A Pre-Harvest Intervention to Reduce *Salmonella* Contamination in Processed Commercial Broilers and Turkeys

Eric Gingerich, DVM

2017 USAHA *Salmonella* Subcommittee Meeting
Outline

- Present emphasis on post-harvest interventions
- Pre-harvest interventions available
- Theory on how a pre-harvest intervention works to reduce Salmonella
- Background information on feed-thru pre-harvest intervention
- Initial evidence of effectiveness
- Example effects of a pre-harvest intervention
  - Ceca prevalence and concentrations
  - Carcasses
  - Parts
  - Ground meat
- Summary
Poultry Processing Flow Diagram

Live Birds → Hanging → Stunning → Slaughter

Hock Cutter → Head Removal → Pickers → Scalding

Oil Gland Removal → Vent Opener → Eviscerator → Giblet Harvest

Washing → Neck Breaker → Cropper → Viscera Removal

Carcasses Routed to: Sizing lines, cut-up, deboning, or further processing

Chiller

Packaging

Shipping

Re-hang

Pre-chill

Post-Chill

Ceca Removal

Post-Harvest Interventions for Reducing Salmonella in Processed Meat Birds

- Alkaline counter-flow scalder water
- Post-scald and post-pick chlorine rinse
- Chemical rinses during evisceration
- Chilling - chlorine
- Chemical dips/sprays post-chill/reprocessing
  - Peroxyacetic acid
  - Trisodium phosphate
  - Lactic acid
  - Sodium bisulfate
  - Cetylpyridium chloride
  - Acidified sodium chlorite
Pre-Harvest Interventions Evaluated for Reducing *Salmonella* in Meat Birds

- **Organic Acids**
  - Citric acid
  - Lactic acid
  - Acetic acid
  - Acidified copper sulfate

- **Inorganic Acids**
  - Sodium bisulfate

- **Probiotics/Prebiotics**

- **Vaccines**

- **Botanical Products**

- **Immunomodulators**
How Does a Pre-Harvest Salmonella Intervention Work?
How Does a Pre-Harvest *Salmonella* Intervention Work?

Pre-Harvest intervention is conveniently added to either the feed, water or both

1. Reduces the *Salmonella* levels in the gut and in the excreted feces
2. Reduced *Salmonella* levels in the broiler house environment; i.e. litter
3. Lower *Salmonella* contamination in the crop from birds fasting prior to slaughter
4. Less *Salmonella* in crop, ceca and intestines that is released during processing
5. Lower *Salmonella* contamination levels on carcasses, parts, and ground meat
Original XPC: A Pre-Harvest Intervention

- A fermentation metabolite/Immunomodulator product
- Conveniently fed to the animal
- Has prebiotic effect
- Helps the immune system recognize pathogens
  - Increased surveillance for pathogens
  - Leads to a more robust immune response
    - Faster response
    - Stronger response
- A "Clean Label" intervention
Initial Evidence - Controlled Experiments

Dr. Steve Carlson, Iowa State University
Experimental Design

Replicated 3 Times

Feye et al., 2016
Salmonella Fecal Shedding: Summary

✓ XPC led to a decrease in fecal shedding at three time points.
Intestinal Colonization: Summary

XPC led to a decrease in intestinal colonization on day 49

Carlson et al., 2016; IPSF, Atlanta, GA

![Graph showing decrease in Salmonella (CFU/g) with XPC treatment compared to CON. *P<0.05]
Commercial Poultry Trials - Combined

The Proof
Materials and Methods

- Commercial poultry field trials with matched houses/farms

- Two Feed Treatments
  - CON diet: standard company diet
  - CON diet plus XPC at 1.25 kg/MT (2.5 lb/t) from day of age to market

- Ceca sampling preferred method

- 21 Companies Reported
- 264 barns
- 12,046 samples
Sampling a Ceca
Ceca Placed Into WhirlPak
In Commercial Field Evaluations XPC Reduces *Salmonella Prevalence* (%) vs. Control

% Reduction from Control

<table>
<thead>
<tr>
<th></th>
<th>Broilers</th>
<th>Turkeys</th>
<th>Layers</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>N = 12,046 samples</td>
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<tr>
<td>Field Trials: AL, AR, CA, GA, IA, IN, ME, MN, MO, NC, OH, SC, SD, TX, VA</td>
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</table>

Avg. = 54.1 % Reduction
In Commercial Field Evaluations
XPC Reduces *Salmonella Numbers* (CFU/g) vs. Control

Avg. = 86.8% Reduction

N = 12,046 samples
Field Trials: AL, AR, CA, GA, IA, IN, ME, MN, MO, NC, OH, SC, SD, TX, VA
Broiler Ceca *Salmonella*: Prevalence and Numbers

