Foreign substance in food

Template:Checked**Toxicology in nutrition**

Together with food, a number of substances from the environment, which are characterized by toxic potential, enter the body. They enter the food from the environment, from polluted air, contaminated water, soil, as a result of the application of agrochemistry, during technological processing of food raw materials, during food production, their packaging and transport. In accidents, contamination of food with radioactive substances can occur. Limits for the most serious foreign substances are listed in the Decree of the Ministry of Health of the Czech Republic.

The toxic effect of "xenobiotics" (substances foreign to the body - foreign substances) and the subsequent influence on the state of health is determined not only by their presence in food, but mainly by the amount that enters the body - dose and frequency - duration of exposure. Xenobiotics can have various toxic effects in food, many times specific only for certain organs, they can influence immune reactions, integrate with nutritional components and worsen their biological values. Their late (*genotoxic, carcinogenic, embryotoxic, teratogenic*) effects have a serious impact, with the possibility of affecting further generations.

NOTE: Previously, foreign substances in food were divided into additive substances (additives - additives) added to food on purpose and contaminating substances - contaminants entering food from the environment. According to the current legislation, food includes any substance that becomes part of the food during processing, preparation or handling, i.e. even additive substances and cannot therefore be considered as foreign substances.

Foreign substances contaminating food include both inorganic and organic substances.

Inorganic contaminants

Cadmium

The source is the chemical and metallurgical industry, it enters the soil through fallout and polluted water. It occurs in soil, plants and animal products. The use of phosphate fertilizers with a high content of this element also contributed to the increased content in the soil. Some types of vegetables, especially root vegetables and cereals, are able to actively absorb this element and build it into their structure. The main route of exposure is food, accumulation occurs in the kidneys and liver. Smoking contributes to the overall exposure to cadmium through inhalation exposure, Cd is contained in tobacco. Acute food poisoning has been described in Japan as Itai-Itai disease, after long-term consumption of rice with high Cd content. kidney tubule involvement resulted in proteinuria, hypercalciuria, calcium leaching from bones, and osteomalacia. The disease was accompanied by great pain, hence the name of the disease, which in our language means Ah - Ah. However, cadmium is a burden for the body even in doses that do not exceed the limits. According to the IARC (International Agency for Research on Cancer), this element was in group 1, i.e. among the proven human carcinogens. Cadmium also interferes with the angiogenesis process by producing prostacyclins in endothelial cells and subsequent increased clustering thrombocytes. It also contributes to the increase in blood pressure, blocks the protective effect of selenium and zinc. Biological monitoring informs about the body's load with this element - the level of Cd in the blood characterizes the current load, the level in the urine the accumulation in the body.

Lead

The main route of exposure is inhalation from air polluted as a result of the use of "petrol" with the addition of "tetraethyl lead". Exposure through the alimentary route occurs through lead-contaminated dust in the vicinity of metallurgical plants, water from lead pipes, or the passage of lead from glazes and enamels of containers or cans. Chronic lead poisoning has been described from drinking tea with lemon from lead-glazed containers. About 5–10% of lead is resorbed from the digestive tract. In the body, lead is "stored" primarily in the bones, to a lesser extent it is contained in other tissues and in the blood. Young children are considered a high-risk group due to the proven influence on their mental development, perceptual abilities and psychological abilities even with relatively low exposure characterized by a blood lead level of 100 µg/l.

Mercury (Mercury)

It comes from both natural and anthropogenic sources. It is present in inorganic and organic form - alkylmercury, which is characterized by toxicity and the ability to penetrate the placenta. The source of alimentary intoxication is contaminated food - fish (encephalopathic symptoms, Minamata disease), feeding contaminated grain and subsequent deposition of mercury in animal meat and eggs.

Arsenic

From a chemical point of view, it belongs to the metalloids. It enters the environment mainly during the burning of brown coal and through industrial use. In agriculture, it is part of some pesticides, which contributes to alimentary exposure, as does the consumption of marine animals. The more toxic form is inorganic, it causes kogeneral, neurological, hematological changes. According to the IARC, it is classified as a **proven carcinogens'**.

