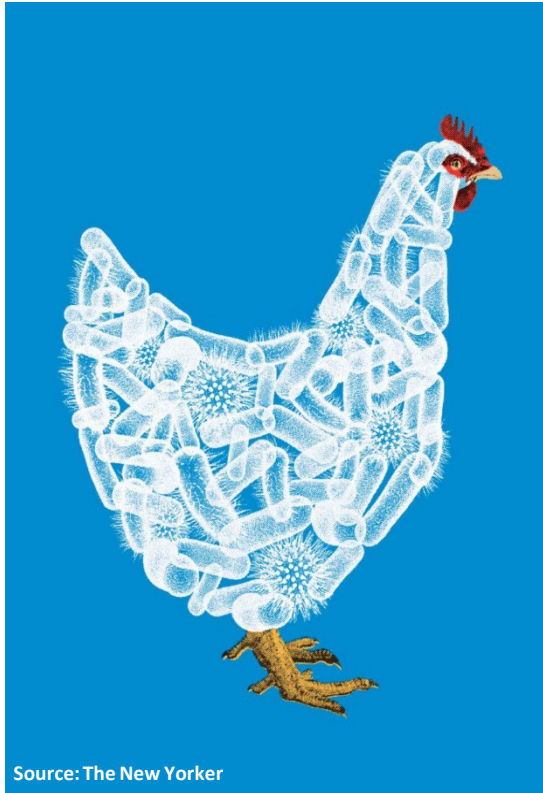


Response of Salmonella to Poultry-Relevant Challenge by Heat, Acid, and Pressure



Source: The New Yorker

John B. Luchansky
Anna C.S. Porto-Fett

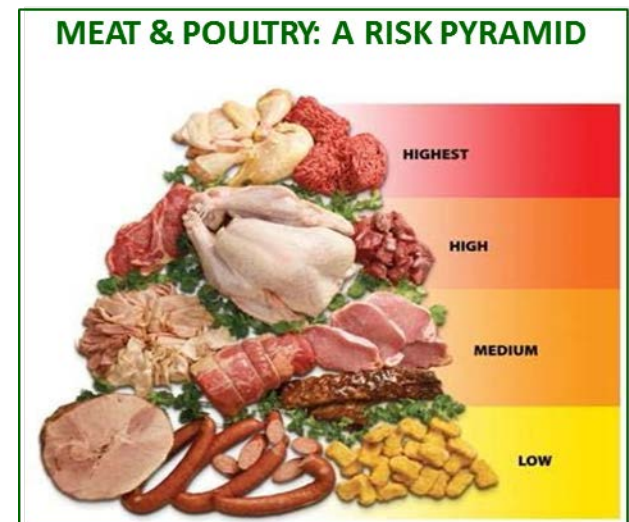


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FSIS/ARS Research Opportunity: Raw Ground Poultry, *Salmonella*, and Lethality...

- FSIS assessing policies associated with raw comminuted poultry products in response to ground turkey outbreaks of *Salmonella* Hadar and *Salmonella* Heidelberg
- FSIS needs research to determine if there are inadequacies in lethality processes, unique strain characteristics, and consumer behaviors that may be contributing to human illness

