Foreign substances in food

Along with food, a number of substances from the environment enter the body with toxic potential. They enter the food from the environment, from polluted air, contaminated water, soil, as a result of the application of agrochemicals, in the technological processing of food raw materials, in food production, packaging and transport. Accidents may result in contamination of food with radioactive substances. The limits for the most serious contaminants are given in the Decree of the Ministry of Health of the Czech Republic. The toxic effect of **xenobiotics** (substances alien to the body - foreign substances) and the consequent effect on health is determined not only by their presence in the diet, but mainly by the amount that enters the body - the dose and the frequency - the duration of exposure. Xenobiotics can have various toxic effects in the diet, many times specific to certain organs, affecting immune responses, integrating with nutritional components and impairing their biological values. Their late ('*genotoxic, carcinogenic, embryotoxic, teratogenic*) effects are of major concern, with the potential to affect future generations.

NOTE:' Previously, foreign substances in food were divided into additives (additives) added to food intentionally and contaminants - contaminants entering the food from the environment. According to current legislation, food includes any substances that become part of the food during processing, preparation or handling, including additives, and therefore cannot be considered as foreign substances. Alien food contaminants include *both inorganic and organic substances*.

Inorganic contaminants

Cadmium

The source is the chemical and metallurgical industries, and it enters the soil through runoff and polluted water. It occurs in soil, plants and animal products. The use of phosphate fertilisers with high levels of this element has also contributed to the increased content in soil. Some vegetables, especially root vegetables and cereals, are able to actively absorb and incorporate this element into their structure. The main route of exposure is through food, with accumulation occurring in the kidneys and liver. Smoking through inhalation exposure contributes to total cadmium exposure, Cd is contained in tobacco. Acute alimentary poisoning has been described in Japan as Itai-Itai disease, following prolonged consumption of rice high in Cd. Affection of the tubules of the renal gland led to proteinuria, hypercalciuria, calcium leaching from the bones and osteomalacia. The disease was accompanied by great pain, hence the name of the disease, which in our language means Ah - Ah. Cadmium, however, is a burden on the body even in doses below the limits. According to the **IARC** (International Agency for Research on Cancer), this element has been placed in **Group 1'**, i.e. among the **proven human carcinogens'**. Cadmium also interferes with the process of angiogenesis by producing prostacyclins in Subscribe to DeepL Pro to edit this document. Visit www.DeepL.com/profor more information. endothelial cells and subsequent increased aggregation thrombocytes. It is also involved in the elevation of blood pressure, blocking the protective effect of selenium and zinc. Biological monitoring informs about the organism's burden of this element - the level of Cd in the blood characterizes the current burden, the level in the urine the accumulation in the organism.

Lead

The main route of exposure is inhalation from air polluted by the use of **gasoline** with the addition of **tetraethylene**. Exposure via the alimentary route occurs through lead-contaminated dust around metallurgical plants, water from lead pipes or through the passage of lead from the glazes and enamels of jars 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 **deposited** primarily in **bone'**, and to a lesser extent in other tissues and in the blood. Young children are considered to be a high-risk group because of proven effects on their mental development, perceptual abilities and psychological abilities, even at relatively low exposures characterised by blood lead levels of 100 µg/l.

Mercury (Mercury)

It comes from both natural and anthropogenic sources. It is present in both inorganic and organic forms - alkyl mercury, which is characterized by toxicity and the ability to penetrate the placenta. Sources of alimentary intoxication are contaminated food - fish (encephalopathic symptoms, Minamata disease), ingestion of contaminated grain and subsequent deposition of mercury in animal flesh and eggs.

Arsenic

Chemically, it belongs to the metalloids. It enters the environment primarily from the combustion of lignite and industrial use. In agriculture, it is a component of some pesticide products, contributing to alimentary exposure, as well as consumption by seafood. The more toxic form is inorganic, causing skin, neurological, haematological changes. According to the IARC, it is classified as a **proven carcinogen**.

Nitrates

They are a common part of the diet. Their content in **vegetables**, **drinking' water'**, but also in **smoke** is a source of alimentary exposure. They are non-toxic in themselves, their health risk lies in their reduction by bacterial nitroreductases to **nitrites'**. These are implicated in the development of **infant' methaemoglobinaemia'**. The reaction of nitrite ions with secondary or tertiary amines in the diet results in the formation of '**nitrosamines** *and other N-nitrosamines and toxic and '**potentially carcinogenic effects'** (oesophageal, gastric, bladder carcinoma). This process occurs not only in food but also **endogenously in the body**, mainly in the stomach or bladder at slightly acidic pH.* Endogenous nitrosation can be blocked by various substances ingested in the diet - vitamin C, vitamin E, plant phenols.

Organic contaminants

Polychlorinated biphenyls (PCBs)

They were used as hot water media and part of coatings. Their production was discontinued in the 1970s. They still persist in the environment, but their persistence is gradually decreasing. Exposure occurs when they enter the food chain from the environment, especially in foods with a higher fat content. In the body, they are preferentially deposited in **adipose tissues**, **cross the placenta and are excreted in breast milk**. A range of symptoms such as **chloracne** and other skin manifestations, eye damage, neurological symptoms, liver dysfunction, elevation of cholesterolu and triacylglycerides in blood, alterations in carbohydrate metabolism, and immune suppression have been observed with high-dose accidental exposure. Yusho's disease was a mass poisoning following the ingestion of contaminated rice oil in Japan in 1968. According to the IARC, PCBs are classified as **Group 2A** - **suspected human carcinogens'**. They interfere indirectly in the carcinogenic process by inducing enzymes that activate carcinogens. Their **immunotoxic action**, their involvement in the increase of **cholesterolaemia'** and the induction of **oxygen radicals'** are also important.

