

Chapter 3:

Bad Bugs

Learning Objectives

After completing this chapter, you will be able to:

- Describe the three types of food safety hazards and conditions that lead to their development
- Explain the potential food safety risks associated with various microorganisms
- Understand the ways pathogens are transmitted

Chapter 3: Bad Bugs

The material in this chapter provides a general overview of foodborne illnesses and the microorganisms that cause them. It answers the broad questions of what contaminates food and what are bad bugs.



For more information on the conditions that support the development of foodborne illness see Chapter 5: Danger Zone Ahead.

Foodborne Illnesses

Foodborne illnesses are caused by consuming unsafe or contaminated foods or beverages. They are called foodborne illnesses simply because food acts as the transmission vehicle for harmful organisms and toxic substances.

Food is unsafe for human consumption when it is contaminated by:

- Disease causing microorganisms (pathogens) such as viruses, bacteria and moulds
- Parasites
- Chemicals such as pesticides, cleaning agents or heavy metals
- Foreign objects such as hair or insects

Proper packaging, appropriate temperature control and applying recommended food handling practices can reduce the risk of foodborne illness.

Foodborne illnesses can spread easily and quickly. For example, an infected food handler can transmit his illness to another person by poor food handling practices such as sneezing or coughing over food, improper hand washing, etc. Foodborne illnesses can range from mild symptoms that last only a few hours to conditions requiring hospitalization and even death. In a small percentage of victims, infections can lead to chronic ailments such as kidney damage, arthritis or heart problems.

Foodborne illnesses are caused by consuming unsafe or contaminated foods or beverages.

Hazards

Hazards are agents in, or conditions of, food that have the potential to cause an adverse health effect in consumers. They are harmful substances that when found in food can cause illness.

Food safety hazards are divided into three categories:

- Physical hazards result from the presence of foreign objects in food
- Chemical hazards arise from contamination by any allergen, natural toxin or chemical
- Biological hazards result from contamination with disease causing microorganisms

Each hazard is associated with different risks in terms of the severity and duration of potential adverse effects. Although you should eliminate all hazards in the foods you market to consumers, pay particular attention to biological hazards. Biological hazards are the most common hazard in the marketplace and present the greatest potential for an adverse health effect.

A food safety hazard is a biological, chemical or physical property that may cause an unacceptable consumer health risk. The objective of any food safety program is to reduce the risks created by all potential hazards.

Pathogen – any bacteria, virus, mould or other form of life too small to be seen by the naked eye and capable of causing disease, illness or injury. Pathogens require moisture, temperature, proper pH and food source to grow. They can double every 10 – 20 minutes and do not necessarily change the look, smell or taste of food.

Table 3.1 Hazards That Cause Foodborne Illness

Hazard	Some Examples	Some Sources/Causes
Physical	Hair, insects, false fingernails, wire, jewelry, wood splinter, glass, metal fragments, stones, rodent droppings	Introduced through improper handling, by equipment malfunction, damaged packaging
Chemical	Allergen, food additives, heavy metals, cleaning agent, sanitizer, pesticide residue, natural toxin, drug residues	Accidentally added to foods during harvesting, processing, transportation, storage, marketing or preparation or added in greater amounts than legally allowed
Biological	Disease causing microorganisms – bacteria, viruses, parasites, fungi, moulds, yeast, worms	Raw foods, untreated water, soil, feces, poor worker hygiene, inadequate cooking or cooling of food

Physical Hazards

Physical hazards are foreign objects in a food product that can cause injury. They are the most visible of the three types and most likely to elicit consumer complaints. They are usually easier to prevent than either chemical or biological hazards because they can be seen. Physical hazards pose a greater risk when they are small enough to miss visual detection.

Chemical Hazards

Chemical hazards may be naturally occurring or added during production, processing or marketing. Allergens are a big issue facing farm direct marketers today. Although not generally classified as foodborne illnesses, allergic reactions to food components are very serious and can be life threatening. Properly label all your food products and avoid a situation that could have serious consequences for a customer.

