Intervention Strategies for Control of *Campylobacter* during Poultry Processing

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CDC Estimates

31 Pathogens Caused Cases in the US

Domestic vs. Internationally Acquired

Non-Foodborne vs. Foodborne

Parasites, Viruses, Bacteria

37.2 M

36.4 M

25.0 M

0.2 M

0.8 M

9.4 M

5.5 M

0.8 M

9.4 M

3.6 M

Scallan et al., 2011
Why Poultry?

- Contaminated poultry has the greatest public health impact among foods
- A few facts as per published reports on poultry:
  - Estimated $2.4 billion in annual disease burden
  - 1.5 million illnesses (17% of total)
  - 11,952 hospitalizations (22% of total)
  - 180 deaths (13.5% of total)
- Appears twice in the top 10 as a source of significant disease burden
  - *Campylobacter* and *Salmonella* (Batz et. al, 2011)
Ranking the Disease Burden of 14 Pathogens in Food Sources in the United States Using Attribution Data from Outbreak Investigations and Expert Elicitation†

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ABSTRACT

Understanding the relative public health impact of major microbiological hazards across the food supply is critical for a risk-based national food safety system. This study was conducted to estimate the U.S. health burden of 14 major pathogens in 12 broad categories of food and to then rank the resulting 168 pathogen-food combinations. These pathogens examined were Campylobacter, Clostridium perfringens, Escherichia coli O157:H7, Listeria monocytogenes, norovirus, Salmonella enterica, and Staphylococcus aureus.
Poultry-related campylobacteriosis

- *Campylobacter*–contaminated poultry responsible for $1.3 billion in costs of illness annually.

- *Campylobacter* in poultry causes more than 600,000 estimated cases of illness annually ~ 72% of the poultry related illnesses.

Emerging Pathogens Institute, University of Florida 2011
Campylobacter spp.

- Gram negative, short rods
- Motility
  - Cork screw motility
  - Changes with age of culture
- Thermophilic (42-43°C)
  - Grows in the GI tract of poultry
  - Body temperature ideal for growth
- Microaerophilic conditions (5%-O₂, 10%-CO₂, 85%-N₂)
- Difficult to culture and isolate – VBNC
  - Coccoid shape
Campylobacter Infection

- Fecal-oral route
- No immune response elicited in poultry
  - Serves as a good host
- Typical symptoms:
  - Diarrhea, fever, cramping, bloody stool, no nausea
  - Incubation 2-10 days
  - Duration 2-7 days
- Implicated in Guillain-Barre Syndrome
  - Severe cases (1 or 2 out of 100,000)
Poultry Meat Consumption

• Recent growth due to:
  • Negative press associated with beef industry
  • High beef prices
• U.S. menu items with poultry as an ingredient has increased 12% in past three years
  • (Mintel Menu Insights, May 2012)

✓ Safety of these products is still crucial!
Time to act on it !!!!

PERFORMANCE STANDARDS

• Effective July 2011
  • New performance standard for *Campylobacter*
    • 15.6 % (8 out of 51 sample set)- Post-chill in young chicken
    • 0.79% for turkeys (4 out of 56 sample set)

• Plant shut down?
  • Data published online
  • Down time
What to do? And….. How?

Recommendations to monitor, evaluate, and revise → critical components for kinds of innovations undertaken by FSIS
Where are the issues?

Farm?

- *Campylobacter* is found in the tract of most poultry.

- No symptoms of infection, easily within flock.

- Wide variety of sources of contamination (insects, rodents, soil, water, farm animals, human traffic).

- Extremely difficult to prevent *Campylobacter* from infecting new poultry flocks.
Where are the issues?

**Consumers?**

- No methods to test for *Campylobacter* contamination in purchased raw poultry.

- Poultry is assumed safe when cooked.

- Source of infection may be out of consumer’s control – Restaurants etc….
Where are the issues?

*Campylobacter* control falls on processing plants

- Cross contamination at a minimum.

