

# FOOD SAFETY HAZARDS:

## AN OVERVIEW



## Introduction

Each year, approximately 48 million US citizens become sick, and around 3,000 die from eating contaminated food products (CDC 2018). The cost of foodborne illnesses in the US has been estimated to exceed \$15.6 billion in 2013 (USDA 2014). Thus, preventing food contamination and strengthening our food safety system is of the utmost importance.

Preventing food contamination begins with production, and food producers are primarily responsible for controlling the hazards and ensuring the safety of the food. In 2016, the Food Safety Modernization Act (FSMA) Preventive Controls for Human Food (PCHF) rule was implemented to enhance the safety of the US food system. The rule obligates food producers to perform analysis of hazards and establish risk-based preventive controls to address the identified hazards (FSPCA 2016).

Hazard analysis is the process of identifying potential food safety hazards which need to be addressed via appropriate preventive controls (FSPCA 2016). Food safety hazards are unique to the type of product, facility infrastructure, size of the company, and even the location of the facility. Thus, hazard analysis should be performed for each facility and each product or group of similar products. Numerous contamination agents affect food products, such as pathogenic microorganisms, toxins, pesticides, or pieces of foreign material. A deeper understanding of the hazards allows for establishing appropriate controls that can mitigate the risks.

This publication presents an overview of potential food safety hazards associated with food production and provides additional resources where food producers can obtain guidance on this topic.

## Food Safety Hazards

Hazard is defined as a “biological, chemical (including radiological), or physical agent that is reasonably likely to cause illness or injury in the absence of its control” (FSPCA 2016).

The contamination agents can be introduced at different stages of the production process; thus, producers should be aware of ingredient-related hazards, process-related hazards, and hazards that may be introduced from the food-production environment (facility-related hazards).

### *Biological Hazard*

Biological hazards including bacteria (spore-forming and non-spore forming), protozoa, parasites, and viruses are responsible for most foodborne illnesses in the US (FSPCA 2016). Table 1 shows some of the most common biological hazards and their potential sources. Presented hazards may not apply to all types of foods and all types of facilities.

### *Chemical (Including Radiological) Hazards*

Chemical hazards include food allergens, mycotoxins, toxic chemicals, radiological agents, and biogenic amines. Eating food contaminated with chemical agents may cause instantaneous or long-term effects on human health. Consumption of a food product that contains an undesirable allergen (for example, peanuts in peanut-free chocolate) may lead to immediate negative health effects such as hives, redness, or swelling if the consumer is allergic to peanuts. Chronic exposure to aflatoxin (mycotoxin commonly found in corn) may lead to liver cancer. Table 2 presents common chemical hazards and examples of their sources.

### *Physical Hazards*

Physical hazards are the physical objects present in food that can cause injury to the consumer. Physical hazards are divided into “hard/sharp” or “choking” hazards. Consumption of food that contains undesirable physical objects can lead to damage to teeth; can cause deep cuts or tears in the flesh of the mouth, throat, or intestine; or can cause choking. Table 3 presents common physical hazards and examples of their sources.

Table 1. Examples of biological hazards and their potential sources. Adapted from FDA 2016.

BIOLOGICAL HAZARD		INGREDIENT-RELATED	PROCESS-RELATED	FACILITY-RELATED	PEOPLE-RELATED
Bacteria (spore-forming)	<i>Bacillus cereus</i>	✓ Grains	✓ Cooked products that have been improperly cooled or held at warm temperatures		
	<i>Clostridium botulinum</i>	✓ Produce	✓ Use of reduced oxygen packaging		
	<i>Clostridium perfringens</i>	✓ Spices, produce	✓ Cooked products that have been improperly cooled or held at warm temperatures		
Bacteria (non-spore-forming)	<i>Campylobacter jejuni</i>	✓ Poultry, raw milk			
	Pathogenic <i>Escherichia coli</i> such as O157:H7	✓ Produce, sprouts, ruminant animals			
	<i>Listeria monocytogenes</i>	✓ Produce, raw agricultural commodities	✓ Raw agricultural commodities, contaminated products	✓ Cold, wet areas; floors; equipment; drains; condensate; coolers	
	<i>Salmonella</i> spp.	✓ Produce, poultry, nuts	✓ Inadequate heat treatment will lead to bacteria survival	✓ Pests, dirt, soil	✓ Food contaminated by infected personnel
	<i>Shigella</i> spp.				✓ Food contaminated by infected personnel
	<i>Staphylococcus aureus</i>				✓ Food contaminated by infected personnel
Protozoa and Parasites	<i>Cryptosporidium parvum</i>	✓ Water used as an ingredient	✓ Water used in the process		✓ Food contaminated by infected personnel
	<i>Cyclospora cayatanensis</i>	✓ Berries			✓ Food contaminated by infected personnel
	<i>Giardia lamblia</i>	✓ Water used as an ingredient			
	<i>Toxoplasma gondii</i>	✓ Meat			
Viruses	Norovirus	✓ Produce, shellfish			✓ Food contaminated by infected personnel
	Hepatitis A	✓ Produce			✓ Food contaminated by infected personnel
	Rotavirus				✓ Food contaminated by infected personnel

Table 2. Examples of chemical (including radiological) hazards and their potential sources. Adapted from FDA 2016.

