Controlling *Salmonella* in Poultry Plants

For the FSIS “How to” Workshops

Spring 2009

Presented by

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By the end of this workshop, you will be able to

- Understand the characteristics of *Salmonella* and its serotypes
- Identify practical tools and methods to control *Salmonella*
- Develop and implement controls for *Salmonella* in your operations
Salmonella

- Rod-shaped, motile bacterium
- Non-spore forming
- Gram negative
- Found on animals and in the environment
- Grows well at body temperature
Salmonella (con’t)

- Optimum temperature for growth is between 35°C and 37°C
- Slow growth has been observed at 5°C, with a maximum growth between 45°C and 47°C
- Growth may occur between pH 4.0 (depending on the acid) and pH 9.0; optimum pH is between 6.5 and 7.5
- D-value of 4 to 5 minutes at 60°C has been reported for Salmonella
Over 2,000 different *Salmonella* serotypes

All serotypes are now being compared to the CDC list of top 30

75% of all “A” sets have fewer than four serotypes linked to CDC list
It is important to know which serotypes of *Salmonella* you have!
### Top 30 Serotypes in 2005

**Human 2005**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Serotype</th>
<th>Reported</th>
<th>Percent</th>
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Sub Total: 29507 (81.5)

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Screen clipping taken: 11/11/2008, 7:31 PM
Preharvest

*Salmonella* Control
Preharvest *Salmonella* Control

- **Restricting access**
  - Vehicles
  - People
  - Animals

- **Biosecurity**
  - Dedicated clothing and boots
  - Disinfectant boot dip

![Image of a farm or agricultural setting]
Preharvest *Salmonella* Control (con’t)

- **Feed**
  - Heat treated
  - Pelletized
- **Litter**
  - Maintain low water activity

ARS Photo by Stephen Ausmus
Recommended Preharvest Best Practices

- Implement biosecurity measures
- Use good sanitation practices
- Control litter moisture
- Use well-timed feed withdrawal
- Use acids in drinking water during feed withdrawal

ARS Photo by Stephen Ausmus
Discussion Questions

- What do you know about the live birds from which you are producing product?
- Do you know the level of *Salmonella* contamination?
FSIS Category Levels for Serotypes

- Samples containing 1 of the top 30 serotypes identified by CDC
  - Low level
    - 0–1 samples per set
  - Medium level
    - 2–4 samples per set
  - High level
    - Greater than 5 samples per set
Target for *Salmonella* Reduction

**FSIS performance measure:** 90% of plants in Category 1 by October 2010

![Bar chart showing the percentage of plants in different categories from 2006 to 2007, with the Sep 2010 target indicated.](image)
Salmonella and HACCP Plans

- A poultry HACCP plan **MUST** have a critical control point (CCP) to address *Salmonella*
- Support documentation is required
- Verification of the HACCP plan’s ability to control *Salmonella* is required
Sanitation

What role does sanitation play in controlling Salmonella?
Plants may address *Salmonella* control in their sanitation standard operating procedure (SOP) or other prerequisite program.

How effective is **YOUR** sanitation program in controlling *Salmonella*?
Sanitation and Hygiene

- Clean before sanitizing
- Enforce employee hygiene
Alkaline Detergents
- Sodium hydroxide
- Nitrous oxide
- Sodium silicate
- Trisodium phosphate

Note: Frequently used and vary in strength

Acid Detergents
- Hydrochloric acid
- Sulfuric acid
- Phosphoric acid
- Acetic acid

Note: Vary in strength
Sanitation and Hygiene (con’t)

- **Sanitizers**
  - Quaternary ammonia*
  - Industrial strength bleach
  - Iodine compounds
  - Peracetic acid
  - Steam
  - Ozone

- **Some sanitizers work better in certain parts of the plant**
  - Iodophors
    - Aluminum equipment, rubber belts, tile walls
  - Active chlorine
    - Walls (other than tile), wooden crates, concrete floors

*Quaternary ammonia is a type of synthetic detergent.
Live Receiving and Live Hanging

- Recommended best practices
  - Sanitize and dry cages thoroughly
  - Maintain positive air flow from inside to outside the plant
  - Provide SOP and employee training
  - Schedule flocks for slaughter based on pathogen loads
Recommended best practices

- Consider electrical stunning
  - Cheapest and most effective method
- Use well-timed feed withdrawal to reduce feces release
Scalding

- Recommended best practices
  - Use counter-flow water movement
  - Use high flow rates with agitation to help dilute dry matter and bacteria
  - Use multi-stage tanks
  - Maintain pH above 7.5 or below 6.5
  - Use pre-scald brushes to help clean birds before entering scalder
  - Use post-scald rinse to help remove debris
  - Maintain scalder temperature
Recommended best practices
- Prevent feather buildup on equipment
- Rinse equipment and carcasses
- Use 18–30 ppm chlorine rinse post-picking
Evisceration

- Recommended best practices
  - Adjust and maintain equipment regularly and as needed
  - Use 20 ppm chlorine for whole-carcass rinses
  - Enforce employee hygiene standards

Note: Feed withdrawal practices affect process control at this step.
Carcass rinses
- 23 ppm free available chlorine
- 10% TSP (trisodium phosphate)
- 2% lactic acid
- 5% sodium bisulfate
- 5% cetylpyridinium chloride

