NUTRITIONAL TOXICOLOGY

Milena Bušová

Department of Hygiene and Epidemiology, First Faculty of Medicine,
Charles University in Prague

Introduction to Toxicology

Xenobiotics - substances - foreign to body (xenos – forein, bios - life)

- natural origin
- artificial substanties

In the body:

- are not natural, for human body forein
- most of xenobiotics in the body are converted (metabolised)
- effective mechanisms for detoxification and elimination of xenobiotics
- depends on characteristics of substances (lipophilic x hydrophilic)

Toxicology

Toxicology (from the Greek words *toxikos* "poisonous" and *logos*) is a branch of biology, chemistry and medicine or specifically – pharmacology concerned with the study of the **adverse effects of chemicals on living organisms**

- ✓ also studies the harmful effects of chemical, biological and physical agents in biological systems that establishes the extent of damage in living organisms
- ✓ studies the relationship between **dose and its effects** on the exposed organism

Factors that influence chemical toxicity: the **dosage** (acute or chronic); the **route of exposure**, the **species, age, sex** and **environment**.

Toxicology

History: **Theophrastus Phillipus Auroleus Bombastus von Hohenheim** (1493–1541) - known as **Paracelsus** **is also considered "the father" of toxicology**

Definition:

- **POISON - toxic chemical substances** or mixtures which are **able to cause damage of organism** and that can be fatal

Paracelsus:"All things are poisonous and nothing is without poison; only the dose makes a thing not poisonous.

„ The dose makes the poison" or in Latin "Sola dosis facit venenum"

RESOURCES

Recources:

- **environment** – polluted atmosphere, water, soil (traffic, industry, agriculture) and working environment
- **food, feed, drinking water, interiors** (flats, offices)
- **agriculture → Food and Feed**
- **industry**

Situation isn´t so horrible - institutions, authorities - issue regulations in the form of legislation limited using of pesticides, and wastewater discharges and **emissions** to atmosphere, other contaminants … ! **Emissions x imissions** ! difference

Discharge of effluents into water, atmosphere, environment - guarding by the **Ministry of Environment,** other authorities as **Central Institute for Supervising and Testing in Agriculture -** authorizes use of pesticides - **subordinate to Ministry of Agriculture**

Entrance paths into the body

Commonly:

Main: **by the digestive tract** – **orally**

- thrue the skin (dermal input), respiratory system (input by inhalation), injection - intravenous, intramuscular, subcutaneous
- most of the substances absorbed **in the intestines, stomach**
- **they migrate either**: the portal vein to the liver and subsequently to the large circulation – **hydrophilic** = polar xenobiotics
- **via the lymphatic system** directly to the large circulation – **lipophilic** = non-polar compounds
- partially - absorbed in the mouth (sublingually)

Substances entering **by a different route than through the digestive system** to the liver come later (slowly)

Path xenobiotics in the body

Polar - hydrophilic xenobiotics

- soluble in water environment
- poorly penetrate through the membranes of cells - through a variety of channels, receptors, transporters
- in blood - transported freely (without transport protein)
- rapidly eliminated by the urine

Path xenobiotics in the body

Non-polar – hydrophobic, lipophilic xenobiotics

- water insoluble or poorly soluble
- can diffuse freely through the membrane
- in the blood bounded to the transport proteins - leads to their slow elimination from the organism
- bounded to the protein can´t be secreted into the urine

Biotransformation

Biotransformation of xenobiotics and metabolism

- **Phase I. = <u>biotransformation</u>** ⇒ free polar functional groups in the molecule
- **Phase II. = <u>conjugation</u>** ⇒ binding with endogenous compounds

<u>Objective of xenobiotics metobolisation:</u>

- **<u>inactivation</u> of xenobiotics and <u>increase the solubility</u> of hydrophobic xenobiotics and removal from the body**

Phase I. - biotransfromation

Localization:

- **in liver** - in the ER membrane, in cytoplasm
- **in many other tissues** - especially at entry, and place of excretion (lung, intestine, skin, kidney)

Enzymes:

- hydrolases - esterases, peptidases, etc.
- monooxygenases ((ie. system cytochrome P450)

Result:

inactivation of xenobiotic and detoxification of organism

- Danger: increasing the biological activity of xenobiotics

  combination: drugs and xenobiotics → **procarcinogens**!

Phase II. - conjugation

Localization:

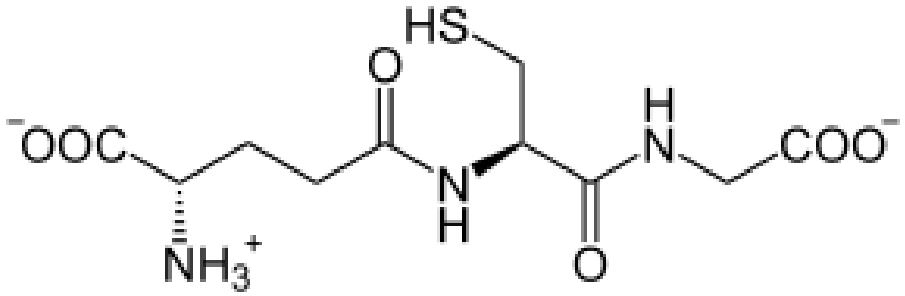
- **liver** (intestinal mucosa, skin): ER, cytoplasm

Result:

- increasing the polar property (solubility) and a reduction (decreesing) their biological activity

Requires - the presence of endogenous conjugating component - **glucuronic acid and glutathione (**synthesized in the liver)