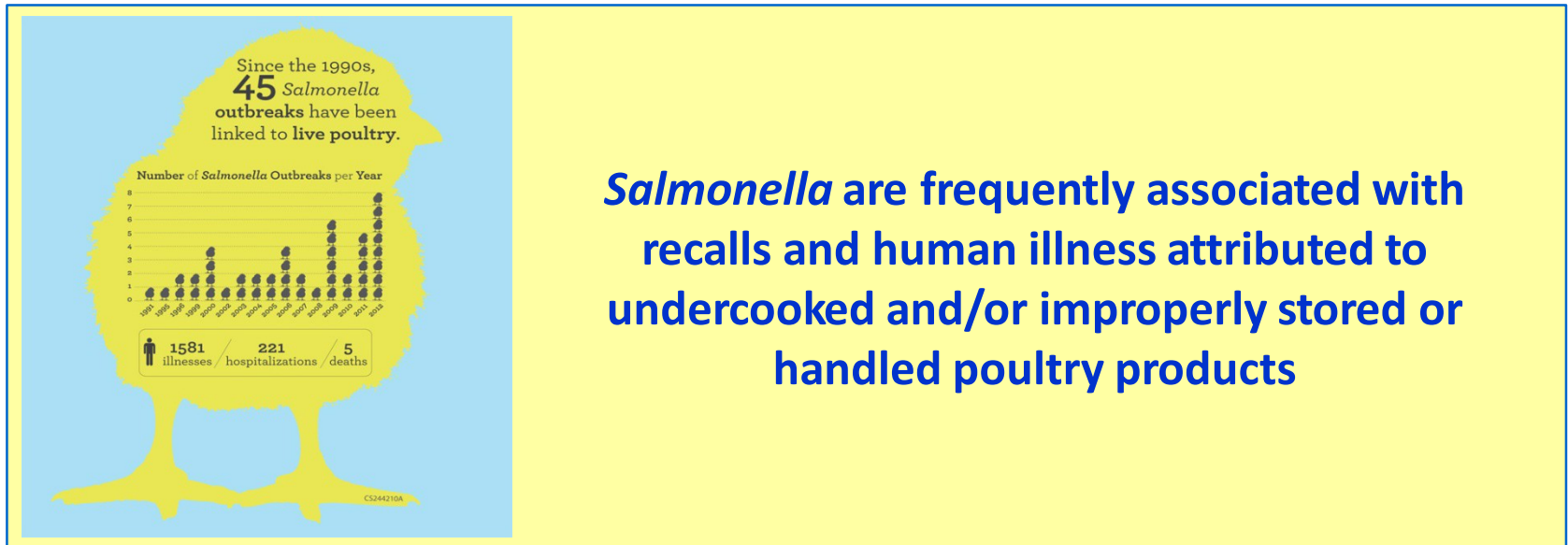
Ensuing results will facilitate risk analysis and policy development to prevent future outbreaks associated with raw poultry



Research Objective

- Phase I:

- Determine if outbreak *Salmonella* strains possess unique characteristics which may increase their ability to survive interventions and/or infect consumers
 - Heat, pressure, and acid challenge
 - Patient-product paired strains

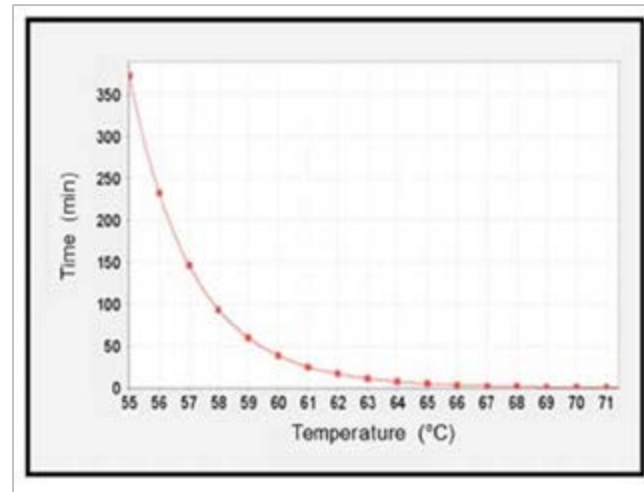


Salmonella are frequently associated with recalls and human illness attributed to undercooked and/or improperly stored or handled poultry products

Research Objective (cont.)

- **Subsequent Phases:**

- **Determine lethality curves for *Salmonella* in turkey burgers**
 - Develop lethality standards and cooking instructions
- **Determine consumer preferences for ground turkey products which may impact pathogen survival**
 - Moistness, degree of doneness



Strain Selection and Marking

- Are there phenotypic characteristics associated with *Salmonella* Hadar and/or *Salmonella* Heidelberg isolates from ground turkey outbreaks that enhance the ability of these strains to survive in poultry?
 - **Developed MTA's + obtained APHIS permits**
 - **Shared patient:product paired *Salmonella* strains**
 - Several strain sets to choose from
 - **Genetically marked all strains**
 - Rif^R [at 100 µg/ml]
 - **Selected strains for challenge studies**
 - 27 strains further characterized
 - 50 strains total – OH, WI, CO, VT, MN, WI