- Regular testing for prevalence and levels of *Campylobacter*.

- Antimicrobial interventions can be applied to raw product.
Current Plant Treatment Points

- Scalders
- Inside-Outside Bird Washers
- Pre-chillers
- Main chillers
- Post-chill interventions
Carcass Chilling

• Reduce carcass temperature below 40°F/4.4°C within 4 hours of slaughter
  – Immersion
  – Air chilling
• Three main types:
  – Drag
  – Screw/Auger
  – Rocker
• Most chillers are counter-flow or counter-current
• Eliminate product pile-ups
Opportunity for cross-contamination!!!!

Need for reduction in bacterial accumulation and hence product contamination

- Chiller management
  - Temperature
  - pH
  - Water quality
- Antimicrobials

- No dripping/lesser contamination
- Investment
- Lesser volumes of production
Commonly used antimicrobials

- Chlorine
- Other halogens – Bromine compounds
- Tri Sodium Phosphate
- Per Acetic Acid (PAA)
- Cetylpyridinium Chloride

INJURY vs. KILL
Comparison of antimicrobials, application methods and processing steps against *Campylobacter* in processing plants
Treatments

• Solutions prepared and chilled to 10°C
  – DBDMH (50, 75, 100, 200, 300 ppm)
  – Sodium Hypochlorite (25 and 50 ppm)
  – Peracetic acid (100 and 200 ppm)
  – Negative & Positive Control
  – Hach Pocket Colorimeter II
Procedure

**Inoculation:** 10 mL *C. jejuni* (10⁷ CFU/mL); 30 min attachment

**Treatments:** DBDMH (50, 75, 100, 200, 300), SH (25, 50), PAA (100, 200)

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**Immersion Application**
- Immersed individually in a 5 gallon bucket
- 6.05 L of antimicrobial
- Time: 0, 30, 60, 90, 120 s
- 0.25 mL plated onto *Campylobacter Cefex* agar
- 200 mL carcass rinse after application of antimicrobial

**Spray Application**
- Garden Sprayer with fan nozzle
- 460 mL of antimicrobial
- Carcass suspended in fume hood
- 60 s of spray application
Survival populations ($\log_{10} \text{CFU/mL of rinsate}$) of *Campylobacter jejuni* on chicken carcasses following immersion application with various antimicrobials.

DBDMH = 1,3-Dibromo-5, 5-Dimethylhydantoin; SH = Sodium Hypochlorite; PAA = Peracetic Acid; ppm = parts per million
Immersion Application

Reductions in *Campylobacter*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Log CFU/ml of rinsate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>0.91</td>
</tr>
<tr>
<td>50 ppm DBDMH</td>
<td>0.8</td>
</tr>
<tr>
<td>75 ppm DBDMH</td>
<td>0.8</td>
</tr>
<tr>
<td>100 ppm DBDMH</td>
<td>0.61</td>
</tr>
<tr>
<td>200 ppm DBDMH</td>
<td>0.94</td>
</tr>
<tr>
<td>300 ppm DBDMH</td>
<td>0.68</td>
</tr>
<tr>
<td>25 ppm SH 50 ppm SH</td>
<td>0.19</td>
</tr>
<tr>
<td>100 ppm PAA</td>
<td>0.35</td>
</tr>
<tr>
<td>200 ppm PAA</td>
<td>1.42 *</td>
</tr>
</tbody>
</table>
Survival populations ($\log_{10}$ CFU/mL of rinsate) of *Campylobacter jejuni* following spray application with various antimicrobials

DBDMH = 1,3-Dibromo-5, 5-Dimethylhydantoin; SH = Sodium Hypochlorite; PAA = Peracetic Acid; ppm = parts per million
Reduction of *Campylobacter jejuni* populations on poultry