γ-glutamylcysteinylglycin

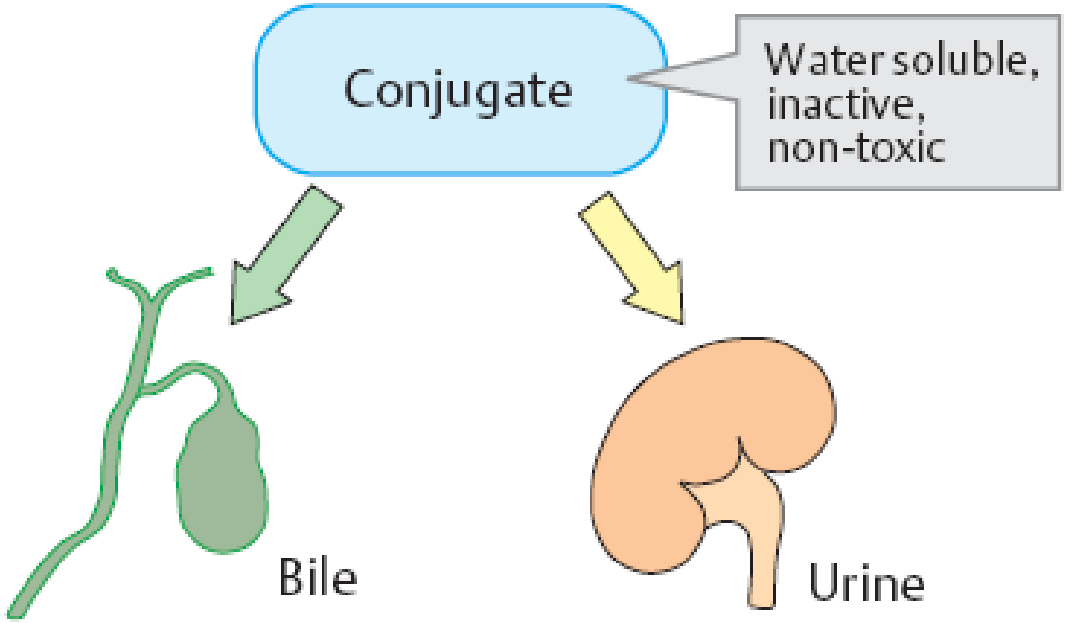


Conjugation of xenobiotics

Endogennous conjugated component

↓

activated conjugate component



- Převzato z Coolman: Color atlas of biochemistry

Nutritional Toxicology

Toxic compounds in food (feed):

- **Entry of xenobiotics into the organism by food** (toxic potential of food)
- **Health risk from consumption of food is almost unlimitled**
- **Absolute food security** – **can´t be guaranteed**
- **Toxic substances in foods** - are a hazard, risk potential of food (feed)

Risks - can be minimized ☺

Entry into the food chain

Definition:

Toxic substance in food - is a harmful chemical that **is not a natural part of the food**.
Their presence in food may endanger human health

- **1. Contaminants - exogenous**
  - endogenous
- **2. Residues**
- **----------**
- **3. Aditives - xenobiotics, are not natural in food - non toxic!!!**
  can be added to food products (according legislation)

1. CONTAMINANTS

Characterized briefly

Substances:

- A. **pass into** the food in - advertently during manufacture, farming, planting on field, (plants), storage, transport, processing … = **exogenous**

  Exogenous - get into the food from the **external** environment

- B. **are formed** in foods by physical, chemical, biochemical and biological factors or interactions between food ingredients = **endogenous**

  Endogenous - **arise in food from natural (main) components** as a result of interaction of environmental influence, processing conditions and storage (by heat treatment, the effect of other physical factors, degradation of main components e.g. proteins…)

2. RESIDUALAS

Residual substances – after application (farming, field production):

- **residues of veterinary drugs -** drugs for treatment of farming animals (residues in muscles, organs, lipids) for human consumption - biologically active agents - antimicrobials, antiparasitics, hormonal agents, morforegulators – prohibited! not allowed, antibiotics (limited use, decreasing) fertilizer ingredients, additives to farm animals feeds …

- **agrochemicals** = substances used to control pests, used to crop treatment (pesticides) and as fertilizers (residues in food – grain, fruits, vegetables, herbs, tea!)

3. ADDITIVES

Characterized briefly“

- substances that **are added to foods** only in **strictly necessary quantities** in accordance with the principles of good manufacturing practice
- **Reason**:

- technological, sensory, transport, storage and others purposes, but in most of the highest allowable amount (treshold!)

MRLs = Maximal Residual Limits in food =

= **total content in food** in the form for consumer or in the consumer packaging (mg/kg of food)

In the Czech Rep.: **ML** – Maximum allowable amount in food

Limits

- **TDI (ADI)** – Tolerably Daily Intake (or Acceptably)
- **TWI** – Tolerably Weakly Intake
- **PTWI** – provisionally tolerably weekly intake

- **Evaluation of Toxicity**

- **NOAEL - No observed Adverse Effect Level**
- SF (Safety factor /100) → TDI(ADI)
- **LOAEL - Lowest Observed Adverse Effect Level**

Units: miligrams or micrograms/kg of body weight/day or /week

✓ mg/kg b.w./day

✓ mg/kg b.w./week

Food – cocktail of chemical substances

Fresh foods - contains about **half a million different chemical compounds**.

