

## Environmental Contaminants in Foodstuffs

### Dr. Mária Túri-Szerletics

Hungarian Food Safety Office  
Gyáli út 2-6, H-1097 Budapest, Hungary  
E-mail: turi.maria@mebih.gov.hu

### Dr. István Patkó

Environmental Engineering Institute  
Rejtő Sándor Faculty of Light Industry and Environmental Protection Engineering  
Budapest Tech Polytechnical Institution  
Doberdó út 6, H-1034 Budapest, Hungary  
E-mail: patko@bmf.hu

---

*Abstract: Consumers have specific concerns about food contaminants but often lack the means to make appropriate judgements on what is high risk and what is not. Contaminants in foods can be grouped according to their origin and nature. Environmental contaminants of food-safety concern includes toxic metals and elements, organometallic compounds, agricultural chemicals and persistent organic pollutants such as halogenated hydrocarbon pesticides, polychlorinated biphenyls, dioxins, polycyclic aromatic hydrocarbons, phthalates, nirates, nitrites. These contaminants may present a potential hazard for human health if exposure exceeds tolerable levels. This article shows the characteristics and the dietary intake of these elements and compounds. Further works need to concentrate on mechanism of different contaminants toxicity and metabolism, reevaluation of acceptable limits, and their control in foods and in the environment.*

*Keywords: chemical food safety, environmental contaminants*

---

# 1 Chemical Contaminants in Foods from Environmental Origin

## 1.1 Introduction, Background

Food may be contaminated with many chemicals from the environment that pose the potential for toxicological consequences in humans consuming the contaminated food items [2].

One of the main objectives of the Hungarian Food Safety Program: Decrease of contamination of raw materials deriving from the environment. Keeping the environmental contamination at the possible lowest level is basic condition of producing safe foods. Lowering the level of contaminating, poisoning materials present in soil, air and water build into the vegetable and animal organism and their elimination in the course of food manufacture is difficult or impossible [1]. The contamination of environmental origin gets into the human organism and causes diseases. This article discusses how these type of food contaminants enter the food supply, the types of food items in which they are most likely to occur, and the potential toxicological consequences resulting from exposure to these contaminants. The main groups of chemical contaminants that can be found in food share the following characteristics: they are not intentionally added to food; contamination can happen at one or more stages in food production; illness is likely to result if consumers ingest enough of them [3]. The environmental contaminants are a group of substances with quite diverse chemical structures that exhibit common characteristics in terms of behaviour. These substances tend to be stable and thus persistent in the environment; they tend to bioaccumulate in food chain and can be transformed with increased toxicity. To control environmental pollution and protect humans and animals from the hazards of environmental contaminants a concept of persistent organic pollutants (POPs) has emerged [4].

## 1.2 Particular Contaminants

### 1.2.1 Toxic Metals and Elements

**Lead** is ubiquitous in an industrial environment. Ingestion or inhalation occurs as a result of environmental contamination, including food and water [6]. People with certain macronutrient and micronutrient deficiencies are prone to experience increased absorption of lead in the diet. Adults may normally absorb approximately 15% of their lead intake, pregnant women and children may absorb up to 3.5 times that amount [2]. Toxic effects of lead involve the nervous system, the liver, gene function, the composition of circulating blood, kidney function, the vitamin D endocrine system and bone [2].

**Cadmium:** Humans can be exposed to cadmium through either diet or industrial contact. Toxic manifestations of cadmium ingestion include renal dysfunction, osteoporosis and bone pain, abdominal pain, vomiting and diarrhea, anemia, and bone marrow involvement. Only 2-8% of dietary cadmium is absorbed and significant cadmium ingestion is accompanied by vomiting [2]. There is epidemiological evidence that cadmium exposure may be carcinogenic [6]. Cadmium accumulates in lower marine life, such as plankton, molluscs, and shellfish, and continues through the food chain as these organisms are consumed. However cadmium is toxic to fish and fish embryos. Cadmium is taken up by the leaves and roots of plants (vegetables), so those near industrial sources may be very high in cadmium.

