Postharvest Pathogen Interventions for Meat and Poultry

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Meat Safety/Health Issues

• Foot and Mouth Disease
• BSE
• Listeria
• Yersinia
• Campylobacter
• E. coli
• Salmonella etc. etc……
E. coli O157
AOAC-RI
In Process!
All it takes is a little cross-contamination in your plant to spell disaster.
Decontamination Research/Usage

- Animal cleaning
- Chemical dehairing
- Carcass
  - Knife trimming
  - Steam/hot water vacuuming
  - Spraying/washing/rinsing
    - Before and after evisceration
  - Sanitizing solutions
- Irradiation
Postharvest Interventions-Poultry

- **Chicken carcasses**
  - Acidified Na+ chlorite/citric acid – 0.72-2.6 logs
  - Trisodium phosphate – 0.74-4.87 logs
  - Lactic acid – 1.0-1.77 logs
  - Cetylpyridinium chloride – 0.9-2.3 logs
  - Sodium bisulfate – 1.6 logs

- **Chicken wings**
  - Lactic acid/sodium benzoate – 0.5-2.5 logs

- **Turkey breast cores**
  - Sodium lactate/sodium diacetate – 0.2-0.8 logs
Postharvest Interventions-Poultry

- **Ground chicken**
  - Hydrostatic pressure – 1.7-7.5 logs
- **Various meat models**
  - Hydrostatic pressure – 1.3-5.5 logs
- **Ground turkey from RTE breasts**
  - Sodium diacetate/nitrate/lactate and pediocin combinations – 3.4-6.6 logs
Postharvest Interventions-Pork

- Rib/loin chops
  - Acetic acid – 0.1-2.5 logs
  - Lactic acid – 0-0.5 logs
  - Organic acid combinations – 0-2.5 logs
- Pork trim meat cores
  - Water/lactic acid and hot air comb. – 2.0-3.0 logs
Postharvest Interventions-Lamb

- **Muscle cores**
  - Acetic acid – 0-2.5 logs

- **Subcutaneous**
  - Hot water – 4.0 logs
Postharvest Interventions-Beef Cuts/tissues

- **Organic acids/log reductions**
  - Lactic – 0.2-3.1 logs
  - Acetic – 0.3-3.4 logs
  - Formic – <1 log
  - Citric – <1 log
  - Gluconic – <1 log
  - Mixed organic acids – 0.4-1.7 logs
  - Heated organic acids – <1 log - >3 logs
Postharvest Interventions-Beef Cuts/tissues

- **Water/reductions**
  - Cold – 0.1 – 1.2 logs
  - Hot – 1.5 – 2.7
  - Steam – 0.1 (few postharvest intervention pubs)

- **Chemical**
  - Na+ hypochlorite/Hypochlorous acid – 0.2-1 log
  - Trisodium phosphate – 0-4.3 log
  - Cetylpyridinium chloride – 5.0-6.0 logs
Postharvest Interventions-Beef Cuts/tissues

• Multiple interventions – 1.3 – 2.5 logs

• Low intensity ultrasound - < 1 log
Postharvest Interventions-Beef trimmings then ground

- **Water/reductions**
  - Hot and cold – 0-2.4 logs

- **Organic acids/acidulants**
  - Lactic – 0.1 - 3.2 logs
  - Acetic – 0.1- 2.8 logs
  - Gluconic – 0.1-0.5 logs
  - Trisodium citrate – 0.6-2.3

- **Oxidants**
  - Ozone – 0.1 – 0.8 logs
Postharvest Interventions-Beef trimmings then ground

• Chemical
  – Chlorine dioxide - 0.6-0.7 logs
  – Trisodium phosphate – 0.6-2.3 logs
  – Cetylpyridinium chloride – 0.6-0.7 logs
  – Multiple interventions – 0.6-2.6 logs
Postharvest Interventions-Ground beef – Direct Interventions

- Sodium lactate – 0-0.8 logs
- Sodium diacetate – Delayed growth
- Sodium acetate – 0.1-0.6 logs
- Sodium citrate – 0-0.2 logs
- Potassium lactate – 0.5-1.0 logs
- Hydrostatic pressure - ~ 2.2 logs
Commercial Interventions

- Ozone
- Chlorous acid system
- Peroxyacid system
- Others on the horizon???
Research at U of A

• Evaluated a number of antimicrobials in ground beef production
  – Hot water
  – Ozone
  – Trisodium citrate
  – Gluconic acid
  – Acetic acid
  – Trisodium phosphate
  – Cetylpyridinium chloride
  – Lactic acid
  – Chlorine dioxide
  – Various combinations (Hurdles)
Results

• With the exception of hot water and trisodium citrate, all were effective for reducing one or all:
  – *E. coli*
  – *Salmonella Typhimurium*
  – Aerobic bacteria
  – Coliform
Multiple Interventions - Day by Treatment
Effect on *E.Coli*

![Graph showing effect of interventions on E.Coli over days of storage.](image_url)

- **Control**
- **aacpc**
- **clo2cpc**
- **cpctsp**

Log CFU/g vs Days of Storage

(P<.05)
Multiple Interventions - Day by Treatment Effect on Coliforms

![Graph showing the effect of different interventions on coliform counts over days of storage. The graph compares CONTROL, AACPC, CLO2CPC, and CPCTSP treatments. The y-axis represents Log CFU/g, and the x-axis represents Days of Storage. The graph includes letters (a, b, c) indicating statistically significant differences at P<.05.](image-url)
### Multiple Interventions - Treatment Means of Salmonella and APC

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Salmonella</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>5.80&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.06&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>CLO2/CPC</td>
<td>4.42&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.89&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>CPC/TSP</td>
<td>4.63&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.18&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>AA/CPC&lt;sup&gt;abc&lt;/sup&gt; (P&lt;.05)</td>
<td>3.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.30&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Single and multiple interventions

• No special processing concerns
• Little impact on:
  – Color – sensory and instrumental
    • Some doubled color shelf-life
    • Enhanced myoglobin stability
  – Odor
  – Sensory flavor, juiciness and bind
    • Some more juicy
Summary

• The use of single or multiple antimicrobial interventions in a ground beef production system
  – reduces microorganisms
  – probably increases yields
  – little effect on
    • instrumental color
    • texture
    • sensory properties
    • may improve shelf life stability
  – Part of HACCP plan?
Summary

• Postharvest microbial interventions
  – Water
  – Organic acids
    • Not all equally effective
  – Chemical
    • May be most effective
      – Trisodium phosphate
      – Cetylpyridinium chloride
  – Hydrostatic pressure
  – Multiple interventions
    • May be more effective than single interventions

• Ground beef most difficult

• Ground beef
  – Trimming intervention larger reduction than direct intervention
Regulatory – USDA-FSIS

- Oct. 1994 – *E. coli* an adulterant – ground beef
- Backgrounder - 9/24/02
  - *E. coli* O157:H7 more prevalent than thought
    - 28% of animals
    - 43% of carcasses
  - *E. coli* “reasonably likely to occur”
  - Reassess HACCP Plans
  - FSIS developing publication – decontaminate carcasses, beef trimmings and ground beef
Regulatory – USDA-FSIS

- April 29, 2003 – Direct Final Rule on New Binders/Antimicrobials in Standardized Products
  - 9 CFR Parts 319 and 381
  - FSIS – case by case rulemaking inefficient
  - Permits the use of “safe and suitable” binders and antimicrobial agents in standardized foods without rulemaking, provided the standard already permits the use of such substances.
All this information, and it's FREE!