Much larger amounts of the compounds furthermore arises by enzymatic and non-enzymatic reactions during storage, processing…

Not all are dangerous! ☺

- **main compounds of food** (proteins, lipids, saccharides, minerals….) and others

EFSA: **All food is made up of chemical substances. Chemicals in food are largely harmless and often desirable – e.g. nutrients such as carbohydrates, protein, fat and fibre are composed of chemical compounds …**

EFSA- European Food Safety Authority, based 2002 y., European Parliament,

from 2005 - **Parma, Italy** → **WHO, FAO, EPA**

Food – cocktail of chemicals…

Chemicals can, however, have a variety of toxicological properties, some of which **might cause harmfull effects** in humans, animals

- usually, these **are not harmful** unless we aren´t exposed to them for **a long time at high levels**
- **protection against harmful effects** - establishing **safe levels – MRLs (Maximal Residual Limits in food**)
- **EFSA:** „Chemical substances (used in protection of crop) - can play an important role in **food production and preservation“**

Exogenous contaminants

- **chemical compounds** present at various levels **in the environment**, e.g. **in soil, water and the atmosphere**
- examples include **industrial pollutants** such as dioxins and PCBs, PAH …
- heavy metals (Cd, Pb,Hg, As…) can be present **naturally** in the environment or as a **result of human activity**

Exogenous contaminants

Resource: **polluted environment**

Example: * **heavy metals** - Hg, Cd, As, Pb .. fish (!MeHg) - fish, seafood !

PAHs, bisphenol A…

* **Brominated flame retardants (BFRs)** - reduce **flammability** of materials

HBCDD – **hexabromcyclododecane**, **TBBPA-tetrabrombisfenolA, PBDE - polybrominated difenylethers** – lipophilic, persistent….

* **contaminants from industry** – plastic s**oftener**s (plasticisers) - in textiles, components of cars, computers, toys for babies, commonly used objects - contact with food…, some food additives…

Endocrine disruptors

Hormonally active substanties – harmfull for animals (water animals, fish, crayfich and **HUMAN reproduction)**

BFRs

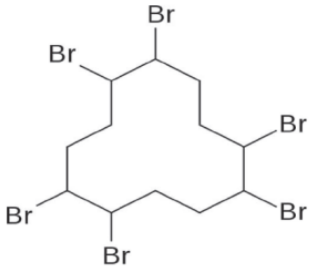
BFRs are mixtures of man-made chemicals that are added to a wide variety of products to **make them less flammable**

- commonly used in plastics, textiles and electrical equipment, many are **persistent, bioaccumulative, and toxic to humans** and the environment

- Between October 2010 and October 2012, **EFSA's Panel on Contaminants in the Food Chain (CONTAM Panel)** reported - main **groups of BFRs - potential risks to public health from their presence in food!** → **intensively monitored**

BFRs – structure

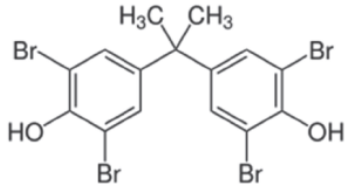
organobrominated compounds



- ✓ **HBCDD – hexabromcyclododecane-**

r.2010 Stockholm´s declaration - reccomended a worldwide ban on its use

- ➢ **TBBPA-tetrabrombisfenolA** - in epoxides, electronics
- ➢ **PBDE-polybrominated difenylethers –**
- ➢ 209congeners - structure similar as PCB !



BFRs

↑ temperature, sun lights – released from plastics (interiors of cars, airplanes, electronics, PCmonitores, PC components, building, isolation materilas, textiles..)

Property:

- **nonpolar**– hydrophobic - not in hydrosphere, not transported by water, but **bioaccumulation!**
- **lipids, tissue – accumulation, chronic toxicity**
- structurally similar as thyroid **hormones**
- **binded to transport proteins of blood**
- **mobilised from lipid tissue – released - afinity to CNS, reproduction system**

Exogenous contaminants – not only from environment

Food packaging materials and containers **- bottles, cups and plates**, used to improve food handling and transport, can contain chemical substances such as **plastic…**

✓ elements **can migrate into food**

Can have effect as endocrine disruptors - estrogenicity

E.g. packing, plastic objects, things, PVC, appartment interiors, cosmetics, plastic toys for babies – **phtalic acid esters =phtalates (PAE) – prohibited! -** plastic bottles for babies – dangerous especially for little boys – can cause feminization! prohibited in toys, bottles…

E.g. di-(2-ethylhexyl) phtalate (***DEHP***), di-butyl phtalate (***DBP***), benzylbutyl phtalate (***BBP***) ….

DANGER: Low acute toxicity, **but – long term exposition of low dose** – proven negative effects: **embryotoxicity, teratogenity, spermiotoxicity, hepatotoxicity, nefrotoxicity, carcinogenity, disturb blood coagulability**

BPA

Phtalates:

- **TDI = 0,05 mg/kg**, established from **NOAEL 5 mg/kg** divided by **safety factor (SF) 100** for phtalates (EFSA)

Occurence in food:

- ✓ small amounth – in spirits and bottled water
- ✓ in food with fat - can migrate (phtalates are lipophilic) - due to contact with **plastic bottle cap** (peppers or olives in oil, dressings, peanut butter)

Bisphenol A - BPA – **bisfenol-A-diglycidylether**

- basic component epoxy –resins, used as inner coating of food cans, water tanks …

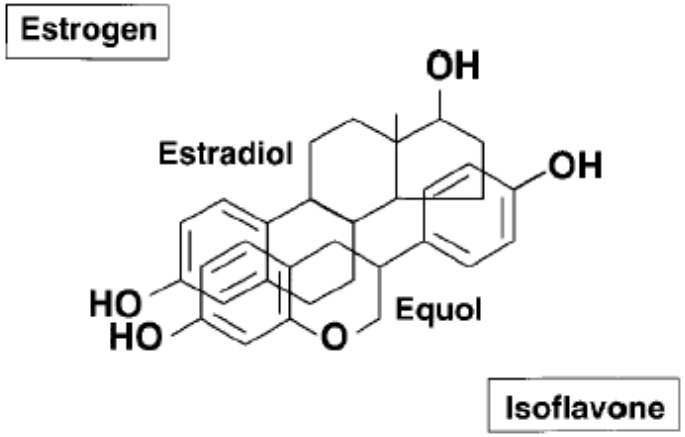
Toxicity: carcinogenity is not strictly proved, but from 2006 y.

