

Overview of hazards that may be associated with consumption of fresh produce [1]

1. Hazard

A hazard is a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect. All three types of hazards are associated with fresh produce comprise include others:

- **Biological hazards**
 - bacteria
 - parasites
 - viruses
 - (moulds)
- **Chemical hazards**
 - naturally occurring hazards
 - added chemical hazards
 - contaminants
- **Physical hazards**
 - foreign bodies like glass, wood, stones, insulation, plastic, etc

2. Biological hazards

Foodborne microorganisms such as bacteria, viruses and parasites are often referred to as biological hazards (FAO, 1998). Some fungi are able to produce mycotoxins and need to be considered as chemical hazards.

2.1 Micro-organisms

Because microbial pathogens are part of the environment fruit and vegetables can easily become contaminated when they are grown, harvested, stored and handled. Pathogenic bacteria associated with fruits and vegetables include:

- *Salmonella*
- *Shigella*
- *Escherichia coli* (pathogenic)
- *Campylobacter* species
- *Yersinia enterocolitica*
- *Listeria monocytogenes*
- *Staphylococcus aureus*
- *Clostridium* species
- *Bacillus cereus*
- *Vibrio* species

Many bacterial pathogens have been implicated in foodborne outbreaks associated with the consumption of fresh fruits and vegetables (Beuchat, 1998). Table 1 provides a list of

many of these outbreaks and the organisms associated with them.

Table 1. Outbreaks of foodborne disease associated with fresh fruits and vegetables*

Agent	Implicated/suspected food	Reference
<i>Bacillus cereus</i>	Sprouts	Portnoy et.al. (1976)
<i>Campylobacter</i>	Cucumber	Kirk et al. (1997)
<i>Campylobacter jejuni</i>	Lettuce	CDC (1998)
<i>Clostridium botulinum</i>	Vegetable salad	PHLS (1978)
<i>Clostridium botulinum</i>	Bamboo shoots	CDC (1999)
<i>Cryptosporidium</i>	Apple cider	CDR (1991)
<i>Cyclospora</i>	Raspberries	Herwaldt et al. (1997)
<i>Cyclospora</i>	Basil	CDC (1997)
<i>Cyclospora</i>	Raspberries	CDC (1998)
<i>Cyclospora</i>	Mesclun lettuce	Cited by SCF, 2002
<i>E. coli</i> O157	Radish sprouts	WHO (1996)
<i>E. coli</i> O157	Apple juice	CDC (1996)
<i>E. coli</i> O157	Apple cider	Besser et al. (1993)
<i>E. coli</i> O157	Iceberg lettuce	CDR (1997)
<i>E. coli</i> O157	Alfalfa sprouts	CDC (1997)
<i>Fasciola hepatica</i>	Watercress	Hardman (1970)
<i>Giardia</i>	Vegetables, incl. Carrots	Mintz et al. (1993)
Hepatitis A virus	Iceberg lettuce	Rosenblum et al. (1990)
Hepatitis A virus	Raspberries	Ramsey et al. (1989)
Hepatitis A virus	Strawberries	Niu et al. (1992)
Norwalk virus	Tossed salad	Lieb et al. (1985)
Norwalk virus	Mixed salad	Cited by SCF, 2002
Norwalk virus	Watercress	Cited by SCF, 2002
<i>Salmonella</i> Agona	Coleslaw & onions	Clark et al. (1973)
<i>Salmonella</i> Enteritidis	salad	Cited by SCF, 2002
<i>Salmonella</i> Miami	Watermelon	Gayler et al. (1955)
<i>Salmonella</i> Muenchen	Orange juice	CDC (1999)
<i>Salmonella</i> Oranienburg	Watermelon	CDC (1979)
<i>Salmonella</i> Poona	Cantaloupes	CDC (1991)
<i>Salmonella</i> Saint-Paul	Bean sprouts	O'Mahony et al. (1990)
<i>Salmonella</i> Stanley	Alfalfa sprouts	Mahon et al. (1997)
<i>Salmonella</i> Thompson	Root vegetables & dried seaweed	Kano et al. (1996)
<i>Shigella flexneri</i>	Mixed salad	Dunn et al. (1995)
<i>Shigella sonnei</i>	Iceberg lettuce	Kapperud et al. (1995)
<i>Shigella sonnei</i>	Parsley	CDC (1999)
<i>Shigella sonnei</i>	Tossed salad	Martin et al. (1986)

Bacteria such as *Clostridium botulinum*, *Bacillus cereus* and *Listeria monocytogenes* can be found in the soil and can easily contaminate produce. Other bacteria such as *Salmonella*, *Shigella*, pathogenic *Escherichia coli* and *Campylobacter* reside in the intestinal tract of animals and/or humans. They can contaminate fruit and vegetables through infiltration of sewage waters into fields, irrigation with contaminated water, presence of animals in the field or inappropriate composting. Contamination also can take place during handling at harvest and packaging and in other steps in the distribution and supply chain.

