Industry Uses of Microbiological Criteria and Testing for Raw Food Products

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This presentation is limited to food safety, quality is not considered.
Raw food products

- Examples: raw meat, poultry, seafood, eggs, fruits, vegetables
- They may have been subjected to one or more reduction steps (e.g., washing, sanitizing, steaming) that may be marginally effective

Significance of raw foods as a source of foodborne illness

- Historically, raw foods have been a major source of foodborne disease
- Important factors:
  - Cross contamination to RTE foods (e.g., raw poultry)
  - Survival in marginally processed foods (e.g., raw milk cheese)
  - Growth (e.g., melons, sprouts)
Risk continuum for raw foods

- Raw molluscs, ground beef, poultry, milk and liquid eggs: High
- Sprouts, fresh juices, melons, certain raw milk cheeses: Medium
- Shell eggs, certain fruits, leafy vegetables, nuts, spices: Low
- Most fruits and vegetables, commercial mushrooms, dry cured hams and fermented sausages: Very low

When shopping what do you assume about the safety of the foods you put in the cart?

- Raw molluscs, ground beef, poultry, milk and liquid eggs: High
- Sprouts, fresh juices, melons, certain raw milk cheeses: Medium
- Shell eggs, certain fruits, leafy vegetables, nuts, spices: Low
- Most fruits and vegetables, commercial mushrooms, dry cured hams and fermented sausages: Very low
**Where on this continuum would testing the food be an effective control measure?**

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Food Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Raw molluscs, ground beef, poultry, milk and liquid eggs</td>
</tr>
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</table>

**Risk-based sampling**

- Influenced by:
  - Importance to food safety
  - Whether sampling is used as a control measure (e.g., CCP) to manage risk.
    - If yes, a more stringent sampling plan is needed
  - The expected prevalence rate of a microbial hazard (e.g., >5%; < 0.5%)
Sampling is a control measure (i.e., CCP):
- dry sausage blends - *E. coli* O157:H7
- ground beef - *E. coli* O157:H7
- sprouts - salmonellae, *E. coli* O157:H7

Sampling is for process verification of each lot:
- fresh juice - *E. coli*

Sampling to assess trends for process control (e.g., moving window):
- *E. coli* and salmonellae on carcasses

Company policy requires a report-for-the-file

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**Risk based sampling - another continuum**

High: ICMSF-type of plan

Medium

Low

Very low

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**No. samples required for 95% confidence of detecting at least 1 defective unit**

<table>
<thead>
<tr>
<th>% defectives in lot</th>
<th>No. sample units</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>5</td>
<td>59</td>
</tr>
<tr>
<td>2</td>
<td>149</td>
</tr>
<tr>
<td>1</td>
<td>299</td>
</tr>
<tr>
<td>0.1</td>
<td>2995</td>
</tr>
</tbody>
</table>
Frequency of positive lots for salmonellae

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid whole eggs</td>
<td>48%</td>
</tr>
<tr>
<td>Ground chicken</td>
<td>36%</td>
</tr>
<tr>
<td>Ground beef</td>
<td>1.7%</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>0.3, 0.5, 2.4, 3.3% (4 surveys)</td>
</tr>
<tr>
<td>Leafy greens</td>
<td>0.0, 0.6% (2 surveys)</td>
</tr>
</tbody>
</table>

When does industry test raw foods?

- Three reasons:
  - Lot acceptance sampling
  - Process control
  - Investigational sampling
When does industry test raw foods?

**Lot acceptance sampling**
- Sensitive ingredients that may be added to RTE foods
  - ingredients added to ice cream - salmonellae
- Pre-shipment tests required by purchaser
  - beef trimmings - *E. coli* O157:H7
- Regulatory requirement or guidance
  - irrigation water for sprouts - salmonellae, *E. coli* O157:H7

**Lot acceptance sampling**
- Determine acceptability of a suspect lot
- When confidence in a process is in question
- Buyer wants a report-for-the-file

**Process control**
- Examples:
  - carcasses - *E. coli*
  - fresh citrus juice - *E. coli*
Investigational sampling:
- Validate CCPs ($H_0 - \Sigma R + \Sigma I \leq PO$ or FSO)
- Understand risk (e.g., prevalence and concentration of pathogens)
- Identify sources and routes of contamination to learn where and how control measures can reduce risk

Investigational sampling:
- Investigate process failures and deviations from normal
- Evaluate new suppliers and co-packers
- Evaluate new technologies to control pathogens
The tremendous value of compositing samples

- Compositing has made it possible to apply more stringent sampling plans and increase confidence in the decisions made by industry over the past 35 years

Examples of alternatives to testing

- Molluscs - sample the water (e.g., total coliforms, fecal coliforms)

- Fresh meat and poultry:
  - Specify date from kill and conditions for holding/shipping (e.g., temperature)
  - Can include method of chilling and added ingredients (e.g., CO₂ snow, salt, nitrite)
If a raw food will be subjected to a validated reduction step (e.g., 5D) that operates within a HACCP system, there is no need to test the food.

**Issues**

- Hold and test programs for highly perishable raw foods require very close management to ensure safety, avoid a recall and retain shelf life.
- Where can future improvements in control best be attained: at the plant vs. at the farm?
- Have industry efforts since 1996 to control salmonellae on carcasses led to a reduction in human salmonellosis?
Beef trimmings and ground beef – a unique situation

- Testing beef trimmings and ground beef is being used as a risk management strategy for *E. coli* O157:H7
- Has testing been an effective control measure?
Prevalence of *E. coli* O157:H7 in ground beef - USA, through August 25, 2005
Illness due to *E. coli* O157:H7 - USA

Seasonality is a significant factor in many raw foods

- Seafood toxins
- Vibrios - seafood
- Salmonellae, *Campylobacter* - raw poultry
- *E. coli* O157:H7 - beef
The seasonal effect in raw foods is reflected in the incidence of human disease

*E. coli* O157:H7 in ground beef, USA.  
Positive lots by month: 2001 - August, 2005
FIGURE 1. Rate* of laboratory-confirmed infections with selected pathogens detected by the Foodborne Diseases Active Surveillance Network (FoodNet)† — United States, 1996–1998

*Per 100,000 population
†In 1995, active surveillance was initiated for culture-confirmed cases of Campylobacter, Salmonella, Shigella, and Shiga toxin-producing Escherichia coli O157 infections in Minnesota and Oregon and selected counties in California, Connecticut, and Georgia. Data presented in this figure are from the original FoodNet sites only.

Anon. 1999. MMWR 48:189-194
**Microbiological criteria for pathogens in raw foods**

- Specifications
- Guidelines
- Standards

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**Specifications - microbiological criteria**

- Very common for quality (e.g., SPC)
- Not common for pathogens
  - Example: ingredients added to RTE foods that receive no subsequent pathogen kill step
Guidelines and standards

- Spent irrigation water for sprouts - salmonellae, *E. coli* O157:H7
- Raw meat and poultry carcasses - *E. coli*, salmonellae
- Beef trimmings, ground beef - *E. coli* O157:H7