BPA **prohibited !**

Endocrine disruptors (ECD)

hormonally active substances

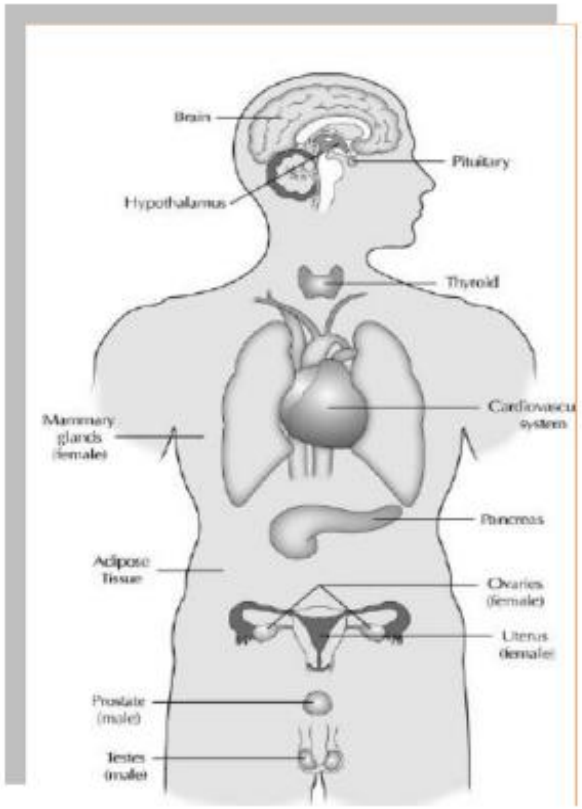
- affect the hormonal system at all levels
- similar structure to hormones
- may occupy receptors
- may modify receptors
- impaired hormon pathways
- conected with metabolic diseases, DM, impaired reproduction, reduction numbers of sperms
- changed sex of fish, other water organisms (crayfish) – the impossibility of reproduction, growth retardation



Obrázek č. 5: Podobnost estradiolu a equolu

Used: google: pictures-wikipedia

ECD



The endocrine system keeps our bodies in balance by maintaining homeostasis and guiding proper growth and development.

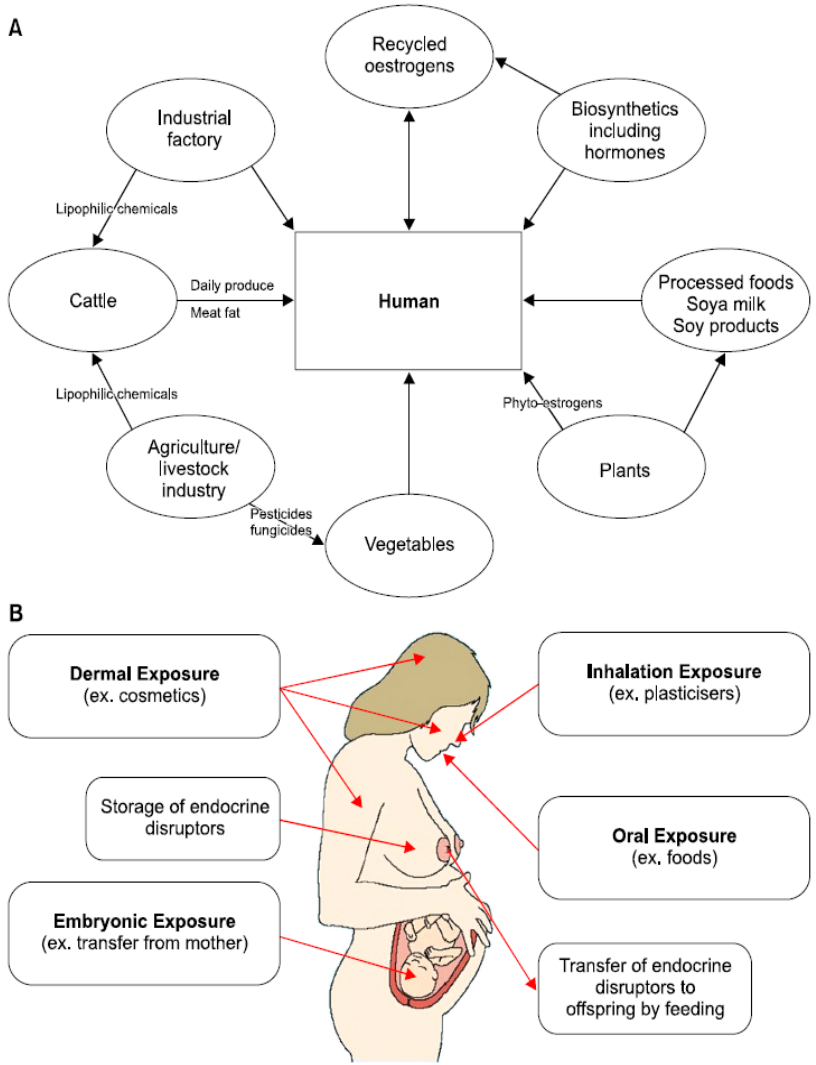
On the other hand, endocrine disruptors interfere with the endocrine system and cause adverse effects both in human and wildlife.