Toxic metals such as copper, brass, cadmium, lead and zinc can be a source of chemical contamination. Zinc is used in galvanized containers such as garbage cans and gray enamelware containers. If these containers are used to store acidic foods like fruit juice, punch, tomato sauce, sauerkraut, or pickles, the metal may dissolve and enter the food, making these foods poisonous. For the same reason, pottery dishes with lead glazes should not be used to store, prepare or serve food.

Physical hazards generate the most consumer complaints because they are the most visible of the hazards.

Chemical hazards may be naturally occurring or added during production, processing or marketing activities.



For information on common food allergens and their labelling visit the allergens page on the website of the Canadian Food Inspection Agency (CFIA) at www.inspection.gc.ca/english/fssa/labeti/allerge.shtml

On the CFIA website, you will also find the document *Reference Listing of Accepted Construction Materials, Packaging Materials and Non-Food Chemical Products* which lists allowable cleaning agents, sanitizers and other chemicals. Visit www.inspection.gc.ca/english/ppc/reference/cone.shtml

Biological hazards are the most serious of the three hazards because they are more likely to cause debilitating illnesses or death. They can't be seen, smelled or tasted.

The steps you take to keep food safe will usually lead to better food quality as well.

Microorganism = Microbe

Biological Hazards

Not all microorganisms found in food are harmful. Yeast used to leaven bread, mould to ripen blue cheese and bacteria to culture yogurt are just a few examples of helpful microbes. The food safety concern focuses on the harmful microbes that make food unfit to eat, cause infection or contaminate water.

Biological hazards present the highest risk to food safety because they can't be seen, smelled or tasted. They are the most serious of the three hazards because they are more likely to cause debilitating illnesses or death.

Bacteria are the most troublesome and important biological foodborne hazard for you. They usually fall into one of two classifications: spoilage or pathogenic.

Spoilage bacteria break down foods so that they look, taste and smell bad. They affect food quality but they do not make you sick. Used under controlled conditions, spoilage bacteria produce beneficial products such as yogurt, cottage cheese and buttermilk.

Pathogenic bacteria are disease-causing microorganisms and if consumed can cause illness. Foods containing dangerous levels of pathogens may show no signs of spoilage. In fact, they do not compete well with spoilage organisms. Pathogens affect food safety, not food quality, and are the focus of this chapter.

Sources of Microorganisms

Microorganisms, or microbes, are found all around us. They are in the air, water, ice, soil, dust and contaminated food. They grow on or in living things such as plants, animals and insects. They flourish in the mouth, nose and intestines of animals including humans. Microbes are commonly found in large numbers on our hair, face and hands, so it's not surprising that they are also found on the items we touch and use.

Foodborne Illness from Biological Hazards

The US Center for Disease Control and Prevention (CDC) has identified more than 400 different food related illnesses and over 200 foodborne hazards. Different illnesses have different symptoms. However, since the microorganisms or toxins enter the body through the gastrointestinal tract, the first symptoms often develop here. That is why common symptoms include nausea, vomiting, abdominal cramps and diarrhea. Headache and dehydration are frequently secondary symptoms.

The symptoms of a foodborne illness may be mild and last only a few hours or they may be serious, lasting much longer and requiring intensive medical treatment. In high risk groups such as children, the elderly or individuals with weakened immune systems, death may occur.

Types of Foodborne Illness

Foodborne illnesses are classified as infection, intoxication or toxico-infection.

An infection occurs when foods or beverages contaminated with disease-causing microorganisms are consumed. It's the pathogen that makes you ill. Foodborne bacteria, viruses and parasites are examples of microorganisms that can cause infection. Bacteria are living organisms that take in food, give off wastes and multiply. One single bacterium can multiply to more than 2 million in seven hours. Salmonellosis is an example of a bacterial infection.

