Pathogens Commonly Associated with Fresh Produce: How Can They Be Controlled?

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Good Agricultural Practices (GAPs) Food Safety Training

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Food Safety – Everyone Can Play A Role
- Growers
- Fresh produce handlers: packers, distributors
- Food processors, wholesalers, distributors
- Retailers including food service
- Consumers

Hazards Occur:
- Growing
- Harvesting
- Processing
- Storage
- Distribution
- Retailing
- Final Preparation

Definitions
- Microorganism: Small, living organism
- Pathogen: Illness-causing microorganism
- Hazard: An agent that is reasonably likely to cause illness or injury in the absence of control
- Contamination: When harmful microorganisms, chemicals or foreign objects get into food, either naturally or by accident
- Cross-contamination: Microorganisms are transferred from one food or surface to another
- Foodborne illness: Illness carried or transmitted to people by food
- Foodborne outbreak: Incident in which two or more people experience the same illness after eating the same food

Types of Food Safety Hazards
1. Microbial Hazards
2. Chemical Hazards
3. Physical Hazards

Foodborne Illness Statistics
- cases: 76 million illnesses in the U.S. each year
- hospitalizations: 325,000 per year
- deaths: 5,000 per year
Cost of Foodborne Illness
- Cost: $10-83 billion each year*


Foodborne Illness Statistics
- Food service: 61%
- Homes: 32%
- Plants: 7%

Foodborne Illness: Symptoms
- Upset stomach
- Fever
- Headache
- Nausea
- Vomiting
- Diarrhea
- Dehydration (sometimes severe)
- Meningitis
- Paralysis
- Death
- Infective dose varies and is thought to be dependent upon the susceptibility of the individual
- As few as 10 to 100 pathogenic cells can make you sick!

Individuals More Susceptible to Foodborne Illness
- The very young – infants and pre-school age children
- Older adults
- Pregnant women
- People taking certain medicines e.g. antibiotics and immunosuppressants
- Those with weakened immune systems

Relative Susceptibility to Listeriosis*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Relative susceptibility</th>
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<tbody>
<tr>
<td>Transplant</td>
<td>2584</td>
</tr>
<tr>
<td>Cancer-Blood</td>
<td>194</td>
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<tr>
<td>AIDS</td>
<td>466</td>
</tr>
<tr>
<td>Dialysis</td>
<td>476</td>
</tr>
<tr>
<td>Cancer-Pulmonary</td>
<td>229</td>
</tr>
<tr>
<td>Cancer-GI/Liver</td>
<td>211</td>
</tr>
<tr>
<td>Cancer-Bladder/Prostate</td>
<td>112</td>
</tr>
<tr>
<td>Diabetes-non-insulin dep.</td>
<td>25</td>
</tr>
<tr>
<td>Diabetes-insulin dep.</td>
<td>30</td>
</tr>
<tr>
<td>Alcoholism</td>
<td>18</td>
</tr>
<tr>
<td>Over 65 years old</td>
<td>7.5</td>
</tr>
<tr>
<td>&lt;65, no other condition</td>
<td>1</td>
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</table>

* Goulet & Marchetti, 1996

Foodborne Illness Statistics
- Microbial: 94% of foodborne illnesses
- Chemical: 4%
- Physical: 2%
Microbial Hazards

- **Microbial Hazards:**
  - Bacteria
  - Viruses
  - Fungi (yeasts, molds)
  - Parasites

- **Bacteria** are the leading cause of foodborne illness

**FAT TOM**

- **Food**
  - Foodborne microorganisms need nutrients to grow. Specifically:
    - Carbohydrates
    - Proteins

**Acidity**

- Foodborne microorganisms grow best in food that has a pH range of 4.6 to 7.5 (food with slightly acidic pH or neutral pH)
- pH of most products falls into this range

<table>
<thead>
<tr>
<th>pH</th>
<th>Acidic</th>
<th>Neutral</th>
<th>Alkaline</th>
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<tr>
<td>4.0</td>
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<td></td>
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</tr>
<tr>
<td>6.0</td>
<td>☑️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>☑️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td></td>
<td>☑️</td>
<td></td>
</tr>
<tr>
<td>9.0</td>
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<td>☑️</td>
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</tbody>
</table>

- Vinegar = 2.0
- Baking Soda = 8.1

**Temperature**

- Foodborne microorganisms survive and grow well at temperatures between 41°F and 135°F.

**Time**

- Foodborne microorganisms need sufficient time to grow.
- Bacterial cells divide every 20 minutes.
- Storing food in TDZ for 4 hours or more would result in bacterial growth and multiplication to dangerous levels.

*These temperatures based on current FDA Food Code/USDA Guidance. State regulations may differ.*
Bacterial Multiplication

Cells divide twofold every 20 minutes.