Polychlorinated dibenzo-p-dioxins (PCDDs)

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

Chlorinated dioxins

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

Polycyclic aromatic hydrocarbons (PAHs)

This is a group of more than 100 chemicals found in all components of the environment. They are formed from the *incomplete combustion of organic material*, including grilling, frying, baking and roasting of food. They have a significant **carcinogenic potential** and may also be involved in mechanisms of atherogenesis and increase the **oxidative stress load** on the body. The main representative and indicator of exposure is **benzo(a)pyrene**. They become carcinogenic only after their metabolic activation in the body, the mode of their metabolic transformation being highly individual and the resulting metabolite may be a carcinogenic and genotoxic biotransformation product, but also harmless conjugates excreted in the urine. Inhalation exposure (cigarettes) is associated with the development of lung cancer and bladder cancer.

Phthalic acid esters

They enter the environment and food as a result of **combustion of plastics**. Phthalates are used as plasticizers in the manufacture of plastics, are sometimes also found in food packaging and can be transferred to food. Phthalic acid esters have been found in small quantities in packaged beverages.
Their significance lies in their **carcinogenic potential** (they are classified as suspected carcinogens with a putative non-gonotoxic mechanism of action) and their ability to induce peroxisomes in liver cells with oxygen radical formation. They have also been attributed with estrogenic effects reducing 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. Heat treatment (frying, baking, grilling, smoking, roasting, roasting) produces **polycyclic aromatic hydrocarbons**. Pyrolysis of animal protein foods produces **pyrolysates** of amino acids (heterocyclic amines) with high mutagenicity and carcinogenicity proven in animals. **Acrylamide** (IARC 2A - a probable human carcinogen) is formed in a wide range of foods (including e.g. bread, potatoes) when they are cooked at high temperatures. Although it has apparently been present in the diet since man began cooking, the EU has developed procedures to reduce its content in industrially produced foods. Inappropriate storage - higher temperature, higher humidity - is linked to an increased risk of mycotoxins. Residues of antibiotics administered to animals during treatment in compound feed may appear in animal products. Residues of disinfectants or hormones may be evidenced in some foods.

Toxic substances resulting from contamination of food with toxigenic moulds =

The most serious group are **mycotoxins**, the toxic products of moulds. Their formation occurs under the right conditions - **moisture, heat'** in moldy food. Particularly at risk are nuts, cereals and products containing these ingredients. '**Aflatoxins (aflatoxin B1)]'** are produced by the fungi Aspergillus flavus and Aspergillus parasiticus. They are one of the most potent hepatotoxins and hepatocarcinogens, in addition to being immunosuppressive. Mycotoxins can be exposed to livestock through the ingestion of mouldy feed. Their metabolites, aflatoxin M, are then present in milk and dairy products. Intoxications from ingestion of aflatoxins are called *aflatoxicosis*. Aflatoxin B1 is believed to be one of the aetiological factors in Reye's syndrome in children. **Ochratoxins** are mycotoxins produced by fungi of the genera Aspergillus and Penicillium. It causes liver and kidney damage. **Patulin'** is a mycotoxin found in improperly stored fruit, especially apples, and is considered a potential carcinogen. In order to prevent the formation of mycotoxins in food, it is necessary to store food under conditions that limit the growth of moulds. If mould growth has already occurred, it is essential not to consume these foods.

Toxic substances produced endogenously in the body

This group includes the endogenous formation of **nitrosamines** in the stomach and bladder during nitrate loading, 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 the intestinal microflora, and the formation of **carcinogenic products** during the metabolic transformation of xenobiotics.

Interactions of chemical contaminants with nutrients

A number of contaminants (PCBs) act as inducers of enzyme systems that perform essential functions in biotransformation processes (formation of endogenous cholesterol, activation of pro-carcinogens). Zinc is a component of the activating enzyme superoxide dismutase and its deficiency reduces the activity of this enzyme and thus the body's defence against oxidative stress. Excess cadmium has a similar effect, which zinc blocks and prevents its protective function. 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, animals. Of the poisonous foods, **fungi** rank first. Toxic substances contained in them can induce changes hepato- and nephrotoxic - Amanita phalloides (green toadflax), neurotoxic (filamentous toadflax, red toadflax), vasotoxic (dung beetle with alcohol ingestion), gastroenteric (satan mushroom). Solanine (in sprouted potatoes) is contained in **bulbous plants** and is characterized by cholinesterase inhibition symptoms. Hydrogen cyanide-cleaving glycosides are found in **bitter almonds**. **Cotyledon kernels'** contain furocoumarins inducing photodermatoses in some vegetables (celery, parsley) and in some medicinal plants (angelica). A number of other naturally toxic, mutagenic and carcinogenic substances are present in foods from tropical and subtropical areas, which are practically unheard of 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 by rather complex processes. **Plants'** contain **pyrrolizidine alkaloids**, genotoxic substances that can be constituents of drugs and teas. Carcinogenic substances may also be present in **some types of spices'**, which contain safrole, eugenol, estragole (black pepper, ginger, nutmeg). However, these are used in insignificant quantities, so there is no significant danger. In the animal diet, naturally occurring toxic latices are found in **some fish species**. The haemolytic protein poison ichthyotoxin has been demonstrated in the blood of eel fish, but is harmless when consumed as meat. Japanese fugu fish have tetrodotoxin in their viscera. Poisoning is manifested by a drop in temperature, slow pulse, cyanosis, vomiting, and unconsciousness.

Links

Related articles

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- Mercury
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