Strain Identification and Prioritization

Source	Serotype of strains	Source	Total # of strains	# of strains used for challenge studies
Washington	Heidelberg	Human, some food	15	6
Athens	Heidelberg & Hadar	Human and Ground Turkey	9	9
FSIS	Heidelberg & Hadar	Chicken parts	14	8
Other (VT, OH, MN, WI)	Hadar and Enteritidis	Ground Turkey	6	4
FSIS (Control strains)	Heidelberg & Hadar	?	2	2
Total			46	29

Strains Used In Challenge Studies

Key		SeroType	PFGE Pattern	Serotype	Source
WA 1		WA14692	JF6X01.0122	HEIDELBERG	HUMAN
WA 2		WA16385	JF6X01.0122	HEIDELBERG	HUMAN
WA 3		WA17839	JF6X01.0122	HEIDELBERG	HUMAN
WA 4		WA17844	JF6X01.0122	HEIDELBERG	HUMAN
WA 5		WA17873	JF6X01.0122	HEIDELBERG	FOOD
WA 6		WA17909	JF6X01.0122	HEIDELBERG	FOOD
Athens 1	2011K-1133	JF6X01.0058	JF6A26.0076	HEIDELBERG	HUMAN
Athens 1	2011K-1133	JF6X01.0058	JF6A26.0076	HEIDELBERG	HUMAN
Athens 2	2011K-1134	JF6X01.0058	JF6A26.0076	HEIDELBERG	HUMAN
Athens 3	2011K-1135	JF6X01.0058	JF6A26.0076	HEIDELBERG	HUMAN
Athens 4	2011K-1138	JF6X01.0032	JF6A26.0076	HEIDELBERG	GROUND TURKEY
Athens 5	2011K-1224	JF6X01.0058	JF6A26.0017	HEIDELBERG	GROUND TURKEY
Athens 6	2011K-1225	JF6X01.0032	JF6A26.0076	HEIDELBERG	GROUND TURKEY
Athens 7	2011K-1226	JF6X01.0058	JF6A26.0076	HEIDELBERG	GROUND TURKEY
Athens 8	11BC001040	RUN 11	10	HADAR	GROUND TURKEY
Athens 9	2011003056	RUN 14	13	HADAR	GROUND TURKEY
Other 1	OH_0366	X		HADAR	GROUND TURKEY
Other 2	WI_0677	TDKX01.001/TDKA26001		HADAR	GROUND TURKEY
Other 3	CO-2955		X	HADAR	X
Other 4	E2010039978		X	HADAR	GROUND TURKEY
FSIS 1	FSIS FY13-1	JF6X01.0122		HADAR	
FSIS 2	FSIS FY13-2	JF6X01.0122		HEIDELBERG	
FSIS 3	FSIS FY13-3	JF6X01.0122		HEIDELBERG	
FSIS 4	FSIS FY13-4	JF6X01.0122		HEIDELBERG	
FSIS 5	FSIS FY13-5	JF6X01.0122		HEIDELBERG	
FSIS 6	FSIS FY14-2	JF6X01.0122		HEIDELBERG	CHICKEN PARTS
FSIS 7	FSIS FY14-3	JF6X01.0122		HEIDELBERG	CHICKEN CARCASS
FSIS 8	FSIS FY14-6	JF6X01.0122		HEIDELBERG	CHICKEN PARTS