Be aware how chemical residues can impact pH of chiller
Immersion Chilling

- If using chlorine, maintain chill water at pH between 6.0 and 6.5 and at a temperature of less than 40°F
- Use high water flow rate and counter-current flow
- Use 20–50 ppm free available chlorine in the potable water measured at intake
- Use oxidation reduction potential pH with pH monitors
- 10 ppm free available chlorine can eliminate *Salmonella* in 120 minutes
- 30 ppm free available chlorine can eliminate *Salmonella* in 6 minutes
- 50 ppm free available chlorine can eliminate *Salmonella* from the water in 3 minutes

Note: Organic matter in the chiller binds the free chlorine and thus makes it unavailable.
Factors Affecting Chiller Water Quality

- High flow rate (1 gallon per bird)
- Counter-current water flow
- 20–50 ppm free available chlorine measured at intake
- Red water (recycled water) may contain up to 5 ppm free available chlorine measured at intake
- Water pH 6.0–6.5
- Water temperature less than 40°F
Air Chilling

- Meet regulatory requirements for chilling
- Clean and oil chains regularly
- Inspect and replace shackles as needed
- Maintain tension on chain to prevent carcass-to-carcass contact
- Sanitation is important—no chemical interventions
Reprocessing

- Use post-chill antimicrobial dips to reduce *Salmonella* loads
- Heated water, agitation, application under pressure, and calibrating pH can enhance *Salmonella* reduction
Reprocessing: Approved Substances

- Chlorine, chlorine dioxide, and acidified sodium chlorite
  - Water soluble
  - Spray or dip
  - Agitation and application under pressure enhance effectiveness
- Chlorine
  - Primarily used to treat processing and chiller water
  - Heat and pH above 6.5 decrease its effectiveness

- Chlorine dioxide
  - Can be used in water
  - Leaves no residue
  - Should NOT exceed 3 ppm residual chlorine dioxide
- Acidified sodium chlorite
  - Combination of citric acid and sodium chlorite
  - Can be used as spray or dip at 500 to 1,200 ppm singly or in combination with other generally recognized as safe (GRAS) acids to achieve a pH between 2.3 and 2.9 as an automated reprocessing method
  - In chiller water, it is limited to 50 to 150 ppm singly or in combination with other acids to achieve a pH between 2.8 and 3.2
Reprocessing: Approved Substances (con’t)

- Trisodium phosphate (TSP)
  - Approved for on-line reprocessing
  - Acts as a surfactant (high pH)
  - Residual TSP carries over into chiller
    - Must monitor pH of chiller water
  - Rinsing carcasses after TSP but prior to chiller decreases its effectiveness
  - More effective with air chilling than with immersion chilling
Cetylpyridinium chloride
- Quaternary ammonium compound
- Approved for processing in ready-to-cook poultry products
- Produces no adverse organoleptic effects
- pH is near neutral
- Stable, non-volatile, and soluble in water
Reprocessing: Approved Substances (con’t)

- **Inspexx 100**
  - Peroxyacetic acid
  - Approved as a carcass spray for OLR
  - Must not exceed 220 ppm

- **Spectrum**
  - Peroxyacetic acid and a proprietary substance
  - Can be used in process, scaler, and chiller water and as a carcass spray, wash, or dip
Other organic acids

- Lactic acid
  - Most commonly used organic acid
  - Applied as rinse
  - Has an organoleptic effect on raw product

- Acetic acid
  - Decreases pH and enhances the washing effect of scalder tank water
  - Has an organoleptic effect on raw product
Web Sites for Most Currently Approved Substances

- **Safe and Suitable Ingredients Used in the Production of Meat and Poultry Products**

- **Proprietary Substances**
Further Processing

To prevent cross-contamination:

- Sanitize well
- Practice good hygiene
- Keep poultry meat below 40°F
- Consider air flow and traffic patterns
Plant Variation

Incoming Birds | Post Scald | Pre OLR | Post OLR | Post Chill
0 | 10 | 20 | 30 | 40
50 | 60 | 70 | 80 | 90 | 100

Incoming Birds | Post Scald | Pre OLR | Post OLR | Post Chill
0 | 10 | 20 | 30 | 40
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Incoming Birds | Post Scald | Pre OLR | Post OLR | Post Chill
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Russell, Scott 2006
Validation

- 9 CFR 417.4
- Validation verifies the effectiveness of interventions
- Establishments must validate their intervention processes
Acceptable Validation Methodologies

- Scientific articles
- Process mapping
- Validation study
Salmonella continues to be an issue in poultry processing plants

Each plant is unique and must determine the best way to control *Salmonella* in their operation

Bio-mapping provides a way to identify critical areas where control measures should be applied
Multiple hurdles are better at controlling *Salmonella* than single control measures.

*Salmonella* testing should be done on a regular basis to validate control measures are working.

Sanitation effectiveness should be monitored.
Salmonella Summary

- Optimum temperature for growth is between 35°C and 37°C
- Slow growth has been observed at 5°C, with a maximum growth temperature between 45°C and 47°C
- Growth may occur between pH 4.0 (depending on the acid) and pH 9.0; optimum pH is between 6.5 and 7.5
- D-value of 4 to 5 minutes at 60°C has been reported for Salmonella