<table>
<thead>
<tr>
<th>DBDMH Solutions</th>
<th>Control</th>
<th>DBDMH 50 ppm</th>
<th>DBDMH 75 ppm</th>
<th>DBDMH 100 ppm</th>
<th>DBDMH 200 ppm</th>
<th>DBDMH 300 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log_{10} CFU/mL</td>
<td>5.43</td>
<td>5.45</td>
<td>5.67</td>
<td>5.48</td>
<td>5.49</td>
<td>5.38</td>
</tr>
<tr>
<td></td>
<td>±0.04</td>
<td>±0.05</td>
<td>±0.04</td>
<td>±0.04</td>
<td>±0.04</td>
<td>±0.04</td>
</tr>
</tbody>
</table>

- **Spray Campy Cefex**
- **Immersion Campy Cefex**
DBDMH Chiller Field Trial

* Means are significantly different at (P > 0.05)
Salmonella and Campylobacter Reduction and Quality Characteristics of Poultry Carcasses Treated with Various Antimicrobials in a Post-Chill Immersion Tank

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http://dx.doi.org/10.1016/j.ijfoodmicro.2013.05.016, How to Cite or Link Using DOI

Highlights

- Chicken carcasses were treated with antimicrobials in a post-chill immersion tank.
- Sensory analysis was done on chicken breast meat from each treatment.
Conclusions

• Immersion application significantly reduced aerobic bacteria compared to spray \((P \leq 0.05)\)
  – 300 ppm immersion showed greatest reduction of \(C. \) jejuni

• Spray treatment showed no significant effect on \(Campylobacter\) \((P > 0.05)\)

• Field trials showed significant reductions post-chill compared to pre-chill
Further Efforts

Develop a risk based approach to mitigate *Campylobacter* during poultry processing
Plant Surveys

• Six poultry processing plants to determine:
  • Production yield
  • Sanitary practices
  • Processing line design
  • Antimicrobial levels and steps
  • Pathogens tested
  • Corrective actions

• Survey Analysis:
  • Sampling procedure for each plant
  • Focus on microbial load throughout the processing lines
In-plant Sampling

• Sampling locations for bird rinses:
  • Post-Pick: After evisceration, before birds have enter the Inside-Outside Bird Washer
  • Pre-Chill: After birds have exited the IOBW, before entering the pre-chiller
  • Pre-Post: After birds have exited the pre-chiller, before they enter the main chiller
  • Post Chill: After birds have exited the main chiller, but before any post-chill intervention
  • Post Dip: After birds have exited the post-chill intervention
Sample Analysis

• Samples were transported back and analyzed within 4-6 h

• Plated on XLT-4, PCA, VRBA, and Campy-Cefex agar

• Enrichments Bolton Broth and re-streaked to determine prevalence of *Campylobacter*
Pathogen tracking

Log CFU/mL

- Post Pick
- Pre-Chill
- Pre-Post
- Post Chill
- Post Dip

- *E. coli*
- Aerobic
- *Campylobacter*
- *Salmonella*
**Campylobacter tracking**
Overall Results

- *Salmonella* growth was inhibited by the antimicrobial measures in all plants
  - Initial plate counts only showing *Salmonella* colonies in manure and scalder samples
  - Enrichment showed *Salmonella* on several bird samples before any antimicrobial treatment, but no *Salmonella* was detected post-intervention
Overall Results

• All plants showed significant reductions (p<0.05) of *Campylobacter* after antimicrobial treatment

• Aerobic growth was also significantly (p<0.05) reduced by the antimicrobial treatment in all plants
Summary

• Plants are doing a good job with *Salmonella* control

• Irregular levels of *Campylobacter* on the birds and in the plant environment make it a challenge for control

• Water is a major source of contamination of the carcasses in poultry processing – VERY COMMONLY OVERLOOKED
Summary

• Not a one step fix:
  – Multi-hurdles approach

• Evaluate ongoing practices to maximize results:
  – Validations
  – Verifications

• Understand high risk areas – implement interventions
THANK YOU