**Mercury:** The primary portal of mercury contamination of food is via its industrial release into water, either fresh or salt water, and its conversion to methylmercury by methanogenic bacteria. With regard to toxicity, mercury affects the skin, kidneys, nervous system, and marrow, with consequent effects on the blood cells, immune system, and bone formation [2]. Seafood is probably the primary source of dietary contamination with mercury [6]. People with regular diet of fish containing high levels of organic mercury, or shellfish containing inorganic mercury, are at greatest risks [6].

**Arsenic** is widely distributed throughout the earth and reaches food sources. Arsenic is present in food in different forms (species) which vary in toxicity, with inorganic forms considered to be the most toxic. Arsenic compounds have occurred in seafood, eggs, and cheese. Most arsenic in the diet is present in the less toxic organic forms [3]. Chronic poisoning from arsenic is unusual unless it occurs naturally in the water supply. Inorganic arsenic is a documented human carcinogen [6]. Foodstuffs that have been mentioned as important sources of inorganic arsenic: rice, seaweed (especially hijiki seaweed), drinking water. To be considered also: baby food on rice basis.

### 1.2.2 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are ubiquitous and occur in all environmental compartments. In the environment PAHs result from combustion of organic matter. They are some of the major carcinogenic constituents isolated from cigarette tar and products of air pollution [5]. PAHs have been found in a wide variety of foodstuffs. Common sources of PAHs in non-processed foods are thermal treatments (grilling, roasting, baking, frying) and processing procedures. The highest PAHs levels were found in grilled food, smoked and broiled fish, mussels from polluted waters, and leafy vegetables grown in areas heavily exposed to air pollution [6]. High PAH levels may be found in oilseeds, and vegetable oils.

### 1.2.3 Polychlorinated Compounds

**Halogenated Hydrocarbon Pesticides:** Organochlorine insecticides (DDT, aldrin, endrin, heptachlor, etc.) were widely used and many persist in the environment today. Because of their stability, metabolites of these and other organochlorine compounds have reached all parts of the world's surface [6]. Many organochlorine pesticides have been linked to hormone disruption and reproductive problems in aquatic invertebrates, fish, birds, and mammals. They degrade slowly and accumulate in the food chain, eventually ending up in body fat [6].

**Polychlorinated Biphenyls (PCBs)** have a tendency to accumulate in animal feeds, particularly those of animal and marine origin, and are subsequently introduced into food. More than 90% of human dioxin exposure derives from foodstuffs, with a large portion of this derived from foodstuffs of animal origin [6]. Milk is a useful indicator of environmental pollution.

**Dioxins:** The dioxins of potential toxicological concern are polychlorinated dibenzo-p-dioxins (PCDDs). They are related, both structurally and toxicologically to polychlorinated dibenzofurans (PCDFs) and PCBs. Specific chemicals belonging to this family are referred to as congeners. A set of toxic equivalency factors (TEFs) has been developed in order to express the concentrations of each the congeners into one figure, which represents the group as if it was only the most toxic congener 2,3,7,8-tetrachloro-dibenzo-p-dioxin [3]. PCDDs and PCDFs are primarily introduced into the environment as by-products of combustion processes [2].

### 1.2.4 Polybrominated Organic Compounds

This type of compounds are used as flame retardants. They are persistent organic pollutants, so they tend to accumulate in the food chain. As they are lipophilic, the major sources in the diet tend to be fat-containing foods of animal origin.

### 1.2.5 Phthalates

Phthalates are a group of organic chemicals that have a variety of industrial uses, including use as plasticisers in wide range of household and consumer goods. Their use in plastic food packaging materials is now limited [3]. As a result of their extensive use and their moderate resistant to degradation, phthalates are widely distributed in the environment and are often found at low levels in food.

