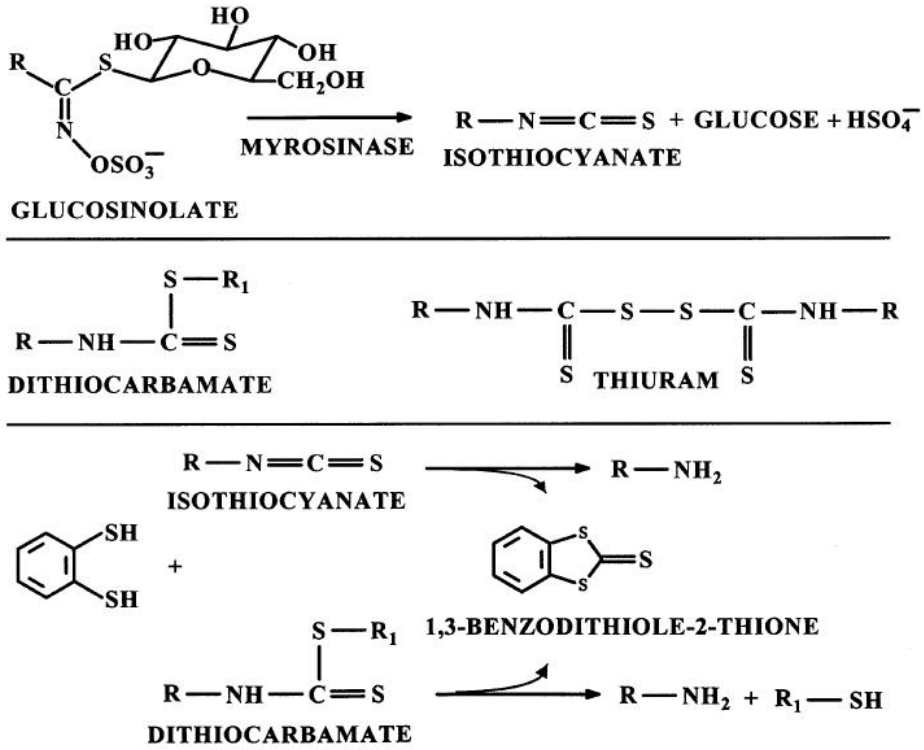
benzyl isothiocyanate

**Antibacterial effect of benzyl-mustard oil is established.**

**Harmful to both Gram (+), and Gram (-) bacteria.**

# THE ROLE OF ANTIOXIDANTS IN SIGNAL TRANSDUCTION





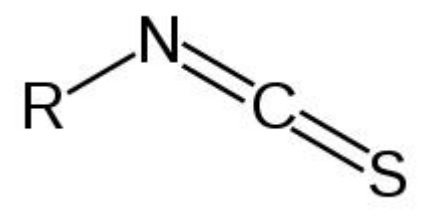

Hydrolysis of glucosinolates to isothiocyanates by myrosinase (top). Structures of dithiocarbamates and thiurams (center). Cyclocondensation of isothiocyanates and dithiocarbamates with 1,2-benzenedithiol gives rise to the same cyclocondensation product (1,3-benzodithiole-2-thione) (bottom). The identity of the monothiol released by the reaction of DTC with 1,2-benzenedithiol has not been confirmed experimentally.

**Most glucosinolates are converted enzymatically to their cognate isothiocyanates (ITC) by the coexisting but normally segregated plant enzyme myrosinase (which is released when food is prepared or chewed), and by the flora of the human gastrointestinal tract.**

**Isothiocyanate is the chemical group –N=C=S, formed by substituting sulfur with oxygen in the isocyanate group.**

**Many natural isothiocyanates from plants are produced by enzymatic conversion of metabolites called glucosinolates.**

**These natural isothiocyanates, such as allyl isothiocyanate, are also known as mustard oils.**




**isothiocyanate**

**Small molecules, such as fenethyl-isothiocyanate, sulforaphane and indol-3-carbinol can be absorbed from food.**

**Following rapid intracellular accumulations, isothiocyanates are formed and conjugated to glutathione by glutathione-S-transferase.**

**After these conjugation reactions, the conjugates are further metabolized. In these processes mercapturic acid is formed by the actions of γ-glutamyltranspeptidase, cysteinylglycinase and N-acetyltransferase.**

# *Raphanus sativus L. var. niger*

**In folk medicine black radish (Raphanus sativus L. var niger) root has been used for thousands of years.**

**A widely planted root all over the world belongs to the Cruciferae family.**

**Black radish was very popular vegetable and folk medicine among Hungarians and other European populations.**

**The natural drug has been used against abdominal inflation, insufficient digestion and for the inhibition of gallstone formation and for the stimulation of bile secretion.**

## *Raphanus sativus L. var. niger*

**This drug contains mainly glucosinolates and/or derivatives (isothiocyanates, nitriles, cyano-epithioalkanes formed during enzymatic hydrolysis by myrosinase)**

