

Toxic substances

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Last update: Friday, 12 May 2023 at 9.44 pm.

This article has been translated from WikiSkripta; ready for the **editor's review**.

Toxic substances present real risks:

- causing food intolerance (*intolerance*), toxic for certain individuals,
- causing *intoxication* , toxic for all individuals.

Substances causing food intolerance:

- allergies (immunological reactions), allergens (immunogens), (do not) induce IgE formation,
 - celiac disease , gluten-free diets (<100 mg/kg gliadin dry weight),
- intolerance (non-immunological manifestations), metabolic disorders, hypersensitivity (anaphylaxis), aversion (idiosyncrasy),
 - lactose intolerance, foods with a low content (<10 g/kg), lactose-free (100 mg/kg),
 - phenylketonuria , hydrolysates without Phe,
 - favism, broad bean (*Vicia faba*).

<https://www.wikiskripta.eu/w/Soubor:Toxiny-vicin.jpg>

Toxins and other substances causing intoxication

Classification:

- by structure,
- physical properties,
- by origin (plant, animal),
- by effects,
- main groups of toxins,
- alkaloids,
- saponins,
- cyanogens,
- glucosinolates,
- lectins,
- estrogenic substances,
- phototoxic substances,
- amino acids,
- biogenic amines.

Antinutritional and toxic substances of legumes:

- protease and amylase inhibitors,
- α -galactosides,
- substances causing favism,
- lectins ,
- cyanogenic glycosides,
- estrogens ,
- saponins ,
- lathyrogens.

Toxic substances of higher mushrooms:

- proteins ,
- peptides ,
- amino acids ,
- amines,
- hydrazines,
- alkaloids ,
- terpenoids.

Alkaloids

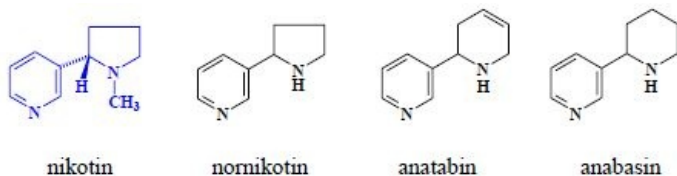
Classification:

- **true alkaloids** (N-heterocycles, derived from amino acids),
 - pyridine (nicotine) and tobacco,
 - piperidine and pepper,
 - pyrrolizidines and senecias (necines),
 - quinolizidine and. lupins,
 - quinoline and cinchona barks,
- **pseudoalkaloids** (N-heterocycles, derived from other precursors),
 - purine a. coffee, tea, cocoa,
 - terpenoid (glycoalkaloids) a. potatoes, tomatoes,
- **protoalkaloids** (not N-heterocycles, derived from amino acids),
 - capsaicinoids and peppers.

Pyridine alkaloids

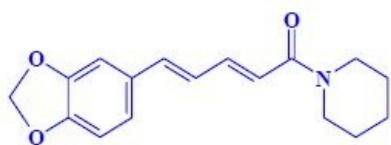
Nicotine and minor alkaloids (~20 compounds):

- tobacco (obligation to indicate content in tobacco products, warnings).



Piperidine alkaloids

Piperine, homologs, geometric isomers, related substances, pepper (hot substances)



Pyrrolizidine alkaloids

Many related esters (mono-, di-, macrocyclic), hepatotoxic substances.

▪



Quinolizidine alkaloids

A number of related compounds, lupine.

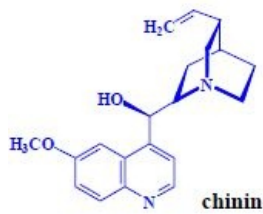
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Quinoline alkaloids

Contents in pod.

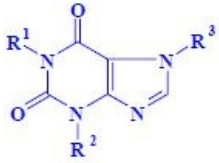
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Legislation: additive, alcoholic beverages 300 mg/l, non-alcoholic (tonics) 75 mg/l (teratogenicity)

Purine alkaloids

a number of related compounds, coffee, tea, cocoa (chocolate), mate, guarana.