### 1.2.6 Nitrates, Nitrites

Nitrates and nitrites themselves are not carcinogenic, but nitrates can be reduced to nitrites, which can be converted in the body to nitrosamines, potent liver carcinogens. Eighty percent of the nitrates and nitrites in the diet are from

naturally occurring sources, with only 20% coming from food additives [5]. Nitrates and nitrites are used to preserve (cure) meat products [4]. The EU set maximum levels for nitrates in water, and for spinach and lettuce, depending on the season in which they are harvested [6].

### **1.3 Regulation of Chemical Contaminants in Foods**

Enhanced food safety problems and the increase in international trade in food are important factors that drives international regulation of contaminants in food. Authorities respond to consumers concerns by more stringent food safety assurance systems, including both lower maximum limits and more efficient control, but also self control and certification control systems [3]. The Joint FAO/WHO Food Standard Programme and the Codex Alimentarius Commission elaborate international food standards and codes of practice for questions related to food. It has also stimulated work on general code of practice for source-directed measures to reduce contamination [3]. Codex Committee on Contaminants in Food (CCCF) is working on setting maximum limits, developing recommendations for contaminants.

In the European Union (EU) the responsibility for initiating work on legislation on heavy metals, nitrate, pesticide residues, mycotoxins, etc. rests with the Commissions's Directorate-General for Health and Consumer Protection (DG SANCO) [3, 7]. All Community legislation are published in the Official Journal of the European Communities - including the maximum limit regulations (e.g. 1881/2006/EK Regulation). Methods of sampling and analysis to check compliance with the maximum levels laid down are also published. Within the EU, harmonisation of certain areas is a continuing process [6]. However, existing limits on contaminants in each member state apply where no level is laid down by EU.

### **1.4 Conclusions, Current and Future Trends**

The control of chemical contamination of food is clearly developing. Key part of this process is the international harmonisation of controls. Main goal of the National Food Safety Program of Hungary is to ensure a high level of human health and consumer protection by enhanced food safety [1]. The key is to ensure that action is taken when problems are found. Main options are: control the availability and usage of man made contaminants; limit or eliminate the source of contamination; police limits; advise; halt the supply of contaminated food [3]. The society shall take every reasonable and realisable measure to reveal and decrease environmental contamination influencing food safety and prevent formation of a new ones.

**References**

- [1] Mária Szeitzné Szabó (Ed.): National Food Safety Program of Hungary, Published at the National Institute of Food Hygiene and Nutrition, Budapest, Hungary, 2004, pp. 17-28
- [2] Benjamin Caballero, Lindsay Allen, Andrew Prentice (Eds): Encyclopedia of Human Nutrition, Elsevier Ltd., Oxford, UK, 2<sup>nd</sup> Edition, 2005, p. 340, 345, 347, 349
- [3] David H. Watson (Ed.): Food Chemical Safety, Volume 1. Contaminants, Woodhead Publishing Ltd., Cambridge, England, 2001, p. 1, 10, 11, 92, 155, 265, 274, 279
- [4] Ronald H. Schmidt, Gary E. Rodrick (Eds): Food Safety Handbook, John Wiley and Sons Inc., Hoboken, New-Jersey, USA, 2003, pp. 245-246, p. 293
- [5] Julie Miller Jones: Food Safety, Eagen Press, St. Paul, MN, USA, 1992, pp. 93-96
- [6] Benjamin Caballero, Luiz C. Truco, Paul M. Finglas: Encyclopedia of Food Science and Nutrition, Elsevier Science Ltd., Academic Press, UK, 2<sup>nd</sup> Edition, 2003, pp. 1595-1598, 3051-3055, 3508-3509, 4617-4619, p. 4136
- [7] [http://europa.eu.int/comm/dgs/heath\\_consumer/index\\_en.htm](http://europa.eu.int/comm/dgs/heath_consumer/index_en.htm)