FAT TOM

Oxygen

- Some foodborne microorganisms require different levels of oxygen or no oxygen at all to grow.
  - Aerobes: require oxygen to grow
    - e.g., *Salmonella, E. coli*
  - Facultative anaerobes: are able to grow either with or without free oxygen
    - e.g., *Staphylococcus aureus*
  - Obligate anaerobes: can survive and grow only when oxygen is absent
    - e.g., *Clostridium spp.*

Moisture

- Most foodborne microorganisms require moisture to grow.
- The amount of moisture available in food for this growth is called water activity (aw).

Water activity (aw) scale:

<table>
<thead>
<tr>
<th>aw values</th>
<th>Growth</th>
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<tbody>
<tr>
<td>0</td>
<td>No growth</td>
</tr>
<tr>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Growth</td>
</tr>
</tbody>
</table>

- **aw minima for growth of microorganisms:**
  - *Staphylococcus aureus*: 0.86
  - *Salmonella spp.*: 0.93
  - *Clostridium botulinum*: 0.93
  - *Clostridium perfringens*: 0.93
  - *Bacillus cereus*: 0.95

Several methods can be used to keep microorganisms from growing:

- Add lactic or citric acid to food to make it more acidic *
- Temperature
  - Refrgerate or freeze food properly
  - Cook food properly
- Time
  - Minimize time food spends in the TDZ (41 to 135ºF)
- Use vacuum packaging to remove oxygen *
- Add sugar, alcohol, or acid to lower food’s water activity *

* Only food processors can use methods involving food acidification, modified atmosphere packaging, and moisture reduction.

Food Safety Management Systems

- **GAPs, GHPs**
- **HACCP, GMPs, SOPs, SSOPs**

- **Active Managerial Control**, SOPs

<table>
<thead>
<tr>
<th></th>
<th>Prevent</th>
<th>Reduce</th>
<th>Eliminate</th>
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<td>HACCP</td>
<td>Hazards</td>
<td>to safe levels</td>
<td>hazards</td>
</tr>
<tr>
<td>Active</td>
<td>Managerial</td>
<td>Prevent</td>
<td>to safe levels</td>
</tr>
<tr>
<td>Control</td>
<td>Control</td>
<td>Control</td>
<td>Control</td>
</tr>
</tbody>
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Microbial Hazards

- **Microbial Hazards:**
  - Bacteria
  - Viruses
  - Fungi (yeasts, molds)
  - Parasites

- **Bacteria** are the leading cause of foodborne illness.
**Some Pathogens Concern in Fresh Produce**

- **Bacteria**
  - Salmonella spp.
  - *E. coli* O157:H7
  - Shigella spp.
  - Bacillus cereus
  - Clostridium botulinum
  - Listeria monocytogenes
  - Vibrio cholera

- **Viruses**
  - Hepatitis A virus
  - Norwalk/Norwalk-like virus

- **Parasites**
  - Cyclospora spp.
  - Cryptosporidium spp.
  - Giardia

**Where Microbial Pathogens Live**

- **Common in soils**
  - Listeria monocytogenes
  - Bacillus cereus
  - Clostridium botulinum

- **Residents of human and animal intestinal tracts**
  - Salmonella species
  - *E. coli* O157:H7
  - Shigella species
  - Viruses and parasites

**Sources of Pathogenic Microorganisms on Fresh Produce**

- human and animal feces
- contaminated water
- unsanitary farm environment
- unsanitary facilities
- improperly treated animal manure or biosolid wastes
- poor worker hygiene and sanitation practices during production, harvesting, sorting, packing, and transport
- cross-contamination during transport of fresh produce from farm to market

**An ounce of prevention is worth a pound of cure**

**Good Agricultural Practices (GAPs)**

- GAPs are the basic environmental and operational conditions that are necessary for the production of safe, wholesome fruits and vegetables*

- GAPs can enhance food safety and help prevent and reduce the risk of foodborne illness

**Strategies for Controlling Potential Microbial Food Safety Hazards on Your Farm**

- You should control hazards during:
  - production
  - harvesting
  - postharvest handling

- Farm food safety plan

- **Goal**: Prevent contamination
**Prerequisite Food Safety Programs**

- Personal hygiene program
- Employee food safety training program
  - Teach workers about food safety and their role in preventing microbial contamination of fresh fruits and vegetables
  - Results – safer produce!
- Provide well maintained restroom to employees and customers
  - Handwashing stations must be equipped
  - Sign should reflect all languages used on the farm
- Record keeping
  - Document what you did for food safety
  - Keep good records - important for traceback

**Review**

- Be aware of the sources of pathogenic microorganisms on fresh produce
- Understand food safety principles
- **PREVENT CONTAMINATION!**
- Good Agricultural Practices (GAPs)
  - GAPs can enhance food safety and help prevent and reduce the risk of foodborne illness

**Farm Food Safety Plan**

- Develop a written farm food safety plan
- Implement farm food safety plan
- Farm food safety plan in effect
  - Current
  - Records on file

**The End**