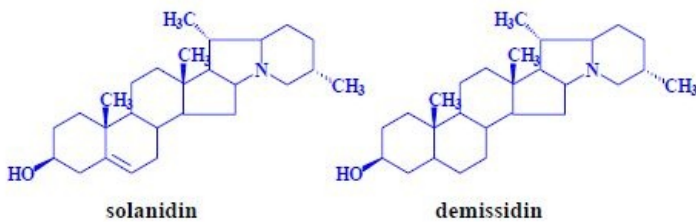
-
- caffeine $R_1 = R_2 = R_3 = \text{CH}_3$
- theobromine $R_1 = \text{H}, R_2 = R_3 = \text{CH}_3$
- theophylline $R_1 = R_2 = \text{CH}_3, R_3 = \text{H}$

Steroidal glycoalkaloids

- a number of related compounds, potatoes, tomatoes, eggplant,
- heteroglycosides, aglycone, sugar.

Potatoes

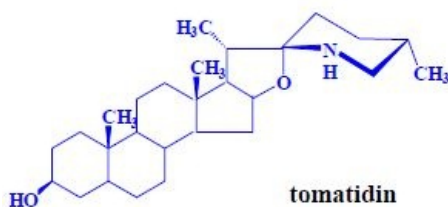
- α -solanine = solanidine + β -solutriose,
- α -chaconine = solanidine + β -chacotriose,



- distribution,
- legislation: 200 mg/kg.

Tomatoes

- tomatine = tomatidine + β -lycotetraose

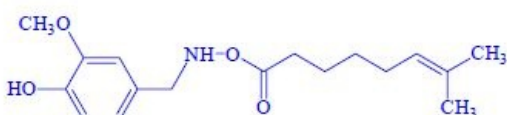


- legislation: 200 mg/kg, teratogenicity

Capsaicinoids

capsaicin, homologues, paprika (hot substances):

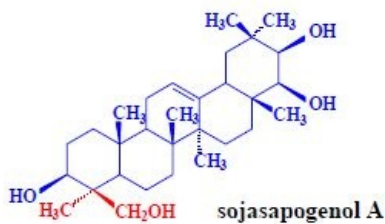
- the effect of technological processing,
- capsaicin, (E)-8-methyl-N-vanillylnon-6-enamide.



Saponins

a number of related compounds, foods of plant origin:

- heteroglycosides, aglycone, sugar,
- aglycon = sapogenin (sapogenol),
 - triterpene alcohols,
 - sterols (4-demethylsterols).



Biological effects:

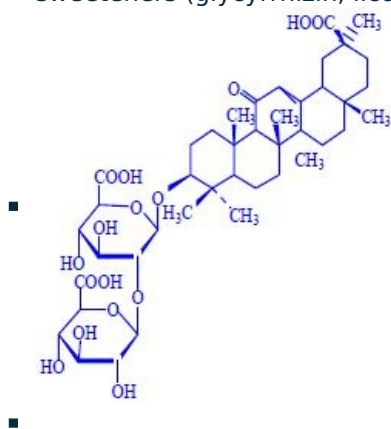
- hemolysis of erythrocytes, other cells, damage to the intestinal mucosa.

Properties

- toxicity to cold-blooded animals,
- bitter taste,
- detergent effects, emulsion (o/w),
- fungicidal, antioxidant, anticarcinogenic, anticholesterolemic effects.

Use

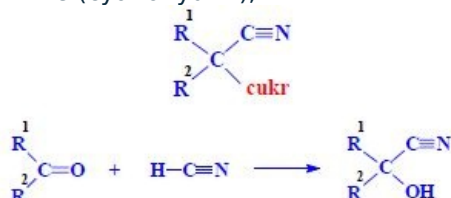
- foaming agents (cosmetics),
- emulsifiers (cosmetics),
- sweeteners (glycyrrhizin, licorice: 0.2–5.6% saponins).



Cyanogenic glycosides

- a number of related compounds, foods of plant origin,
- HCN content in cyanogens,
- heteroglycosides, aglycone, sugar,
- aglycone = 2-hydroxynitrile (cyanohydrin),

- 2-hydroxy acid nitrile.

