Good Agricultural Practices
Food Safety and Foodborne Illnesses: How safe is what I eat?

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http://sickcrops.tamu.edu

Texas AgriLife Research & Extension Center at AMARILLO

Plant Pathology Extension

Dr. Ronald French

Welcome to SICK CROPS

- Citrus
- Corn
- Potato
- Sorghum
- Bean/Soybean
- Vegetables
- Wheat
- Other Crops
- Homeowner/Gardeners

- Contact Information
- Wheat Disease Fact Sheets
- Plant Diagnostic Form
- Texas Plant Diagnostic Clinic (THPPDL)
Wheat in Rio Grande Valley of Texas
Tomato (Greenhouse)
Good Agricultural Practices

Fruit and Vegetable Microbial Safety Issues
Fruit and Vegetable Consumption

Between 1970 - 1997, the U.S. per capita consumption of fruits and vegetables increased 24 % !

577 lbs to 718 lbs per year
Fruits and Vegetables

- Significant increases in the number of produce associated foodborne disease outbreaks in the U.S.

Number of Produce Associated Outbreaks by Decade, 1973 - 1997

Outbreaks / year

<table>
<thead>
<tr>
<th>Decade</th>
<th>Outbreaks / year</th>
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</thead>
<tbody>
<tr>
<td>1973-79</td>
<td>3.7</td>
</tr>
<tr>
<td>1980-89</td>
<td>6.5</td>
</tr>
<tr>
<td>1990-97</td>
<td>10.5</td>
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### Fruit & Vegetable Outbreaks by Specific Agent, 1973 - 1998

<table>
<thead>
<tr>
<th></th>
<th>1973-87</th>
<th>1988-98</th>
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<tbody>
<tr>
<td>Bacterial</td>
<td>24</td>
<td>57</td>
</tr>
<tr>
<td>Parasitic</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Viral</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Unknown</td>
<td>35 (55%)</td>
<td>41 (37%)</td>
</tr>
<tr>
<td>Total Outbreaks</td>
<td>64</td>
<td>112</td>
</tr>
<tr>
<td>Outbreaks/year</td>
<td>4.3</td>
<td>10.2</td>
</tr>
</tbody>
</table>

Source: CDC Foodborne outbreak surveillance system
Fruit and Vegetable Bacterial Outbreaks: 1988 - 1998

- E. Coli 0157:H7 22
- Salmonella 26
- E. Coli 011:H43 1
- E. Coli 0157:H7
- Shigella 3
- Campylobacter 2
- B. cereus 1
- ET E. Coli 2

Source: CDC Foodborne outbreak surveillance system
Fruit and Vegetable Outbreaks by Origin of Produce: 1990 - 1998

- Domestic: 75.3%
- Imported: 7.5%
- Unknown: 17.2%

Source: CDC Foodborne outbreak surveillance system
E. coli O157:H7 Lettuce Outbreak

• A multistate Outbreak of *Escherichia coli* O157:H7 Infections Associated with Consumption of Mesclun Lettuce

• By Elizabeth D. Hilborn, et.al.

• Archives of Internal Medicine, Vol. 159, August 9/23, 1999.

Food Safety Begins on the Farm

[Image of food safety emblem]
E. coli O157:H7 Lettuce Outbreak

- Occurred during May & June, 1996
- 49 Cases
- Two separate outbreaks reported in:
  - Connecticut - mesclun mix
  - Illinois - red leaf lettuce
- Patients had similar demographics
E. coli O157:H7 Lettuce Outbreak

• Were these two outbreaks related?
• Case-control studies conducted.
• Molecular subtyping by pulsed field gel electrophoresis (PFGE) showed they were indistinguishable.
E. coli O157:H7 Lettuce Outbreak

- 49 Cases of Infection
  - Connecticut 21
  - Illinois 28
- 21 Patients (49%) were hospitalized
- 3 Patients (7%) developed HUS (Hemolytic uremic syndrome)
- Patients age from 2 - 87 years
E. coli O157:H7 Lettuce Outbreak

Results of the Investigation

• Lettuce traced back to one California grower.

• Lettuce grown near beef cattle ranch.

• A dirt track separated the two operations.