After ingestion, the pathogen lodges in the gut and begins to multiply, resulting in foodborne illness symptoms like diarrhea and vomiting. The infective dose, or the number of organisms needed to make you sick, can vary from a few (10 to 100) to many (a million or more). The infective dose is also determined by the age and state of health of the person.

Foodborne illness or food poisoning can also result from toxic substances in the food. Intoxication occurs when the microorganism grows on a food and produces a toxin. The food containing the toxin is eaten and the toxin causes the illness. In other words, the organism itself doesn't make you sick; its toxin does.

The three categories of foodborne illness are infection, intoxication and toxico-infection.

Gastrointestinal tract – the part of the digestive tract where the body processes food and eliminates waste. It includes the esophagus, stomach, liver, intestines and rectum.

About two-thirds of all food poisoning outbreaks involve bacteria. Viruses, parasites, fungi and chemical contamination cause the rest. The illnesses may be caused by the microorganisms themselves or the toxins they release.

Generally these toxins are odorless, have no taste and are able to cause illness after the microorganism has been cleared from your system. Examples of microorganisms that can cause food intoxication are bacteria like *Clostridium botulinum* and *Staphylococcus aureus*. Poisoning due to intoxication can also result from consuming food containing toxic chemicals such as cleaners, sanitizers, pesticides or heavy metals.

A toxico-infection is caused when a pathogen is consumed and then proceeds to produce a toxin in the body that results in illness. This is in contrast to intoxication where the toxin is produced on the food and then ingested. Cholera is one example. A toxico-infection also happens from the pathogen *Clostridium perfringens*.

Types of Foodborne Illness

Infection: ingestion of a harmful microorganism within a food

Intoxication: ingestion of a harmful toxin produced within a food

Toxico-infection: ingestion of a harmful microorganism within a food that produces a toxin in the human body

A Closer Look at Some Common Pathogens

Bacteria and viruses cause most of the more than 400 identified food related illnesses. The most commonly recognized foodborne illnesses are those caused by the bacteria *Campylobacter*, *Salmonella*, *Staphylococcus* and *Escherichia coli* (*E. coli*), *Listeria monocytogenes*, and by a group of viruses called calicivirus, also known as Norwalk-like viruses. These are by no means the only organisms that cause foodborne illnesses.