Fig. 6. Model of endocrine systems that include brain and hypothalamic neuroendocrine system; pituitary; thyroid; cardiovascular system; mammary gland; adipose tissue; pancreas; ovary and uterus in females, and testes and prostate in males physiology (Diamanti-Kandarakis et al., 2009).

Kabir E.R., Rahman M.S. and Rahman I.: A review of endocrine disruptors and their possible impact on human health. *Environmental Toxicology and Pharmacology, 2015, vol.40,p.241-258.*

ECD

- **Pesticides (herbicides, insecticides,rhodenticides..)**
- **Additives to plastics (softerners)**
- **BFR = Brominated Flame Retardants**
- **Pharmaceuticals (drugs, contraceptives …)**
- some **additives to food**



Overview of substances with the estrogenic effects in review:

Kiyama,R.-Kiyama,Y.W.:Estrogenic endocrine disruptors:Molecular mechanism of action. 2015, *Environmental Interational*, 83, p.11-40.

Fig: Sharpe, R.M., Irwine D.S.: How strong is the evidence of a link between environmental chemicals and adverse effects on human reproductive health? BMJ,2004,vol.328,p447-451

Endogenous contaminants

Arise in food:

- after **processing conditions** and storages – new substances produced by heat treatment, the effect of other physical factors as -temperature, light, oxygen, etc. **from natural** ingredients → **processed contaminants:** aromatic nitro compounds, PAHs, products of fat oxidation, products of the Maillard reaction

- after activities of contaminating microflora **- mycotoxins** (aflatoxins), **bacterial toxins** (enterotoxins)

- as the breakdown products of metabolism **- biogenic amines**

Mycotoxins

AFLATOXINS – toxins - **Aspergillus family** (Aspergillus flavus, A. parasiticus, A. nomius, A. niger) – extremely high toxicity

aflatoxins **B1, B2, G1 a G2** (according fluorescence UV-light)

- **acute toxicity and carcinogenity**
- **damage the health of humans and animals**
- **primarily affecting the liver (hepatotoxicity)**
- **according classification IARC – group 1-** direct carc.
- **metabolized in the liver to the intermediate epoxide aflatoxins - hepatotoxicity!**
- causes **hepatocellular carcinoma**

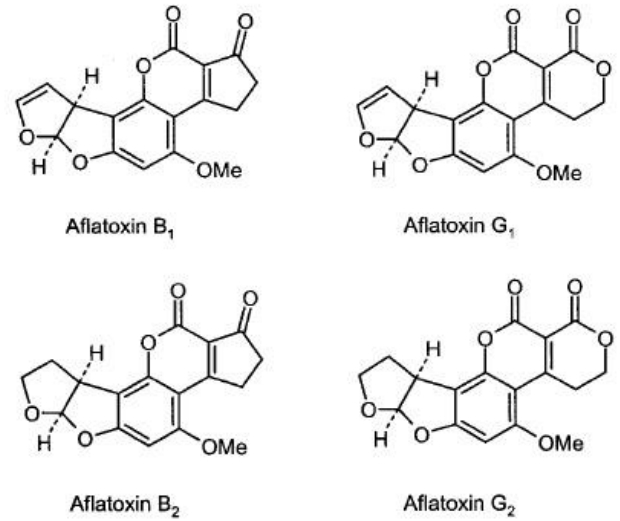


FIGURE 1. Chemical structures of aflatoxins.

MRLs : **Aflatoxins … 0,004 mg/kg** = only **4 µg/kg !**
Aflatoxin B1: 0,002 mg/kg = only **2 µg/kg** - more toxic!

IARC Classification of Chemical Substanties

Group 1	***Carcinogenic to humans***	**119 agents**
Group 2A	***Probably carcinogenic to humans***	**81**
Group 2B	***Possibly carcinogenic to humans***	**292**
Group 3	***Not classifiable as to its carcinogenicity to humans***	**505**
Group 4	***Probably not carcinogenic to humans***	**1**

the numbers change (re-evaluated)

Food and protection

Historically – **discovery of aflatoxins**: turkey – farm near the London (around 1960 y.), feed contaminated - by fungi - **massive mortality of turkeys**

- **bad storage, package and transport conditions** (↑humidity, temperature)
- **foods from tropical countries** (transport - long distance, temperature)

Risky foods - the highest incidence:
peanuts, corn, nuts, pistachios, cotton seeds – subtropic…

Lower: cereals: wheat - flour-bread, rice, almonds, fruit juices, syrups, cheeses, potatoes, oil, coffee, cocoa, chocolate, dried fruit…

Aflatoxins cannot be decomposed !!