• Free range chickens had access to cattle and lettuce fields.
E. coli O157:H7 Lettuce Outbreak

- Unchlorinated well water used for cattle husbandry, lettuce culture and processing.
- The processing shed was open to the environment; there was no mechanism to exclude dust, insects, birds or rodents.
- No handwashing facilities were available.
E. coli O157:H7 Lettuce Outbreak

- Gloves were not worn during processing.
- Recirculated wash water was used.
- The recirculating and filtration systems failed in May and the water was changed 3X a day.
- Lettuce was crisped in reused plastic baskets.
Why Should We Care?

Foodborne illness outbreaks are a major cause of:

• Personal distress
• Preventable death
• Avoidable economic burden
Why Should We Care?

Every year foodborne illnesses result in an estimated:

- 76 million cases of foodborne illness.
- 325,000 people hospitalized for foodborne illness.
- 5,200 needless deaths each year.
- Economic losses between 10-83 billion dollars.
Contamination With Microbial Pathogens: Where Can It Occur?

• In fields or orchards
• During harvesting and transport
• During packing or processing
• In distribution and marketing
• In restaurants and food service facilities
• In the home

FARM to FORK
Cattle meets food crops
Microorganisms of Concern in Production Agriculture
Practical Food Microbiology

- Microorganisms are small, living unicellular or multicellular.
- They include bacteria, viruses, yeasts, molds, and parasites.
- They can be….
  — The good
  — The bad, and
  — The ugly!
Kinds of Microorganisms

• The Good (or helpful):
  – Add them to foods or they are there naturally.
  – They ferment foods to preserve them and/or create unique flavors and textures.
  – Examples: cheese, yogurt, sour cream, bread, sauerkraut and pickles.
Kinds of Microorganisms

• The Bad (or spoilage)
  – Change foods and cause them to “go bad” or spoil.
  – Examples: Discolored, mushy, or fuzzy vegetables; sour milk; and slimy, putrid meat.
Kinds of Microorganisms

• The Ugly (disease-causing, pathogenic):
  – Illness can range from mild to life-threatening.
  – Examples include foods contaminated with *Salmonella* or *E. coli* O157:H7. Common signs and symptoms include nausea, vomiting, and diarrhea.
Microorganisms that cause...

**Food spoilage -**
- Affect aroma, texture and/or appearance of food

**Foodborne illness -**
- May or may not affect sensory characteristics of the food.

Only laboratory testing can tell if harmful microorganisms or toxins are present – some are difficult to detect or cannot be detected.
Current Problems With Harmful Microbes

- Some people are more vulnerable to foodborne illness:
  - Young children or elderly people.
  - Immuno-compromised individuals.
- New ways of transmitting organisms:
  - Widespread food distribution system.
  - New food formulations and handling practices.
  - Changes in food choices.
- New or evolving pathogens:
  - Example - *E. coli* 0157:H7.
# Harmful Microorganisms & Outbreaks Associated with Produce

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Produce</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em> O157:H7</td>
<td>Iceberg lettuce, radish sprouts, unpasteurized apple cider/juice</td>
</tr>
<tr>
<td><em>Salmonella</em> spp.</td>
<td>Tomatoes, bean sprouts, sliced watermelon, sliced cantaloupe, coleslaw &amp; onions, alfalfa sprouts, root vegetables, dried seaweed</td>
</tr>
<tr>
<td><em>L. monocytogenes</em></td>
<td>Cabbage</td>
</tr>
<tr>
<td><em>B. cereus</em></td>
<td>Sprouts</td>
</tr>
<tr>
<td><em>Hepatitis A virus</em></td>
<td>Iceberg lettuce, raspberries, strawberries</td>
</tr>
<tr>
<td><em>Cryptosporidium</em></td>
<td>Apple cider</td>
</tr>
<tr>
<td><em>Cyclospora</em></td>
<td>Raspberries</td>
</tr>
</tbody>
</table>
Microbes That Cause Foodborne Illness

- **Bacteria** – Single-celled organisms that live independently.
- **Viruses** - small particles that live and replicate in a host.
- **Parasites** - intestinal worms or protozoa that live in a host animal or human.
Bacteria...