**essential oils, polyphenols and flavonoids phenolic acids**

**enzymes, enzyme-inhibitors,**

**microelements, vitamins: B-C,**

**phytoncid, raphanin.**

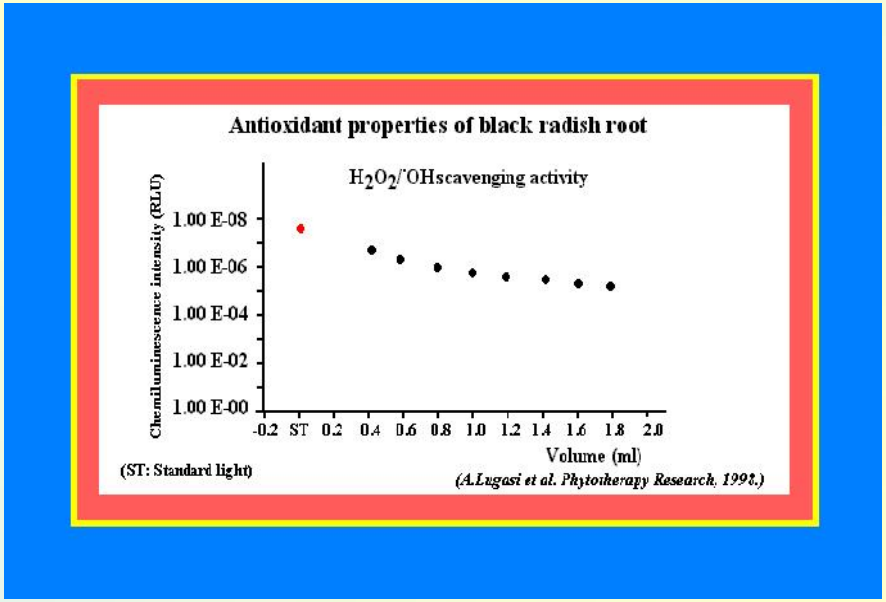
**The most important flavonoid component of black radish is kaempferol (21.1 mg/kg) originating from the fresh edible part of the plant.**

# BIOACTIVE COMPOUNDS OF BLACK REDISH ROOT

by Andrea Lugasi

| Components | mg/100 ml | mg/100 g |
|---|---|---|
| Glucosinolates (mg) | n.d. | n.d. |
| Ascorbic acid (mg) | 5.0 ± 0.08 | 81.6 |
| Carotene (mg) | 0.02 ± 0.002 | 0.33 |
| Tocopherols (mg) | 0.31 ± 0.03 | 5.06 |
| Total polyphenols (mg) | 25.5 ± 5.2 | 415.9 |
| Quercetin (mg) | 0.066 ± 0.022 | 1.08 |
| Kempferol (mg) | 0.495 ± 0.252 | 8.08 |

# Antioxidant effect of bile granule with *Raphanus sativus niger* in vitro




**In a chemiluminescent study the sample showed free radical scavenging activity.**
**Scavenging juice activity in $H_2O_2$/·OH –luminol system was measured.**

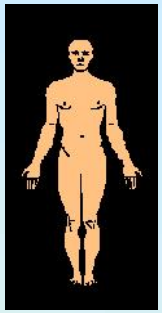
**Bioactive, non nutrient compounds of black radish are active hydrogen donors and they have a reducing power property, so they act as primary and secondary antioxidants in lipid peroxidation.**

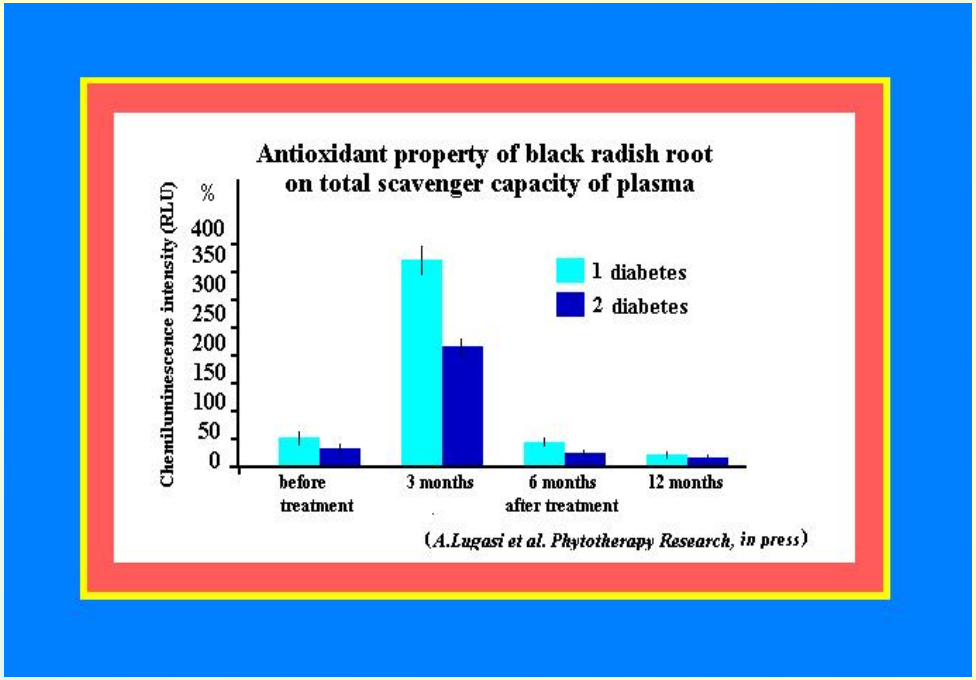
**Hydrogen-donating ability of black radish juice**