Protect food against: protection crop on the field,
against infection by fungi, good storage, sanitation of stocks,
transoport, ↓ temperature, ↓ humidity,

PATULIN – *Aspergilus clavatis* → mycotoxin, on partially rotten fruits
not so danger **(IARC –group3),** can be decomposed by fermentation

In: fruit juice (apple), tomato products, sillage-feed for farm animals

Biogenic amines

Decomposition of organic matter, proteins - decarboxylation of AA (e.g. Histidine - arises **histamine**, lysine **cadaverine**, arginine **agmatine**, **putrescine, tyramine…**)

- at higher levels the **biogenic amines present in** **fermented foods** arise where activity of microorganisms (sauerkraut, aged meats, cheeses, red wine, beer, fermented fruit juices)
- harmfull effect may occur - combining biogenic amines and medication – psychopharmaceutics, in the case of impaired liver function
- high levels of biogenic amines in foods – start processes of food spoilage

Risky food - occurence: caused by contaminating mikroflóra- **mainly in fish** and **meat during storage** (histamine, cadaverine, putrescine, tyramine) and the bad storage of fruits, vegetables and mushrooms (tyramine)

Occurence of biogenic amines - can be used as an indicator (marker) of spoilage (x freshness)

Health effects: **excessive intake can lead to disorders** of the **central nervous system, circulatory disturbances, headaches, heart palpitations, vomiting and diarrhea**

Enterotoxins – alimentary disease

Pathogenic bacteria → toxins: *Campylobacter jejuni*, *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium perfringens*, *Salmonella typhii*, *Shigella dysenterie*…

Botulism - symptoms of poisoning- manifests after 6 to 72 hours after ingestion of food containing the toxin (strong poison) **– botulotoxin.**

Caused: *Clostridium botulinum* (anaerobic microorg.) – food contaminating pathogen

Effect:

- ✓ consist of headaches, nausea, vomiting, dry mouth, double vision, and ultimately in paralysis of muscles, including the respiratory, which ends at 30 to 65% of deaths
- ✓ **botulotoxin - protein**, therefore inactivated by elevated temperature (**15 to 25 minutes at 100 ° C)**
- ✓ Botulism **is rare**, bad sterilization of meat (cans - tempr. > **121°C** - kills bacteria)

Alimentary infections – due to contaminated food or water, bad sanitation, hygiene

PAHs

PAHs - Polyaromatic Hydrocabons

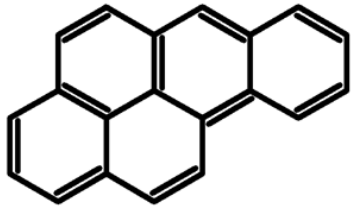


Table: google

Typical representative: benzo(a)pyrene

Occurrence: in coal tar, exhaust gases (traffic), in smoke - combustion of organic materials, fossil fuels, tabacco smoke!, grilled and smoked food

- ✓ **in atmosphere (imission limit** for benzo[*a*]pyrene in external air = **1 ng.m^{-3}**
- ✓ in **heavily smoked and barbecued foods**

Benzo(a)pyrene ... ADI - 3 µg/kg b.w./day = 0.003 mg/kg/day

- ✓ **carcinogenic (proven) for human ! IARC – group 1**

PAHs

- Boiled meat – content benzo[a]pyrene max. **4 ng/g** meat (1)
  - **gently technology -**

www.receptynakazdyden.cz

www.receptyonline.cz

- Fried chicken - content **5,5 ng/g** meat (2)
- Grilled - barbeque beef – content 62,6 meat ng/g (3)

Res: (1) Kazerouni N, Sinha R, Hsu CH, Greenberg A, Rothman N. Analysis of 200 food items for benzo[a]pyrene and estimation of its intake in an epidemiologic study. *Food and Chemical Toxicology* 2002;40(1):133. doi:10.1016/S0278-6915(00)00158-7

(2) Lee BM, Shim GA. Dietary exposure estimation of benzo[a]pyrene and cancer risk assessment. *Journal of Toxicology and Environmental Health Part A*. 2007 Aug;70(15-16):1391-4.

(3) Aygün SF, Kabadayi F. Determination of benzo[a]pyrene in charcoal grilled meat samples by HPLC with fluorescence detection. *International Journal of Food Sciences and Nutrition*. 2005 Dec;56(8):581-5.

Processing contaminants

Heating of lipids (including effect of oxygen) - oxidation - products of lipid peroxidation, **peroxy- acid and hydroxy- fatty acids**

- ✓ irritates the digestive tract, damage of liver functions, retardation of growth, (death)
- ✓ toxic effect can be decreased - enough of **vitamin E (**in organisms)
- ✓ **antioxidants** (added to frying oil) decreases the frying oil oxidation, effectiveness of antioxidant decreases with high frying temperature
- ✓ refined (fresh) oils – **MCPD – Mono-chlor- propan-diole** - product of high temperature in technology, **ADI** - isn´t given yet, EFSA (panel Contam) for MCPD - studies…

High levels: refined -palmic oil, sunflower, soybean, canola

The best: olives extra virgine (best) - technology by pressing (without refining)

Heating carbohydrates (saccharides) - higher temperature - **leads to polymeric products** (under the name **caramel** is used as a pigment, for good taste)

The primary products are primarily aldehydes as **furfural**, which have **adverse health effects**

Processing contaminants

ww.tradicnirecepty.cz

Products of the Maillard reaction

- produces - typical flavors, fragrances and color on processed food

Principle: chemical **reaction between amino acids and carbohydrates** such as glucose, fructose, lactose

- ✓ high temperature is necessary for initiation of reactions
- ✓ **Louis Camille Maillard** (1878-1936), who first described the formation of brown pigments (1912) while heating glucose with glycine
- ✓ studied for more than 110 years
- ✓ produce a number of highly reactive new carbonyl compounds
- ✓ potentially toxic products
- ✓ reduce the nutritional value of food