<b>CHEMICAL HAZARD</b>		<b>POTENTIAL SOURCE</b>	<b>EXAMPLE PRODUCT</b>
<b>Pesticide residues</b>	Organophosphates, carbamates, chlorinated hydrocarbons, pyrethroids	Improper use of registered pesticides (i.e., exceeding allowed doses) Use of prohibited pesticides	Fruits and vegetables, grains, pasta, seafood
<b>Heavy metals</b>	Lead, arsenic, cadmium, mercury	Use of pesticides containing heavy metals Contaminated soil Leaching from equipment, containers, or utensils	Fruits and vegetables, water, chocolate products, dairy products, game meat, seafood
<b>Drug residues (veterinary antibiotics)</b>	Chloramphenicol, beta-lactams	Improper use of registered drugs (exceeding allowed doses) Residues of certain drugs can become concentrated during food manufacturing and processing (e.g., cheese)	Milk, meat, poultry, eggs, honey, bottled water, seafood
<b>Industrial chemicals</b>	Ammonia, caustic cleaning compounds	Refrigerant leak (ammonia) Cleaning compounds not adequately removed from surfaces	Carbonated drinks, ready-to-drink coffee and tea, juice, dairy products, seafood
<b>Mycotoxins</b>	Aflatoxin, patulin, ochratoxin, fumonisin, deoxynivalenol	Toxin-producing molds on agricultural commodities (induced by crop damage, drought stress, wet storage)	Grains (corn, oats), fruits (apple), baked products, tree nuts, peanuts, coffee, raisins
<b>Allergens</b>	Milk, eggs, fish, crustacean shellfish, tree nuts, peanuts, wheat, soybeans	Due to mislabeling or cross-contact	Baked products, chocolate products, dairy-free products, seafood
<b>Unapproved colors and additives</b>	FD&C red #4, melamine	Intentionally introduced for purposes of economic gain Use of unapproved substances	Frosting, confectionary, and dried fruits, dry baking mixes, ready-to-drink coffee and tea, juice
<b>Substances associated with food intolerance or food disorder</b>	Lactose, yellow #5, sulfites, carmine and cochineal, gluten	Exceeding the allowed usage levels Unintentional introduction into the food for which it was not approved	Dairy-free products, chocolate, baked products, wines, candies
<b>Radionuclides</b>	Radium 226 and 228, uranium 235 and 238, strontium 90, cesium 137, iodine 131	Ingredients or food products that originate from areas with a naturally high concentration of radionuclides Areas affected by a nuclear accident	Water (sourced from well), milk, vegetables, seafood

Table 3. Examples of physical hazards and their potential sources. Adapted from FDA 2016.

PHYSICAL HAZARD	INGREDIENT-RELATED	PROCESS-RELATED	FACILITY-RELATED	PEOPLE-RELATED
<b>Metal (ferrous and non-ferrous)</b>	Metal not properly controlled by the supplier (e.g., farm field debris, harvest, cutting, slicing)	Equipment, bolts, nuts and screws, clips, cans, grinders, sieves, screens, slicers, cutting knives, mixing paddles, pumps	Metal racking, buckets	Jewelry, watches, hairpins, glasses
<b>Plastic</b>	Packing materials, farm field debris	Plastic ties, belts, plastic tags, ribbons, string, liners, mixing paddles, buckets	Perspex covers, laminate, plastic strip curtains	Pens, plastic gloves, hairnets, phones, plastic aprons, jewelry, buttons
<b>Glass</b>	Farm field debris	Glass containers	Glass light fixtures, glass windows, glass windows in doors	Glasses, watches
<b>Other</b>	Farm field debris (e.g., wood pieces), pests, animal beaks, feathers, bones, shells, seeds, pits	Inappropriate design	Chipped tiles (ceramic), insulation	Uniform threads

## Where Can You Find More Information?

US Food and Drug Administration (FDA) and Food Safety Preventive Controls Alliance (FSCPCA) websites provide valuable guidelines and manuals on how to perform effective hazard analysis, what are the risks related to specific products, and how they can be controlled. Some available online resources include:

- FDA website:
  - a. [Hazard Analysis and Risk-Based Preventive Controls for Human Food: Draft Guidance for Industry](#)
  - b. [Hazard Analysis Critical Control Point \(HACCP\)](#)—juice, dairy, seafood, retail, and food services
- FSPCA website:
  - a. [Training Manual for the FSMA Preventive Controls for Human Food \(PCHF\) Training Course](#): Chapter 8—Hazard Analysis and Preventive Controls Determination and Appendix 4—Foodborne Pathogen Supplementary Information

## Summary

Food producers are obligated to protect the health and safety of consumers. It is essential for food producers to recognize all the risks that may be associated with any particular product. To do so, food producers must perform a thorough hazard analysis for

each food product produced. Hazard analysis has to be conducted for each ingredient and for each process. Thorough hazard analysis will result in determining possible hazards, and recognized hazards can then be controlled using appropriate preventive controls, thus minimizing the risk of producing unsafe food for consumers.

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## References

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