Statistical analyses

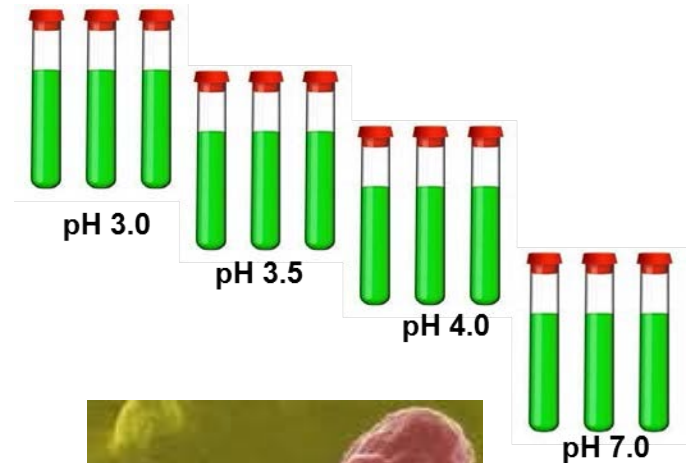
- Means and standard deviations calculated from individual sets of data for each separate trial
- Analysis of variance (ANOVA) was used to determine the effects and interactions of the factors on the log reduction values.
- Pairwise differences in lethality observed for time means at specific levels of acidity, pressure, or heat for each strain; and among levels of acidity, pressure, or heat means at a specific time ($\alpha = 0.05$) .
- The Sidak adjustment was specified to maintain an experiment-wise $\alpha=0.05$, using SAS v9.4 PROC MIXED and the pdmix800 SAS macro to obtain means separation letters.



Analyses conducted by
Dr. Bryan Vinyard
ARS/Beltsville, MD

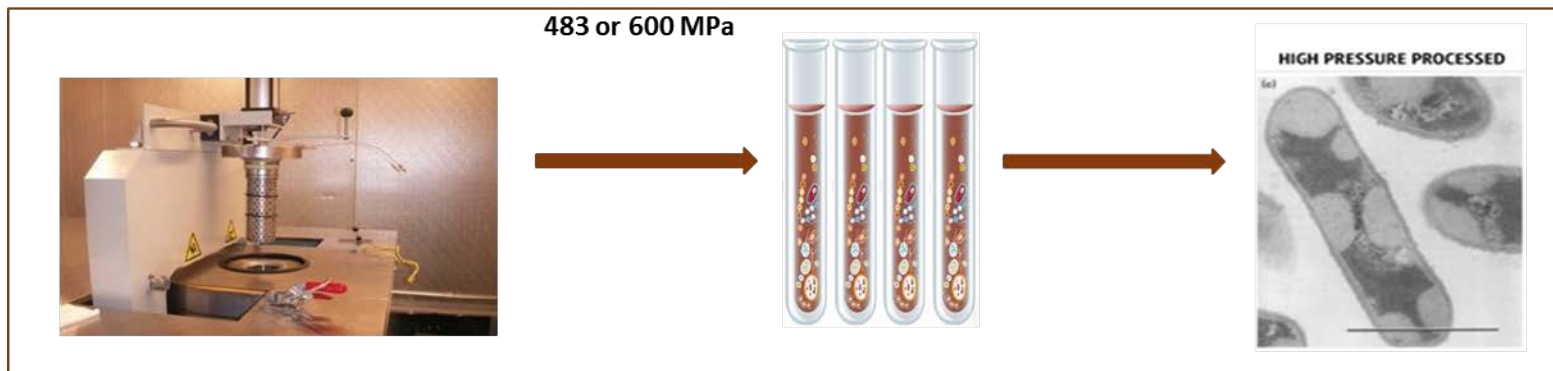
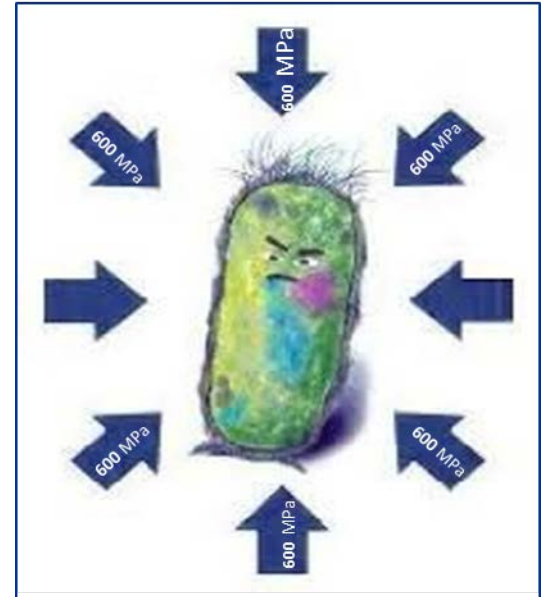
Acid susceptibility of *Salmonella* in BHI broth