- Cause the greatest number of foodborne illnesses.
- Single-celled organisms that live independently.
- Invisible to the naked eye: Must be magnified 1,000 times to be seen.
- 400 million bacteria are equal to a grain of sugar in size.
To Grow & Cause Illness, Bacteria Need:

- Moisture, found in most foods, including fruits and vegetables.
- Nutrients, provided by most foods.
- Warmth, especially room temperature or a little higher.
- Time
Bacteria Increase in Number by Dividing in Two

- With ideal conditions, they double every half hour.
- 1 becomes 2, 2 become 4, 4 become 8, and so on...
- In 12 hours, 1 cell could multiply into 33 million cells!
- Usually you start with many bacterial cells, not just one.
The Bacterial Growth Cycle has Four Phases

- **lag**
- **exponential**
- **stationary**
- **death**

Graph showing the growth cycle with time on the x-axis and log cfu/ml on the y-axis.
Bacteria Are Found Everywhere

- In air, soil, and water
- In intestines of animals & humans
- On skins of fruits & vegetables
- On raw meat, poultry, & seafood
- On shells of nuts
- On insects & rodents
- On hand, skin, hair, & clothing of people
3 Harmful Foodborne Bacteria

- *E. coli* 0157:H7
- Salmonella
- Listeria
E. coli / E. coli O157: H7

- *Escherichia coli*: common microbe in animal and human intestinal tracts.

- Most strains of *E. coli* are not harmful.

- But harmful strains, such as *E. coli* O157: H7, cause severe illness.
**E. coli O157:H7**

- First recognized as human pathogen in 1982.
- Outbreaks often associated with undercooked ground beef.
- Produce associated outbreaks have involved lettuce, unpasteurized apple cider & juice, radish sprouts, and alfalfa sprouts.
**E. coli O157:H7**

- Naturally exists in animals without symptoms
  - cattle, sheep, deer, dogs, cats, other animals

- Can contaminate/grow on fresh produce:
  - minimally processed cantaloupe
  - watermelon cubes
  - shredded lettuce
  - sliced cucumbers
  - mesclun lettuce
Contamination of Fruits and Vegetables by *E. coli* O157:H7

- Wild or domestic animals.
- Improperly composted animal manure.
- Fruits and vegetables dropped on the ground have a higher chance of being contaminated by manure.
- Water may carry and spread organisms.
- Farm and packing house workers, as well as any food handlers, may also contaminate produce.
Foodborne Illness Caused by *E. coli* O157:H7

- Causes severe cramps, bloody diarrhea, vomiting, dehydration.
- Severe complications can include kidney failure, strokes, seizures, and sometimes painful death.
- Onset 3 - 9 days; lasts 2 - 9 days, unless there are complications.
Salmonella species

- More than 2300 types.
- About 200 types cause human illness.
- Comes from intestinal tracts of poultry, pigs, birds, and insects.
- Also can be carried by humans.
- Infective dose – a few cells to millions.
Salmonella species

- Isolated from many types of raw fruits and vegetables – not a frequent event.
- Outbreaks linked to:
  - tomatoes
  - bean sprouts
  - melons
  - unpasteurized orange juice and apple juice
Salmonella enterica

• About 142,000 Americans infected each year (about 30 deaths) with Salmonellosis (diarrhea, fever, vomiting, abdominal cramps). Most recover without treatment.

• Fecal matter on egg shell.

• Related subspecies *S. enterica enterica* serovar Typhi causes Typhoid (slow fever up to 104 F, sweating, gastronenteritis)
Foodborne Illnesses Caused by *Salmonella* species

- Illness causes nausea, vomiting, abdominal cramps, diarrhea, fever, and headache.
- Symptoms occur in 12 - 48 hours and last 2 - 6 days in otherwise healthy people.
- May last weeks in immuno-compromised people.
- Secondary problems such as reactive arthritis or pericarditis may result in some patients.
Listeria monocytogenes

- Widely distributed in nature.
  - In soil, sewage, fresh water sediments.
  - In silage, decaying plant matter.
  - In animal intestinal tracts.
- Animal carriers may not be sick.
- Found in raw foods.
  - Meats, unpasteurized milk.
  - Vegetables.
Listeria monocytogenes

