Challenges in controlling *Salmonella* in poultry and poultry products

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**Why is Salmonella so important?**
- Number **ONE** cause of food-borne illness (diarrhea)
- Live poultry is the *reservoir host* of *Salmonella*
- Poultry and poultry products (eggs and meat) are **PRIMARY** sources of human infection

**What is Salmonella?**
- **Biology of *Salmonella*** is complex
- **Many serotypes** (>2500)
  - At least 10% of these are found in poultry
  - Few are MOST common in the US poultry
  - What *Salmonella* serotypes are most common problems for US poultry meat producers?

- *S. Enteritidis*
- *S. Typhimurium*
- *S. Heidelberg*
- *S. Kentucky*
- *S. Infantis*
- *S. Mbandaka*
- *S. Montevideo*
- *S. Seftenberg*

**Incidence of *Salmonella* serotypes in the retail chicken in the US**

*Most Prevalent Poultry-associated *Salmonella* seroTypes (MPPSTs)*

**Incidence of *Salmonella* serotypes in the raw poultry products in the US**

USDA-FSIS (1996-2012)

**Population dynamics of *Salmonella*** is a challenge & a significant concern

- **MPPSTs**
  - *S. Enteritidis*
  - *S. Typhimurium*
  - *S. Heidelberg*
  - *S. Infantis*
  - *S. Mbandaka*
  - *S. Montevideo*
  - *S. Kentucky*
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**March 1, 2013 to July 11, 2014**: Foster Farms recalled 12 million lb of potentially contaminated chicken products (804 sick people)

**January 10, 2014**: Tyson Foods, Inc. recalled 33.840 lb of potentially contaminated chicken products (9 sick people)

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**February 2013-2014** (mail-order hatchery related outbreaks)
- Mt. Healthy Hatchery (Ohio) - 521 sick people
- Estes Hatchery (Missouri) - 96 sick people
- Salmonella in backyard poultry

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**2013-2014**: Ciprofloxacin resistant sequence type 198 has emerged in the US and Canada (African origin?)

**WSU (2012)**: Two strains isolated from CA broiler samples (resistant to 3rd generation cephalosporin)
Why is *Salmonella* control so challenging?

* Each serotype is unique in its own way
  - Resistance to antimicrobials
  - Infectivity in chickens (e.g., high invasive vs low invasive)
  - Biofilm production
* There are phenotypic differences within each serotype
  - Not all S. Enteritidis strains contaminate eggs equally well
  - Not all S. Heidelberg strains are resistant to antimicrobials
* Current food-safety protocols are primarily based on the big TWO
  - S. Typhimurium
  - S. Enteritidis

Why is *Salmonella* control so challenging?

- Carcass chilling: Important step in reducing *Salmonella*
  - pH (≤ 6.5)
  - Max. 50 PPM Free Chlorine
  - Temp. ~4°C
- High amounts of organic matter (fat, blood and protein) can get accumulated in chiller tank and can reduce available chlorine
- Several contaminating serotypes
- Do different serotypes differ in their susceptibility to chlorine in chiller tanks?

Why is *Salmonella* control so challenging?

- Another challenge is EXTERNAL vs. INTERNAL contamination of carcasses
  - Conventional paradigm is that ALL contamination occurs at EXTERNAL surface of carcasses during processing

What we KNOW about *Salmonella*?

- *Salmonella CAN get inside the internal organs of chickens* (liver, spleen, muscle, bone marrow etc)

Why is *Salmonella* control so challenging?

- What we DO NOT know
  - Are all MPPSTs equally efficient in their ability to internalize in organs including bone marrow?
  - Are there within serotype differences for other MPPSTs?
  - Which MPPSTs persist in internal organs until the age of slaughter?
  - If *Salmonella* is HIDDEN in organs, how effective surface decontamination will be?
Why is *Salmonella* control so challenging?

- Another challenge is **BIOFILM** production by *Salmonella*

**Biofilms protect *Salmonella***
- can carry billions of *Salmonella*
- can provide physical barrier to antimicrobials such as chlorine or other disinfectants
- can be 1000 times more resistant to antibiotics
- Provides means to persist in the environment

MPPSTs differ in their ability to form biofilm & resistance to antibiotics

- 145 MPPSTs tested so far
- Most isolates were obtained here at AHFSL, Puyallup
- Biofilm production is common among most MPPSTs
- Antibiotic resistance is common among MPPSTs

Take home message

- All MPPSTs are potential pathogens
- Current food-safety protocols may not work effectively against all serotypes/strains of *salmonella*
- Need to develop of **serotype-independent strategies** to control *Salmonella* for both on-farm and in-plant control of *Salmonella*
  - Better understanding of the differences in the biology of MPPSTs
  - Infectivity of MPPSTs in chickens (internal vs. external contamination)
  - Biofilm and its role in resistance to carcass decontaminants and persistence in the poultry environment

Questions?