Maillard reaction

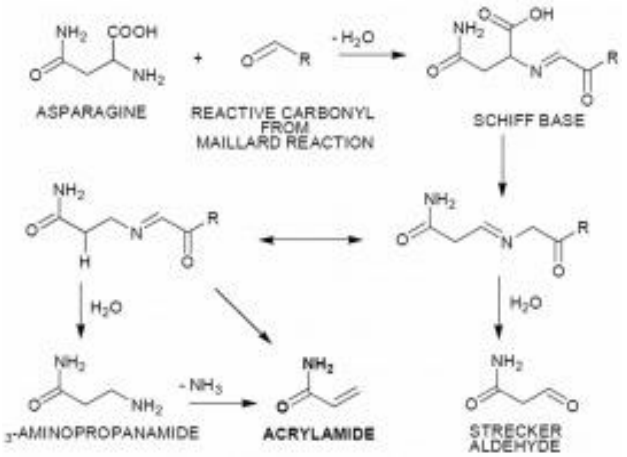
Principle: chemical **reaction between amino acids and carbohydrates** such as glucose, fructose, lactose

- ✓ Maillard reaction - among the **most complex chemical reactions in food**
- ✓ **formed toxic compounds, most of non-stable intermediates (Amadoriho products)**

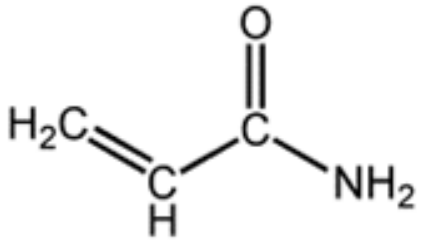
Negative health effects:

- ✓ Amadori products or their degradation compounds with free amino groups of proteins **react in organism with long life tissues** - collagen, elastin, myelin – **damage them!**
- ✓ AGEs products - Advanced Glycation End products)
- ✓ processes are irreversible, **permanent damage tissues** (in higher concentrations in patients with chronic diseases)
- ✓ reducing immunity, cause chronic inflammation, diabetes, disruption of the mechanisms of DNA repair
- ✓ One of the **most toxic known substance - Acrylamide**

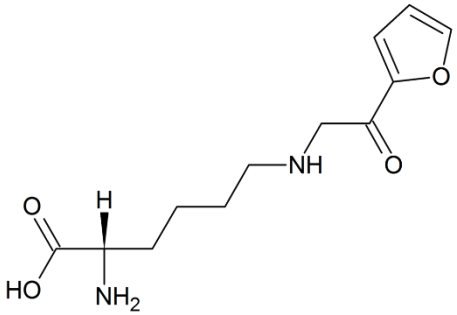
http://www.chempoint.cz/akrylamid-v-potravinach



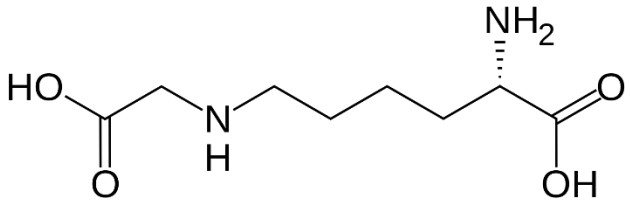
- **Akrylamid**



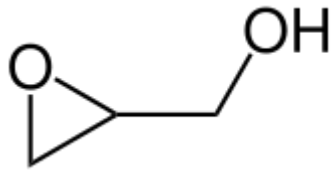
- **Furosin**



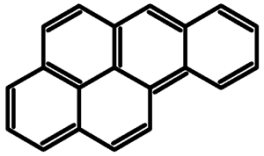
- **Carboxymethyllysin**



- **Glycidol (**2,3-Epoxy-1-propanol)

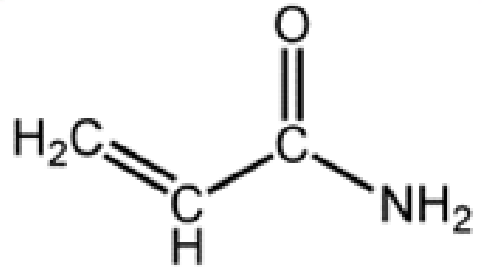


- **Benzo(a)pyren**
- **and more ….**



Structure: www. wikipedia

Maillard reaction



Acrylamide – presence in food is undesirable

- known from industrial use in the manufacture of plastics, glues, paper and cosmetics
- professionally exposed employers – neurotoxicity
- has the ability to damage the nerve tissue (high concentration)
- discovered **in foods in high concentrations,** since 2002 y. (Stockholm University reported)

Acrylamide can be formed in food technology after heat treatment:

> t 120 ° C = baking, frying, deep frying, roasting, grilling

Risky foods: **potato chips, crackers, crisp bread, breakfast cereals (müsli), bread, roasted coffee, dried fruits, baked-grilled vegetables, roasted cernels (almonds, walnuts) …**

Acrylamide monitoring

Chem. Listy *108*, 205–210 (2014) Referát

Tabulka II
Obsah akrylamidu [μg kg^{-1}] v různých potravinách v letech 2007–2010 (cit.[41])

Kategorie potravin	Rok 2007			Rok 2008			Rok 2009			Rok 2010		
	Počet vzorků	X	M	Počet vzorků	X	M	Počet vzorků	X	M	Počet vzorků	X	M
Hranolky (upravené ke konzumaci)	648	356	2668	563	277	2466	501	342	3380	256	338	2174
Bramborové lupínky	293	551	4180	532	580	4382	414	639	4804	242	675	4533
Předsmažené hranolky	137	306	2175	254	223	3025	249	270	2762	117	331	3955
Čerstvý chléb	176	75	1778	259	53	565	182	46	1460	150	30	425
Snídaňové cereálie	144	149	1600	166	155	2072	191	139	1435	174	138	1290
Sušenky, krekry, chlebové čipsy	938	326	4200	898	272	3307	964	247	4095	462	333	5849
Káva a náhražky kávy	312	373	4700	443	393	7095	279	463	4300	151	527	8044
Dětská výživa jiná než obilná	93	29	162	149	22	180	128	38	677	55	69	1107
Dětská výživa obilná	170	119	1215	194	69	1200	153	72	710	128	51	578
Snack (nebramborový)	63	275	2110	33	238	2120	66	208	621	80	192	1910
Müsli, obilná kaše	47	241	1315	26	33	112	72	58	487	14	80	420