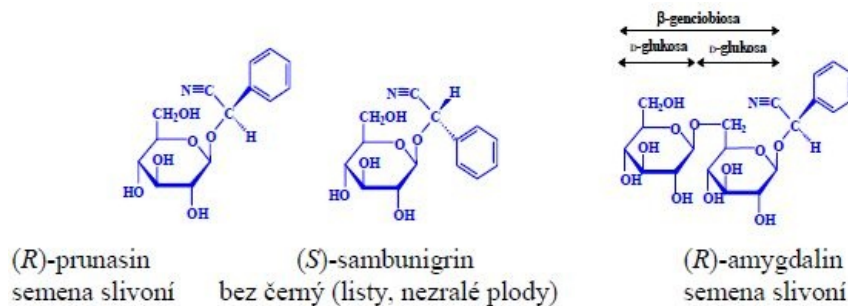


Substituents - Chirality:

- aliphatic - acetone, methyl (ethyl) ketone,
- aromatic - benzaldehyde.

Sugar

- usually Glu,
- genciobiosis disaccharides etc.

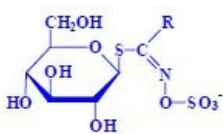


Properties

- decomposition (β -glucosidase) \rightarrow HCN, toxicity (inhibition of cytochrome oxidase in the respiratory chain),
- acute intoxication, chronic intoxication (cassava, cassava).

Glucosinolates

- thioglucosides (glucosides of mustard oils), a number of related compounds, foods of plant origin (cruciferous plants),
- names and structure,
- dominant glucosinolates in vegetables,
 - heteroglycosides, aglycone, sugar, aglycone = thiohydroxamate-O-sulfonate, counterion K^+



Substituents

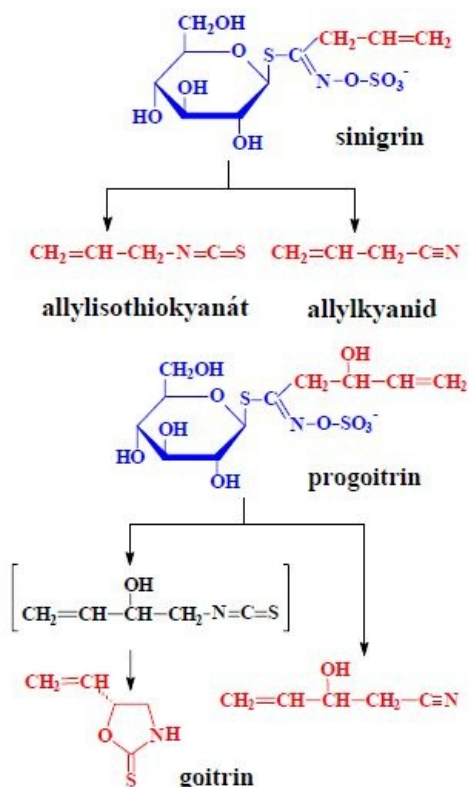
- aliphatic,
- aromatic,
- heterocyclic.

Sugar

- exclusively Glc.

Properties

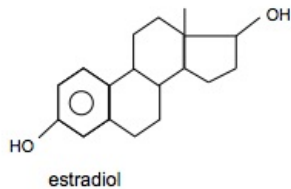
- decomposition (myrosinase) \rightarrow isothiocyanates, nitriles, etc.,
- toxicity, isothiocyanates and goitrin strumogenic, nitriles hepatotoxic.



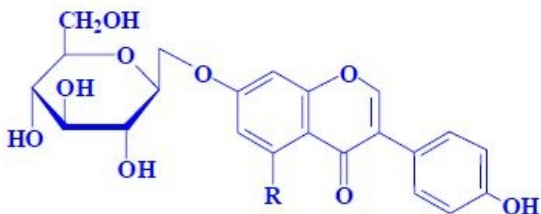
Plant phenols

estrogenic substances

- phytoestrogens - foods of plant origin,



- isoflavones,
- content in soybeans.