| Sample | Absorbance (517 nm) | Inhibition (%) |
|---|---|---|
| control | 0.604 ± 0.005 | – |
| sample (mL) | | |
| 0.05 | 0.560 ± 0.005 | 7.3 |
| 0.10 | 0.519 ± 0.003 | 14.1 |
| 0.50 | 0.307 ± 0.002 | 49.2 |
| 1.00 | 0.072 ± 0.001 | 88.1 |

*(A.Lugasi et al. Phytotherapy Research, 1998.)*

# Beneficial effects on diabetes mellitus






**Patients were under regular medical control and received adequate treatment of diabetes.**

**Blood samples were collected before the first administration of Raphacol, and after 3 and 6 months.**

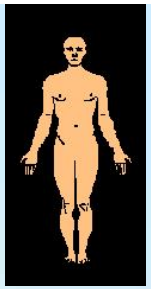
**Usual laboratory parameters were analyzed in the sera.**

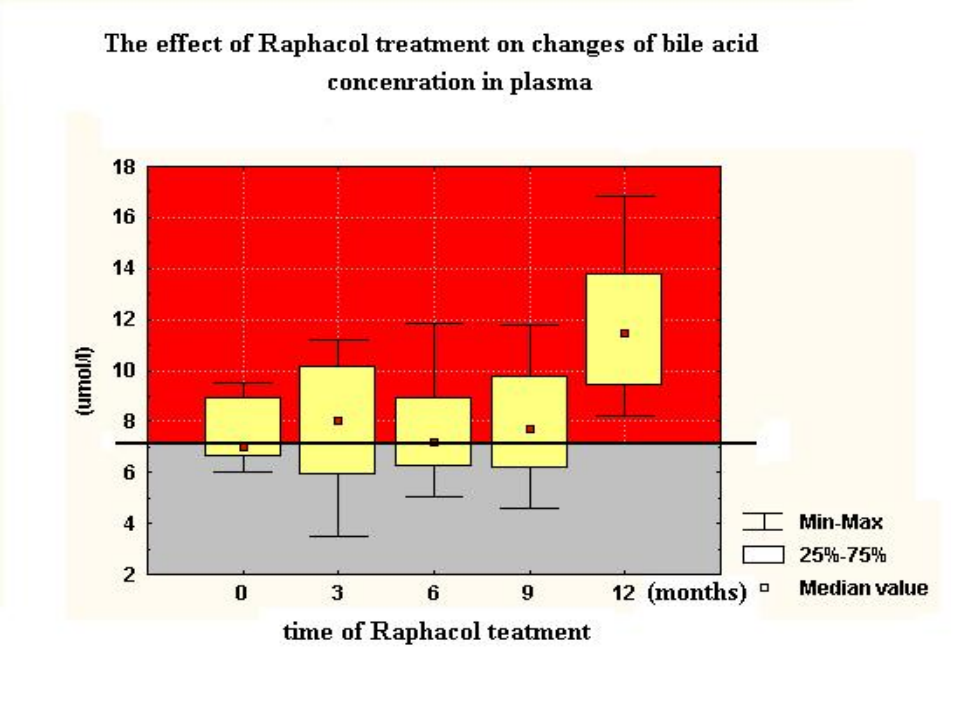
**Most serum parameters such as ions, hemoglobin, hematocrit, liver function enzymes did not change during the treatment.**

**After 6 months some serum parameters such as glucose, hemoglobin-Alc, glycohemoglobin, cholesterol and triglyceride levels improved, and the majority of the patients reported the elimination of the abdominal inconveniences in both diabetic groups.**

**New balance will be formed after three month long treatment.**

# NOT BENEFICIAL EFFECTS OF ISOTHIOCYANATES IN IBD PATIENTS






Usual laboratory parameters were analyzed in the sera. Most serum parameters such as ions, hemoglobin, hematocrit, liver function enzymes did not change during the treatment.

After 6 months, some serum parameters such as glucose, Hgb-Alc, glycohemoglobin, cholesterol, and triglyceride levels improved and the majority of the patients reported the elimination of the abdominal inconveniences in IBD.

Patients were under regular medical control and received adequate treatment of IBD.

Blood samples were collected before the first administration of Raphacol, and after 3, 6, 9 and 12 months.

Bile acid concentration of plasma was higher than the normal value after 12 months long treatent.


THANK YOU FOR YOUR ATTENTION!