Nitrates

They are a common part of the diet. The source of alimentary exposure is their content in vegetables, drinking water, but also in cured meats. They are non-toxic in themselves, their health risk lies in their reduction by bacterial nitroreductases to "nitrites". These are involved in the formation of **infantile''''''''''''''''''''** *The reaction of nitrite ions with secondary or tertiary amines in food leads to the formation of "nitrosamines" and other N-nitrosolates and toxic and "potentially carcinogenic effects" (esophageal, stomach, bladder cancer). This process occurs not only in food, but also* ***endogenously in the organism'****, mainly in the stomach or in the bladder at a slightly acidic pH.* Endogenous nitrosation can be blocked by various substances taken in food – vitamin C, vitamin E, plant phenols.

Organic contaminants

Polychlorinated biphenyls (PCB)

They were used as hot-water media and part of coating materials. Their production was stopped in the 1970s. They still persist in the environment, but their persistence is gradually decreasing. Exposure occurs when it enters the food chain from the environment, especially foods with a higher fat content. In the body, they are preferentially stored in *fat tissues*, *pass through the placenta and are excreted in breast milk*. When exposed to high doses in accidents, a range of symptoms such as *chloracic* and other skin manifestations, eye damage, neurological symptoms, liver dysfunction, increased cholesterol and triacylglycerides in blood, alterations in carbohydrate metabolism and immune suppression. Yusho disease was a mass poisoning after ingestion of contaminated rice oil in Japan in 1968. According to the IARC, PCBs are classified in **group 2A' -** *suspected human carcinogens*. They intervene in the carcinogenic process indirectly by inducing enzymes that activate carcinogens. Their "immunotoxic effect", contribution to the increase of "cholesterolemia" and the induction of "oxygen radicals" is also significant.

Polychlorinated dibenzo-p-dioxins (PCDD)

They are released into the environment during combustion, and are characterized by a similar but more pronounced spectrum of effects than PCBs – carcinogenicity of the non-genotoxic type, reproductive disorders, fetal development disorders, estrogenic effects.

Chlorinated dioxins

They are created as a by-product in the production of many chemical substances and decompose very slowly in nature. They are carcinogenic to humans. In high doses, they cause permanent damage to the skin called chloracne. The scandals with contaminated feed (and therefore also meat) in 2008 in Ireland and 2010 in Germany are well known. In Germany, a technical mixture of fatty acids contaminated with dioxins was added to industrially produced feed.

Polycyclic aromatic hydrocarbons (PAH)

It is a group of more than 100 chemical substances occurring in all components of the environment. They are created during the **imperfect combustion of organic material'**, including grilling, frying, baking, and roasting of foods. They are characterized by a significant *carcinogenic potential*, they can also participate in the mechanisms of atherogenesis and increase the body's *oxidative stress load*. The main representative and at the same time the exposure indicator is **benzo(a)pyrene'**. They become carcinogenic only after their metabolic activation in the body, while the method of their metabolic transformation is highly individual and the resulting metabolite can be a carcinogenic and genotoxic biotransformation product, but also harmless conjugates excreted in the urine. Inhalation exposure (cigarettes) is associated with lung cancer and bladder cancer.

Phthalic acid esters

They enter the environment and food as a result of "burning of plastic materials". Phthalates are used as plasticizers in the production of plastic materials, sometimes they are also found in food packaging, and phthalic acid esters can pass into food. Phthalic acid esters were found in small amounts in packaged beverages.
Their importance lies in their *carcinogenic potential* (they are classified as suspected carcinogens with a presumed, non-gonotoxic mechanism of action) and in the ability to induce peroxisomes in liver cells with the formation of oxygen radicals. They also have an estrogenic effect that reduces male fertility.
The use of phthalic acid esters as plasticizers in the production of plastics is currently regulated by legislation.

Toxic substances arising from technological processes

Production, storage and heat treatment can cause the formation of toxic products in food. During heat treatment (frying, baking, grilling, smoking, toasting, roasting), ``polycyclic aromatic hydrocarbons *are formed.* The pyrolysis of animal protein foods produces ``pyrolysates *of amino acids (heterocycleschemical amines) with high mutagenicity and carcinogenicity proven in animals.* ***Acrylamide*** *(IARC 2A – probable human carcinogen) is formed in a wide range of foods (including e.g. bread, potatoes) during their heat treatment at high temperatures. Although it appears to have been present in the diet since the time when man began to heat treat it, the EU has developed procedures to reduce its content in industrially produced foods. Improper storage – higher temperature, humidity, leads to an increased risk of mycotoxins.* Residues of antibiotics given to animals during treatment in compound feed may appear in animal products. Residues of disinfectants or hormones can be proven in some foods.