- 2 trials, 3 replicates per sampling interval
- Individual strains of *Salmonella*
 - 6 log CFU/ml
- Various pH levels
 - pH 3.0, 3.5, 4.0, and 7.0
- Single incubation temperature
 - 37°C for 120 minutes



High pressure inactivation of *Salmonella* in BHI broth

- 2 trials, 3 replicates per sampling interval
- Individual strains of *Salmonella*
 - 8.5 log CFU/ml
- 2 pressure treatments
 - 600 MPa (87,000 psi)
 - 0, instantaneous & 3 min
 - 483 MPa (70,000 psi)
 - 0, instantaneous, 0.5, 1.0, 1.5, & 2.0 min



Thermal inactivation of *Salmonella* in “Wafers of Poultry”

Inoculation levels	~6.0 CFU/gram
Fat Content	92:8% lean:fat
Product type	3 gram, flattened (ca. 1.0 mm) wafers
Heating Temperatures	130°, 140°, 150°F (Internal Inst.) [5 seconds to 50 minutes]
Heating Source	Circulating water bath
Microorganisms	Individual Strains [2 trials, 3 replicates/sampling point]
Risk Assessments	Yes





Conclusions



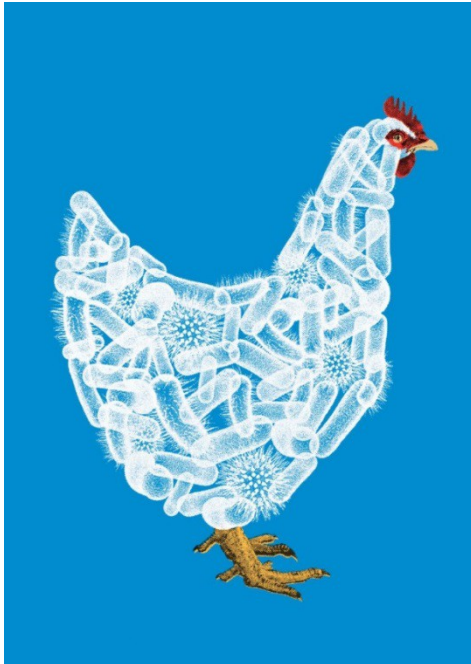
- In general, greater reductions were achieved at:
 - Higher temperature, higher pressure, lower pH, and longer exposure times
- No single strain possessed an unique or high tolerance for conditions of high acid, high pressure, or high temperature,
- Further studies are warranted to test additional strains and a wider range of food-relevant conditions in synthetic media and ground poultry



Next Steps...

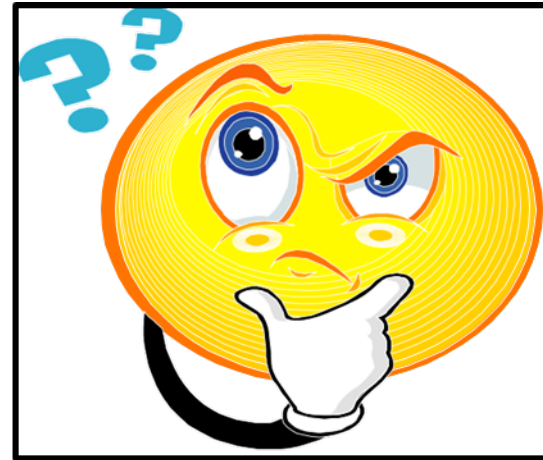
- **Analyze/publish data from Phase I experiments**
 - Drafting separate manuscripts for response of *Salmonella* to heat, acid, and pressure
- **Discuss plans for Phase II and III experiments**
 - D-values in wafers of poultry
 - Validation of time/temperature effects in patties
 - Sensory analyses on selected treatments
 - Other experiments?

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- **Denise Eblen (FSIS)**
- **David Goldman (FSIS)**
- **Vivian Chen (FSIS)**
- **James Lindsay (ARS)**
- **Mary Torrence (ARS)**

Thank you for your attention!



Any Questions?



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