Table 3.2 Sources of Most Common Foodborne Illnesses

Organism & Illness Caused	Symptoms	Source of Organism	Some Common Foods Involved
<i>Campylobacter jejuni</i> Campylobacteriosis	Fever, headache, nausea, muscle pain, diarrhea (sometimes bloody)	Intestinal tracts of animals and poultry Soil, untreated water	Raw and undercooked poultry and meat, raw milk, raw clams Foods contaminated by raw meats and raw meat juices
<i>Salmonella</i> species Salmonellosis	Nausea, vomiting, fever, headaches, diarrhea, abdominal cramps Can be serious for persons with weakened immune systems	Intestinal tracts of animals especially pigs and poultry, human carriers	Raw meats, poultry, fish, shrimp Foods contaminated by raw meats and raw meat juices Eggs, raw milk, dairy products
<i>Staphylococcus aureus</i> Staphylococcal intoxication	Nausea, vomiting, abdominal cramps (usually severe), sweating, diarrhea, headaches Organism produces a highly heat-stable toxin that cooking doesn't destroy; salt tolerant	Hands, throats, nasal passages and sores of humans Good personal hygiene, especially hand washing, is very important to reduce risk	Foods requiring significant handling and kept at warm temperatures are greatest risk. Meat and meat products, meat salads, poultry and egg products, milk and dairy products, cream filled bakery products, custards, sandwich fillings
<i>Escherichia coli</i> O157:H7 Hemorrhagic colitis	Severe and bloody diarrhea, severe abdominal cramps, nausea, vomiting, kidney failure and death in severe cases Young, elderly and persons with weakened immune systems at greater risk for severe symptoms	Intestines and feces of animals particularly cattle, sheep, pigs and poultry Soil, untreated water	Raw and undercooked beef and chicken, raw milk, raw milk products Foods contaminated by raw meats and raw meat juices Faecally contaminated foods and water
<i>Listeria monocytogenes</i> Listeriosis	Nausea, vomiting, diarrhea, mild flu-like symptoms Abortions Can be very serious for persons with weakened immune systems, often resulting in death	Intestinal tracts of animals and humans Soil, silage, contaminated water Listeria frequently found on processing equipment if improperly cleaned and will grow at refrigeration temperatures	Raw meats and poultry, fermented sausage, raw milk, dairy products, uncooked vegetables, raw and smoked fish
<i>Clostridium botulinum</i> Botulism	Generalized weakness, dizziness, dry mouth and throat, blurred vision, followed by paralysis and respiratory failure. Fatal without antitoxin. <i>C. botulinum</i> toxin is the most toxic compound known.	Improperly canned and preserved foods Organism grows in the absence of oxygen to produce toxin. Toxin present even after organism dies.	Home canned low acid, foods, e.g., meat, antipasto, vegetables and salsas, commercially canned foods (avoid bulging or severely dented cans), smoked and fermented fish
<i>Calicivirus</i> (Norwalk and Norwalk-like virus) Gastroenteritis	Nausea, vomiting, diarrhea	Human carriers, water Good personal hygiene, especially hand washing is very important to reduce risk. Infected personnel should not handle food.	Infected workers contaminate food Contaminated water Shellfish and salads are often implicated in outbreaks

Other foodborne illnesses are typically transmitted by water or other routes. These include infections caused by the parasites *Giardia lamblia* and *Cryptosporidia*. On-farm food safety programs (OFFS) and good production practices (GPPs) in our meat industries have made infections from parasites uncommon.

Almost three-quarters of Canadians are concerned about E. coli and Salmonella bacterial contamination in food.



For more information on specific foodborne illnesses visit Alberta Health and Wellness website at:
www.health.gov.ab.ca/public/diseases/FH1Foodborne.html

More information on causes of foodborne illnesses, common foods involved and disease characteristics can also be found in Appendix I: Common Foodborne Pathogens.

Transportation of Microbes

Microbes cannot move on their own. Most microbes are hitchhikers, relying on people, animals, insects and water to transport them from one host to the next. Microorganisms readily spread from one person to another through coughing, sneezing, speaking and touching. Animals, including pets and rodents, may transfer microbes to humans through their saliva, fur, dander, paws, feces and urine. Insects such as flies and roaches are common carriers of many microorganisms. Viruses and parasites are frequently transported by water. Microbes can also be thrown into the air and carried to different places by dust.

Disease Transmission

Disease causing microorganisms can be spread by direct or indirect means. Direct transmission occurs when the organism goes directly from the source to the food, for instance when an infected worker coughs or sneezes onto food or mice leave droppings in cereal.

Indirect transmission occurs when there is an in-between step where the microbe goes from the source to a carrier such as food and then to another person. This situation occurs when an infected person contaminates a knife that is subsequently used to cut cheese which causes the consumer to become ill after consuming the cheese. Preparing raw chicken on a cutting board that is then used for slicing bread or sneezing into your hand and then packing strawberries without properly washing your hands are other examples of indirect transmission. In these instances, the microbes can contaminate the cheese, bread and strawberries and be transferred to another person when eaten. Indirect transmission commonly occurs through food, sewage or objects.

Pathogens can be spread directly or indirectly. Direct transmission occurs when the organism goes directly from the source to the food. Indirect transmission occurs when the microbe goes from the source to a carrier such as food and then to another person.



This graphic illustrates how a sneeze or cough can project pathogens into the air, contaminating everything that the pathogens land upon. Note the amount of material that is released.

