

College of Applied Medical Sciences

Department of Environmental Health

*Introduction to Food Safety and
Microbiology*

Lecture 11



Chemical Contaminants in Food

Chemical contaminants may occur in our food from various sources. They typically pose a health concern, resulting in strict regulations of their levels by national governments and internationally by the Codex Alimentarius Commission. Therefore, analysis of relevant chemical contaminants is an essential part of food safety testing programs to ensure consumer safety and compliance with regulatory limits. Modern analytical techniques can determine known chemical contaminants in complex food matrices at very low concentration levels. Moreover, they can also help discover and identify new or unexpected chemical contaminants.

Sources of Chemical Contaminants in Food

Chemical contaminants can be present in foods mainly as a result of the use of agrochemicals, such as residues of pesticides and veterinary drugs, contamination from environmental sources (water, air or soil pollution), cross-contamination or formation during food processing, migration from food packaging materials, presence or contamination by natural toxins or use of unapproved food additives and adulterants.

Pesticide Residues

The use of pesticides, such as insecticides (insects), fungicides (fungi), nematicides (nematodes), rodenticides (rodents) or herbicides (weeds), has become an integral part of modern agriculture to increase crop yields and quality by controlling various pests, diseases and weeds.

Furthermore, pesticides can be misused or present in food due to contamination during application (spray drift), storage or transportation or from environmental sources, such as contaminated water or soil.

Veterinary Drug Residues

Similar to pesticides, veterinary drugs are agrochemicals that undergo a thorough registration process, resulting in setting of their maximum residue limits/tolerances in animal-derived foods. The major classes of veterinary drugs include

antibiotics, anthelmintics, coccidiostats, nonsteroidal anti-inflammatory drugs, sedatives, corticosteroids, beta-agonists and anabolic hormones.

These drugs, which are administered to live animals, can remain as residues in animal tissues. Liver and kidney are highly susceptible to residues given their biological function.

Environmental Contaminants

Environmental contaminants can be man-made or naturally occurring substances present in air, water or soil. They can enter the food chain and even bioaccumulate. Some can pose an acute health risk if present at higher concentrations, but the major concern related to the presence of environmental contaminants in foods is their potential endocrine disruption, developmental, carcinogenic and other chronic effects.

Examples of environmental contaminants that enter the food chain include :-

(heavy metals Cd, Pb, Hg, Cr, As) , polychlorinated biphenyls (PCBs), “dioxins” (polychlorinated dibenzodioxins and dibenzofurans), persistent chlorinated pesticides (e.g., DDT, aldrin, dieldrin, heptachlor, mirex, chlordane), brominated flame retardants (mainly polybrominated diphenyl ethers), polyfluorinated compounds, polycyclic aromatic hydrocarbons

(PAHs), perchlorate, pharmaceutical and personal care products or haloacetic acids and other water disinfection byproducts.

Food Processing Contaminants

Certain toxic or undesirable compounds can be formed in foods during their processing, such as during heating, baking, roasting, grilling, canning, hydrolysis or fermentation. Precursors of these contaminants can occur naturally in the food matrix,

1- such as in the case of acrylamide being formed during the Maillard reaction between the amino acid asparagine and a reducing sugar (especially in potato- and cereal-based, heat-treated products).

2- Alternatively, certain processing contaminants, such as N-nitrosamines, can be formed by interaction of natural food components with food additives.

3-Carcinogenic and genotoxic chloropropanols, such as 3-monochloropropane-1,2 diol (3-MCPD), are formed during the acid hydrolysis of wheat, soya and other vegetable protein products.

4-Examples of other processing contaminants include polycyclic aromatic hydrocarbons (PAHs), (in grilled and smoked products),

5- Ethyl carbamate (in yeast-fermented alcoholic beverages and other products) or

6-Furans (in a variety of heat-treated foods(heating processes)e.g., cooking, bottling, and canning, especially coffee and canned/jarred food).

7-Food processing may also be a source of cross-contamination, such as contamination of nonallergenic foods with known food allergens.

Migrants from Packaging Materials

Direct contact of foods with packaging materials can result in chemical

contamination caused by migration of certain substances into foods.

Examples of migrants of health concern may include :-

bisphenol A or phthalates from plastic materials, 4-methylbenzophenone and 2-isopropylthioxanthone from inks, mineral oil from recycled fibers or semi carbazide from a foaming agent in the plastic gaskets that are used to seal metal lids to glass packaging.

Toxins

Toxins are naturally occurring substances that are produced by various organisms, with mycotoxins and marine biotoxins typically representing the major concerns in foods.

Other examples of toxins in foods may include:-

1-Microbial toxins include:

a- bacterial toxins (e.g., staphylococcal toxins, botulinum toxins) .

b-Mycotoxins(e.g., Mycotoxins from molds, toxic or poisonous Mushroom) .

c- algal toxins

2- certain plant toxins, such as pyrrolizidine alkaloids that can be found in honey, milk or eggs.

3-animal toxins

While the bacterial/fungal contamination can be eliminated with heat treatment, the toxins can remain in the food product as contaminants.

Mycotoxins are toxic secondary metabolites produced by fungi (molds) that can colonize various crops. They are of concern mainly in cereals, nuts, infant formula, milk, dried fruit, baby food, coffee, fruit juice and wine. There are many mycotoxins, but only a few are currently regulated, with the European Union having a more comprehensive list than most other

countries, which includes aflatoxins, ochratoxin A, patulin, deoxynivalenol, zearalenone, fumonisins and T-2/HT-2 toxins. Different mycotoxins are prevalent in different climates and in various growing and storage conditions.

Marine biotoxins, such as saxitoxin, domoic acid, okadaic acid or ciguatoxin, are highly toxic compounds produced by phytoplankton. During so-called harmful algal bloom events, they can accumulate in fish or shellfish, such as clams, mussels, scallops or oysters, to levels that can pose serious health risks or even be lethal to humans.

Unapproved Food Additives and Adulterants

Food adulteration can happen accidentally when unapproved additives are introduced to the food, or the wrong additive is introduced through formulation error. This results in mislabeled food. Perhaps a larger health issue is when foods are adulterated intentionally for economic reasons to sell a low-value food or material for more or to mask food spoilage. Some adulteration may just mislead or cheat consumers, such as adding high fructose corn syrup to honey, but some may be harmful to them. The most notorious example from recent years is the addition of melamine to whey and other protein concentrates to increase their apparent protein content analyzed as total nitrogen.

Other examples include the use of toxic Sudan dyes in adulterated chili powders or adulteration of virgin olive oil with hazelnut oil, which can cause unexpected allergic reactions in sensitive individuals.