Toxic substances arising as a result of food contamination by toxigenic molds

The most serious group are *mycotoxins*, toxic products of molds. Their formation occurs under suitable conditions - "moisture, heat" in moldy foods. Nuts, cereals and products containing these ingredients are particularly risky. **Aflatoxins (aflatoxin B1)** are produced by the fungi Aspergillus flavus and Aspergillus parasiticus. They are one of the most effective hepatotoxins and hepatocarcinogens, in addition to having an immunosuppressive effect. Livestock can be exposed to mycotoxins by ingesting moldy feed. Their aflatoxin M metabolites are then present in milk and milk products. Intoxications from the ingestion of aflatoxins are called "aflatoxicoses". Aflatoxin B1 is believed to be one of the etiological factors of Reye's syndrome in children. '*Ochratoxins* are mycotoxins produced by fungi of the genera Aspergillus and Penicillium. Causes liver and kidney damage. **Patulin** is a mycotoxin found in improperly stored fruit, especially apples, and is considered a potential carcinogen. From the point of view of the prevention of the formation of mycotoxins in food, it is necessary to store them in conditions limiting the growth of molds. If mold already occurs, we generally do not consume these foods.

Toxic substances arising endogenously in the organism

This group includes the endogenous formation of "nitrosamines" in the stomach and bladder when the body is overloaded with nitrates, the formation of "active oxygen" and "oxygen radicals" as a result of lipid peroxidation of cell membranes, the formation of toxic substances by the action of intestinal microflora and the formation of "carcinogenic products" during the metabolic transformation of xenobiotics.

Interactions of chemical contaminants with nutrients

A number of foreign substances (PCBs) act as inducers of enzyme systems that perform essential functions in biotransformation processes (formation of endogenous cholesterol, activation of procarcinogens). Zinc is part of the activating enzyme superoxide dismutase, and its deficiency reduces the activity of this enzyme and thus the body's defense against oxidative stress. An excess of cadmium, which blocks zinc and makes its protective function impossible, has a similar effect. Ascorbic acid and α tocopherol inhibit the reaction leading to the formation of nitrosamines, but at the cost of their higher consumption or insufficient performance of their other protective functions.

Natural toxicants in the diet

Toxic substances, which are a natural part of some plant foods, are produced essentially as a defense against attack by bacteria, fungi, insects, and animals. Among the poisonous foods, mushrooms are in the first place. The toxic substances contained in them can cause hepato- and nephrotoxic changes - Amanita phalloides (green toadstool), neurotoxic (fibers, red toadstool), vasotoxic (dung beetle with alcohol consumption), gastroenteric (satan mushroom). Solanine (in sprouted potatoes) is contained in ``lilac-like plants*, which is characterized by symptoms of cholinesterase inhibition. In ""bitter almonds"" there are glycosides that split hydrogen cyanide. A number of other natural toxic, mutagenic and carcinogenic substances are in foods of tropical and subtropical regions, which we practically do not encounter in our country. An example is the cyanogenic glycoside "linamarin" found in cassava, which is a staple food for about 300 million people. The population rids the tubers of poisonous substances using relatively complex procedures.* **Plants** contain **pyrrolizidine alkaloids**, genotoxic substances that can be part of drugs and teas. Carcinogenic substances can also be present in "some types of spices" that contain safrole, eugenol, estragole (black pepper, ginger, nutmeg). However, these are used in negligible amounts, so there is no significant danger. In animal food, naturally toxic substances occur in "some types of fish". The hemolytic protein poison ichthyotoxin was proven in the blood of eel-like fish, but it is harmless when the meat is consumed. Japanese fugu fish have a entrailsh tetrodotoxin present. Poisoning is manifested by a drop in temperature, slow pulse, cyanosis, dizziness, unconsciousness.

Links

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- Cadmium
- Lead
- Mercury
- Arsenic
- Polycyclic aromatic hydrocarbons

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