- **Listeriosis**: symptoms last 7-10 days
- Fever, muscle aches, vomiting (sometimes nausea and diarrhea).
- If infections spreads to brain/spinal cord, can cause meningitis (headache, stiff neck, confusion, loss of balance, and convulsions).
Foodborne Illness Caused by *Listeria monocytogenes*

- Causes flu-like symptoms in healthy people.
- May progress to meningitis, blood poisoning, abortion in pregnant women, or death.
- Symptoms appear within 1 day to 3 weeks.
- Duration depends on treatment.
- High fatality rate in immune-compromised individuals.
Other Microbial Hazards: Viruses

- Excreted in feces by infected individuals.
- Can be carried by raw produce, uncooked food.
- Persists for weeks or months on crops or in soils.
- Examples
  - Hepatitis A on lettuce, raspberries, and strawberries.
One Virus of Concern: Hepatitis A

• An infected person can spread the disease to others well before the symptoms of Hepatitis A are present.

• It is primarily transmitted by person-to-person contact through fecal contamination, but can also be spread through food and water.

• Causes fever, nausea, vomiting, abdominal cramps, extreme fatigue, jaundice (affects the liver).

• Onset 15 - 50 days after ingestion.

• Lasts 1-2 weeks to months in severe cases.
Streptococcus pyogenes

Salmonella enterica/bongori
Streptococcus pyogenes

- Responsible for Streptococcal infections Group A.
- Throat or skin infections.
- Bacterium may produce toxins.
- Treated with penicillin.
Botulinum toxin

- Protein produced by Clostridium botulinum.
- Causal agent of botulism (paralysis, respiratory failure)
- Initially for treatment of strabismus (crossed-eyes) and blepharospasm (uncontrollable blinking)
- BTX-A for muscle pain disorders.
- Also used for cosmetic surgery
Food Safety for Seniors

- Raw foods are risky
- Microbes/Germs are tougher to get rid off
- Avoid raw meat: Raw fish, raw shellfish, raw beef, raw poultry, unpasteurized cheese or milk.
- Avoid soft cheeses (brie, blue)
- Raw/lightly cooked eggs.
- Untreated gruit/vegetable juice
What’s wrong with this picture?
What’s wrong with this picture?
<table>
<thead>
<tr>
<th>Facts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Serving Size</td>
<td>1 Egg (50g)</td>
</tr>
<tr>
<td>Servings</td>
<td>12</td>
</tr>
<tr>
<td>Calories</td>
<td>70</td>
</tr>
<tr>
<td>Fat Calories</td>
<td>40</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>1.3g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>215mg</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>6%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>0%</td>
</tr>
<tr>
<td>Calcium</td>
<td>2%</td>
</tr>
<tr>
<td>Iron</td>
<td>4%</td>
</tr>
<tr>
<td>Not a significant source of Dietary Fiber or Sugars</td>
<td></td>
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<table>
<thead>
<tr>
<th>Protein</th>
<th>6g</th>
<th>100%</th>
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<tbody>
<tr>
<td>Total Carbohydrate</td>
<td>1g</td>
<td>0%</td>
</tr>
<tr>
<td>Calories per gram:</td>
<td>Total Fat:</td>
<td>Cholesterol:</td>
</tr>
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</table>

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</thead>
</table>
Food Safety: Cooking Outdoors?

- Choose fresh meat; refrigerate within 30 min
- Cook / freeze within 1 to 2 days
- If thawing, do it in the fridge!
- If marinating, do it to add flavor not microbes.
- Wrap meat (prevent “contamination” of foods)
- Wash hands, cutting boards (don’t mix meat with veggies).
- Cook to a safe temperature (160-165° F)
Food Safety at Home

- Spoiled food can make you sick (don’t trust smell)
- Keep food viable: clean, cook, chill, separate
- Wash hands and counters.
- Use plastic cutting boards.
- Use paper towels; cloths need to be washed.
- Separate raw foods.
- Cook at adequate temperature.
- Chill right away.
Reduce Your Risk of Foodborne Illness

- One out of every 4 (~25%) get it yearly.
- Usually caused by bacteria.
- Buy food from reliable source.
- Perishable foods need to be stored or cooked.
- Check your refrigerator temperature.
- Thaw foods safely.
- Keep cutting boards clean.
- Wash hands (reduce FB illness 50%)
Washing Vegetables?
Thank You!