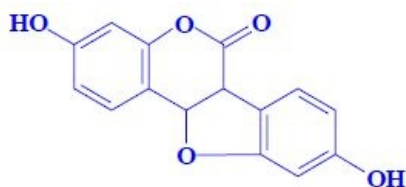


daidzin, R = H aglycon daidzein
genistin, R = OH aglycon genistein
soybeans (0.13–0.42%)

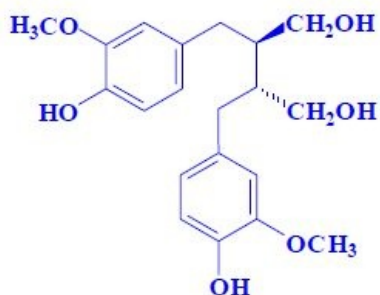
- pterocarps,
- lignans.

content in food

coumestrol – sprouting – soybeans



secoisolariciresinol – flax seeds



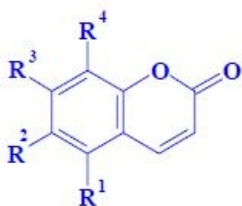
- mycoestrogens,
- xenoestrogens.

Properties

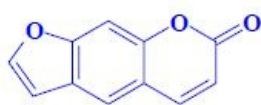
- simultaneously useful and harmful.

Phototoxic substances

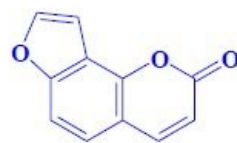
- coumarins,
- furanocoumarins,
- foods of plant origin.



kumariny



lineární psoralen



angulární angelicin

Properties

- phototoxicity (sensitivity of non-pigmented skin, association with skin cancer, acute dermatitis),
- phytoalexins (phytonicides, plant antibiotics, pesticides), blastocolins (inhibits seed germination),
- antimicrobial and other effects.

Phototoxic pigments

- hypericin (St. John's wort), fagopyrin (buckwheat).

Lectins (phytohemagglutinins)

foods of plant origin (seeds and other parts)

Proteins with a non-catalytic center:

- merolectins (1 center, catalytic no),
- hololectins (2 centers, no catalytic),
- chimerolectins (1–2 centers, catalytic yes).

Soy lectin

- metalloprotein, 120 kDa, hololectin, N-acetyl-D-galactosamine binding.

Properties

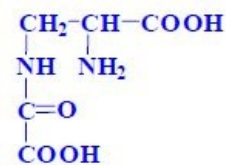
- precipitation of erythrocytes, interaction with sugars in glycoproteins and glycolipids of membranes (plant protection mechanism against predators, parasites),
- toxic intravenously, some orally, some not at all, some probiotics (garlic).

Amino acids

Lathyrogens:

- foods of plant origin (seeds of vetiver and peas),

- amino acids (peptides, nitriles) -3-(N-oxaly)-2,3-diaminopropanoic acid



Properties

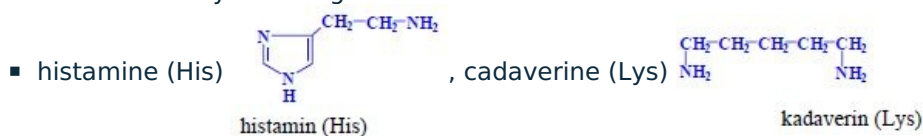
- structural form with proteinogenic amino acids, metabolic disorders,
- deformation of the lower limbs (osteolathyrism), damage to blood vessels (angiolathyrism), disorders of the nervous system (neurolathyrism), humans, mainly farm animals.

Biogenic amines:

- precursors,
- aliphatic, aromatic, heterocyclic bases with biological activity, fermented and microbially degraded foods of plant and animal origin

Emergence

- from amino acids by microorganisms



Properties

- tissue hormones (allergic reactions, anaphylactic shock)
- psychoactive and vasoactive substances

Content

- changes in salami

Links

Internal links

- Natural toxic substances (1. LF UK, NT)

Source

- DAVIDEK, Jiří. *12. NATURAL ANTINUTRITIONAL AND TOXIC SUBSTANCES* [online]. [feeling. 2012-03-13]. <
<https://el.lf1.cuni.cz/p30693038/> >