Broiler Field Samples; n = 5,891

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Pavlidis et al., 2016
Dot Plot of Broiler Ceca *Salmonella* Numbers

Broiler Field Samples; n = 5,891

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Ceca *Salmonella* Prevalence and Numbers: 
Broiler Resampling*

Prevalence (%)

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>XPC</th>
<th>XPC_R2</th>
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<tbody>
<tr>
<td></td>
<td>19.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.3&lt;sup&gt;c&lt;/sup&gt;</td>
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CFU/g

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<tr>
<th></th>
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<th>XPC</th>
<th>XPC_R2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>29.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.6&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b</sup>P < 0.0001

*XPC_R2 = Resample of XPC*
Turkey Ceca *Salmonella*: Prevalence and Numbers

Turkey Field Samples; n = 3,563

Prevalence (%)

- **CON**: 18.9<sup>a</sup>
- **XPC**: 7.7<sup>b</sup>

CFU/g

- **CON**: 29.6<sup>a</sup>
- **XPC**: 2.4<sup>b</sup>

<sup>a,b</sup>P < 0.0001

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McIntyre et al., 2016
Dot Plot of Turkey Ceca *Salmonella* Numbers

Turkey Field Samples; n = 3,563

McIntyre et al., 2016
Cecal *Salmonella* Prevalence and Numbers: Turkey Resampling*

*CON XPC XPC_R2

**Prevalence (%):**
- CON: 26.3<sup>a</sup>
- XPC: 16.4<sup>b</sup>
- XPC_R2: 7.1<sup>c</sup>

**CFU/g:**
- CON: 9.1<sup>a</sup>
- XPC: 2.2<sup>b</sup>
- XPC_R2: 0.9<sup>c</sup>

*<sup>a,b</sup>P < 0.0001

*XPC_R2 = Resample of XPC*
Effects of Original XPC on Pathogen Reduction on Poultry Parts

Commercial Field Data
Whole Bird Rehang Rinsate:
Prevalence and Numbers

**Prevalence (%)**
- **CON** 25.0\(^a\)
- **XPC** 8.3\(^b\)

**CFU/ml**
- **CON** 631.0\(^a\)
- **XPC** 228.5\(^b\)

\(^{a,b} P = 0.0125\)
\(^{a,b} P = 0.0153\)

Broiler Field Samples; BC06
Parts Rinsate: Prevalence and Numbers

Prevalence (%)

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<tr>
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<th>CON</th>
<th>XPC</th>
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<tr>
<td></td>
<td>16.7a</td>
<td>3.1b</td>
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CFU/ml

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<th></th>
<th>CON</th>
<th>XPC</th>
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<tr>
<td></td>
<td>250.7a</td>
<td>41.3b</td>
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a,bP = 0.0010

Broiler Field Samples; BC06
Pre-Chill *Salmonella* Prevalence: Successive Flocks Per Barn

<table>
<thead>
<tr>
<th></th>
<th>Prevalence (%)</th>
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<tbody>
<tr>
<td>CON</td>
<td>42</td>
</tr>
<tr>
<td>XPC_1st Round</td>
<td>33</td>
</tr>
<tr>
<td>XPC_2nd Round</td>
<td>23</td>
</tr>
<tr>
<td>XPC_3rd Round</td>
<td>9</td>
</tr>
</tbody>
</table>
Ground Meat *Salmonella* Prevalence: Successive Flocks Per Barn

![Graph showing prevalence of *Salmonella* in different groups.

- **CON**: 54%
- **XPC_1st Round**: 29%
- **XPC_2nd Round**: 0%
- **XPC_3rd Round**: 0%

Midwest Turkey Processor, 2015
Salmonella Prevalence: Turkey Wings

- CON: 83%
- XPC: 14%
Salmonella Prevalence: Ground Turkey

POSS Drums

- CON: 63%
- XPC: 8%
Salmonella Prevalence: Broiler Breast Tenders

CON XPC

Salmonella Prevalence: Broiler Breast Tenders

Salmonella Prevalence: Broiler Breast Tenders

Prevalence (%)

CON

XPC

30.0a

0.0b

a,bP = 0.0002

Broiler Field Samples; BC02
Salmonella Prevalence: Bone In Parts*

Prevalence (%)

CON

15.4a

XPC

3.8b

a,bP = 0.0140

N=78/Treatment

*Bone In Drums, Thighs, Wings and Breasts

Broiler Field Samples; BC07
Conclusions

- Pre-harvest interventions in poultry flocks can be effective in reducing Salmonella in fecal and cecal contents
- The Salmonella reduction in fecal and cecal contents effectively reduced contamination of carcasses, parts, and ground meat
- Selection of a pre-harvest intervention needs to be based on research results