X – průměrná hodnota [μg kg^{-1}], M – maximální hodnota [μg kg^{-1}]

From study: Cwiková et al: TOXICKÉ ÚČINKY AKRYLAMIDU A JEHO VÝSKYT V POTRAVINÁCH, Chem. Listy *108*, 205–210 (2014)

Maillard reaction

Acrylamide:

- **IARC group 2A - Probably carcinogenic to humans**
- **U.S.-EPA, WHO, FAO → dangerous for human health**
- **ADI** acrylamide has not been established (health effects are studied)
- **NOAEL is: 0,5 mg/ kg of body weight/day - 5 µg kg of body weight/day ???**
- **drinking water: limit for acrylamide is: 0.1 µg.l^{-1}**

Decrease levels of Acrylamide in Food

Blocking the reaction during cooking

- ↓ temperature
- ↓ time of processing
- ↓ content of saccharides (potatoes with low content of starch) …
- change of conditions (pH)
- „**Acrylamide Toolbox“ –** EU authorities

Link:
http://www.fooddrinkeurope.eu/documents/brochures/CIAA_Acrylamide_Toolbox_Oct2006.pdf

3. Additives

- Chemical substances - play an important role in **food production and preservation.**

Additives:

- prolong the shelf life of foods; others, such as colours, can make food more attractive
- Flavourings are used to make food tastier
- Food supplements are used as sources of nutrition (loss of vitamins in processing – heating, conservation of food in high temperature)

Preservatives, antioxidants, vitamines, stabilizers, emulsifiers, artificial sweeteners, colorants …

E110, E 300, E330,…..

ADDITIVES

- substances that **are added to foods** only in **strictly necessary quantities** in accordance with the principles of good manufacturing practice

- **Reason**:

- technological, sensory, transport, storage and others, but in most of the highest allowable amount (treshold!)

MRLs = Maximal Residual Limits in food =

= **total content in food** in the form for consumer or in the consumer packaging (mg/kg of food)

- Some of them can have effects as ECD

Contaminants

- Additives:
- https://www.youtube.com/watch?v=3qdnnhgu4FE

- 10 additives to avoid
- https://www.youtube.com/watch?v=rrAeflOiOts

Monitoring of Contaminants in Europe

- European countries are **monitoring the levels of contaminants** in food and feed
- data **are used to evaluate exposure of people** and animals
- Since 2010 data are submitted to **EFSA** (most of EU countries) = Standard Sample Description –SSD
- found contaminants levels are often very low

EFSA

Second EFSA chemicals in food report underlines “crucial role of data”

webside: http://www.efsa.europa.eu/en/press/news/161215

Pesticides, veterinary drugs, contaminants

The report focuses on two annual reports – **pesticide residues** and **veterinary drug residues** – and on consumer **exposure to process contaminants** of recent public interest: acrylamide in food, and glycidyl esters and 3-MCPD in vegetable oils and food.

EFSA

- across Europe, EU member states (and stakeholders) collect, monitor and analyze information on levels of chemicals in plants, animals, food and drinks

- it can also help them to understand if new safety assessments or control measures

- the data collected can also be used in risk assessments of individual substances, such as e.g. the process contaminants and s.o.

RASFF

Rapid Alert System for Food and Feed

- reported weekly …. dangerous and toxic substanties in food and feed in Europe – webside

- www.bezpecnostpotravin.cz

RASFF - example

- National consumers website: Czech Republic
- Czech Republic RASFF notifications: 7 results

- 03/01/2017 2017.0005 Italy histamine (< 1252 mg/kg - ppm) in anchovy paste from Italy, with raw material from Morocco No Details
- 22/12/2016 2016.1795 Germany Listeria monocytogenes (2200 CFU/g) in raw milk cheeses from France No Details
- 22/12/2016 2016.1800 Denmark nutrition protein bars from Spain infested with moulds No Details
- 19/12/2016 2016.1765 Czech Republic migration of formaldehyde (35.2; 33.2 mg/kg - ppm) from melamine decorated soup plate from China Yes more info Details
- 19/12/2016 2016.1766 Czech Republic migration of cadmium (bowl: 3.42; 2.84 mg/l and plate: 1.54; 1.12 mg/dm²) from ceramic breakfast set from China, via Spain Yes more info Details
- 16/12/2016 2016.1751 Czech Republic chlorpyrifos (0.084 mg/kg - ppm) in apples from Poland No Details
- 22/11/2016 2016.1601 Austria plastic fragment in fruit roaster from Austria No Details

Select another country Open in RASFF Portal

Authorities in the Czech Republic

Authorities in CR:

- **SZPI - Czech Agriculture and Food Inspection Authority**
- **SVS - State Veterinary Administration)**

WEBSITEs: in English, too ☺

- www.**bezpecnostpotravin.cz**
- **www.agronavigator.cz**
- **RASFF (Rapid Alert System for Food and Feed)**
- **EFSA (European Food Safety Authority)**
- **www.foodnet.cz**

Contact: milena.busova@f1.cuni.cz

Thank you for your attention