The number of bacteria that needs to be present to cause human illness varies mainly with the type of organism and the age and condition of the host. In some instances, it is necessary to have over a million pathogenic bacteria per gram or cm² of food surface before illness can occur. However, some pathogens are able to cause disease at much lower numbers. For example, *Shigella spp.* are highly infectious agents with a low infective dose and even one single organism may cause disease. Because of the high infectivity of certain bacteria, prevention of bacterial contamination is the most important control factor to enhance produce safety. It is also important to take steps to ensure that pathogens present cannot multiply to hazardous levels.

Pathogens can be found among the microflora of fruits and vegetables because it is fairly easy for the external surfaces of these commodities to come in contact with soil, water, manure, sewage fluids, air, humans or animals. When conditions become favorable for the natural flora to multiply, these pathogens will also.

2.2 Parasitic Hazards

Parasites are organisms that live in or on another living organism, called the host. They are only able to grow in a host, however, they may be passed from one host to another through some non-host vehicle. Parasites most commonly associated with human infections include:

- *Cryptosporidium*
- *Cyclospora*
- *Giardia*
- *Entamoeba*,
- *Toxoplasma**Sarcocystis**Isospora*
- Nematodes
 - Nematodes (i.e. *Ascaris spp.* etc.)
 - Plathelminthes (i.e. *Fasciola hepatica* and *Cysticercus spp.*)

Because produce is often eaten raw, it can serve as a vehicle to pass a parasite from one host organism to another (Beuchat, 1998 and Murray et al., 1995). Water contaminated with fecal material, infected food handlers, and animals in the field may be vehicles for contamination of produce with parasites that may then be passed on to humans consuming the raw produce.

2.3 Viral Hazards

Viruses that have been reported as transmitted by foods include:

- Hepatitis A

- Norwalk virus and Norwalk-like virus
- Rotaviruses, astroviruses, enteroviruses (poliovirus, echovirus and coxsackie virus), parvoviruses, adenoviruses and coronaviruses.

Viruses are very small and unable to reproduce outside a living cell. Therefore, they do not grow in or on foods. However, raw fruits and vegetables may become contaminated by exposure to contaminated water or during handling by infected people. The viruses infect susceptible individuals that consume the raw produce.

Since the infective dose of most viruses is extremely small, sometimes as few as 10 virus particles, prevention of produce contamination is critical to controlling viral disease.

2.4 Sources of biological hazards

Many of the diseases caused by pathogenic bacteria, parasites, and viruses that have been linked to fruits and vegetables can be transmitted when human feces contaminate the produce. It is important that individuals handling produce at every stage, from field to table, have a good understanding of the proper hygiene practices needed to prevent contamination. Training of workers at every level of the production chain and education of consumers have been identified as key elements to reduce foodborne illnesses associated with fresh fruits and vegetables (Beuchat, 1998).

3. Chemical hazards

Chemical contaminants in raw fruits and vegetables may be naturally occurring or may be added deliberately or inadvertently during agricultural production, post-harvest handling and other operations (FAO, 1998). An overview of the several chemical hazards are presented in Table 2

Table 2. Overview of chemical hazards that may occur in fresh produce

Some naturally occurring chemical hazards

- Allergens (e.g. weeds)
- Mycotoxins (e.g. aflatoxin)
- Mushroom toxins
- Phytohaemagglutinin
- Alkaloids

Extraneous chemical hazards

- Polychlorinated biphenyls (PCBs)
- Agricultural chemicals
 - Pesticides
 - Fertilizers
 - Antibiotics
- Prohibited substances
 - Direct

- Indirect
- Toxic elements and compounds
 - Lead
 - Zinc
 - Cadmium
 - Mercury
 - Arsenic
 - Cyanide
- Other contaminants
 - Lubricants
 - Cleaners
 - disinfectants
 - Coatings
 - Paints
 - Refrigerants
 - Water or steam treatment chemicals
 - Pest control chemicals
- From packaging materials
 - Plasticizers
 - Vinyl chloride
 - Decorative/coding inks
 - Adhesives
 - Lead
 - Tin

Harmful chemicals at high levels have been associated with acute toxic responses as well as with chronic illnesses. Data collected by the WHO Food Contamination Monitoring and Assessment Program (GEMS/Food) indicate that, in many countries, levels of chemical contamination are tending to decline. This is due, largely, to greater restriction on the use of toxic chemicals and pesticides that persist in the environment and to improved control of environmental pollution.

4. Physical hazards

Physical hazards (foreign bodies) may be introduced into fresh fruit and vegetable products at numerous points in the production chain. These physical hazards can result from unhygienic practices during harvesting, washing, sorting and packaging operations (FAO, 1998). Filth and foreign matter are often included among the main barriers to international trade in fruit and vegetables.

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