Figure 3.1 **Contamination From a Cough or Sneeze**

Most potentially hazardous foods such as meat, poultry, fish, eggs and dairy or products made with these ingredients may contain pathogenic microorganisms. When the microbes move from raw food to cooked food, cross contamination occurs. The most common ways for microbes to move from raw food to cooked food is through hands, utensils and equipment and drips or spills. This easily happens during transportation, storage, food handling and preparation.



For more information on preventing cross contamination see Chapter 12: Equipment and Chapter 14: Food Handling.

Preventing Disease Transmission

It's important to make sure that you are doing everything you can to reduce the risk of foodborne illness. Most foodborne illnesses can be avoided by taking steps to prevent the movement of microorganisms from one host to the next. Practicing good personal hygiene, cleaning and sanitizing food contact surfaces, following proper temperature control and eliminating pests in the market reduce the risk of foodborne illness.

If you suspect you or a customer has a case of food poisoning, contact the Environmental Health Department of your regional health authority.

Keeping Records

To protect yourself and your business you need to keep detailed written records of any complaints regarding foodborne illness. You should maintain records of contacts made, date of contact, nature of contact, decisions made and actions taken. Records also help in the event of legal action because of a food safety issue.

If you suspect you or a customer has a case of food poisoning, contact the Environmental Health Department of your regional health authority.

Summary

Foodborne illnesses result from consuming unsafe or contaminated foods or beverages. Symptoms of food poisoning may include nausea, vomiting, diarrhea, dizziness, fever and headaches. They may be mild and last only a few hours or they may be serious and require intensive medical attention. Report any suspected cases of foodborne illness to your regional health authority.

Foodborne illnesses may be classified as infection, intoxication and toxico-infection depending on what effect the microorganisms produce within food or your body. The most serious foodborne illnesses are caused by microorganisms that can be transmitted to you directly or indirectly.

Hazards are any biological, chemical or physical agent in food that have the potential to cause an adverse health effect. Hazards may be naturally occurring or added during any stage of handling a food product.

Market Manager Responsibilities

As a manager of an Alberta Approved Farmers' Market, you must make sure that the market is a safe place for food to be sold. Talk to your vendors and learn about their food safety practices. Observe how vendors handle their products at the market and bring your concerns to their attention.

Document any complaints of foodborne illness. You should maintain records of complaint made, date of complaint, nature of complaint, decisions made and actions taken. These records will help to identify trends in complaints that could aid you in identifying vendors who are not keeping their food safe at the market.



Food Safety Checklists

Use Market Startup and Weekly Food Safety Checklists for Market Managers (see Appendix M) to help you monitor your market. Add any personal hygiene issues that are missing for your market. Remember that you and your vendors should be using the checklists every market day.

“We introduced a stronger code of food safety at our market simply because it was the right thing to do. Customer safety is our first priority at the market.” Jim O’Neill, Manager, Old Strathcona Farmers’ Market

What’s Next

The next chapter introduces you to some life-like example farmers’ market vendors and farm direct marketers. These case examples are used throughout the rest of the manual to illustrate concepts and highlight primary food safety issues.



Resources

If you need more information or have food safety questions about this chapter contact:

Safe Food Systems
Agri-Food Systems Branch, Food Safety Division
Alberta Agriculture, Food and Rural Development
Phone: (780) 427-4054. Dial 310-0000 first for toll free access.



Chapter Review

1. What are the three types of food safety hazards?

2. What is another term for microorganisms that cause diseases and are too small to be seen by the naked eye?

3. Which hazard has the most adverse effect on people?

4. Give two examples of common symptoms of foodborne illness.

5. What are the three categories of foodborne illness?

6. What are the two means of pathogen transmission?

Answers to Chapter Review

- 1) Biological, chemical and physical
- 2) Pathogens
- 3) Biological
- 4) Any of the following: nausea, vomiting, diarrhea, abdominal cramps, headache
- 5) Infection, intoxication, toxico-infection
- 6) Direct, indirect

