Mechanisms of Heat Resistance in *Escherichia coli*

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CMC/CMSA Annual Conference

May 5th 2011

UNIVERSITY OF ALBERTA

Intervention Methods for Meat Processing

- Common intervention methods
  - Steam and hot water washes
  - 2-5% lactic acid wash

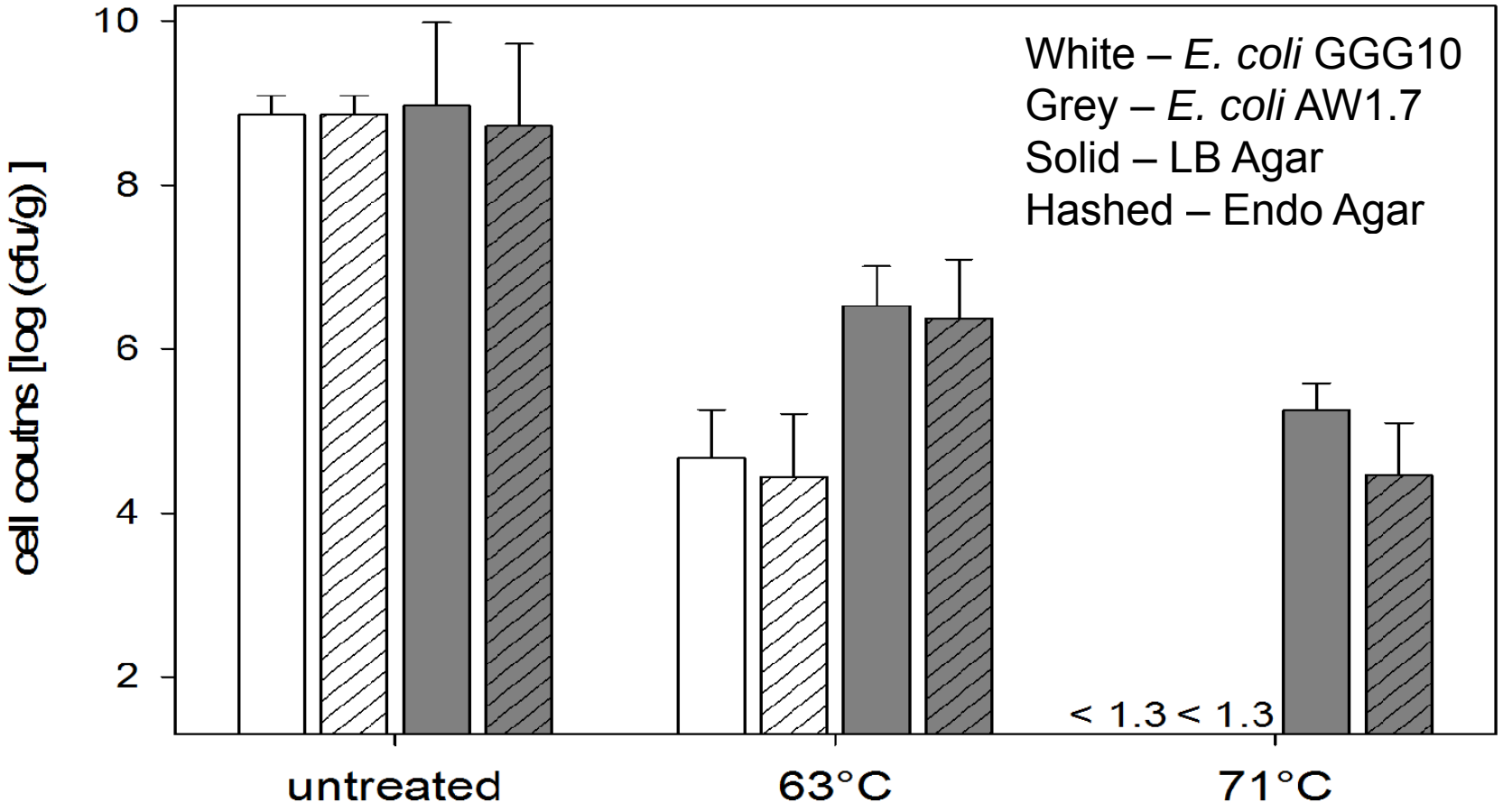
- Such methods reduce *E. coli* and related organisms on animal carcasses during processing, including:
  - *E. coli* O157:H7
  - *Salmonella* spp.

Can *E. coli* Be Heat Resistant?

Strain	D_{60}-value (min)
E. coli K-12	0.11-0.32
E. coli LMM1020	2.3
E. coli ATCC 25922	4.2
E. coli 380-94	6.7
E. coli DM18.3	15
E. coli AW1.7	71

Dlusskaya et al. J. Appl. Microbiol. 110: 840

Survival of *E. coli* AW1.7 during Cooking of Ground Beef

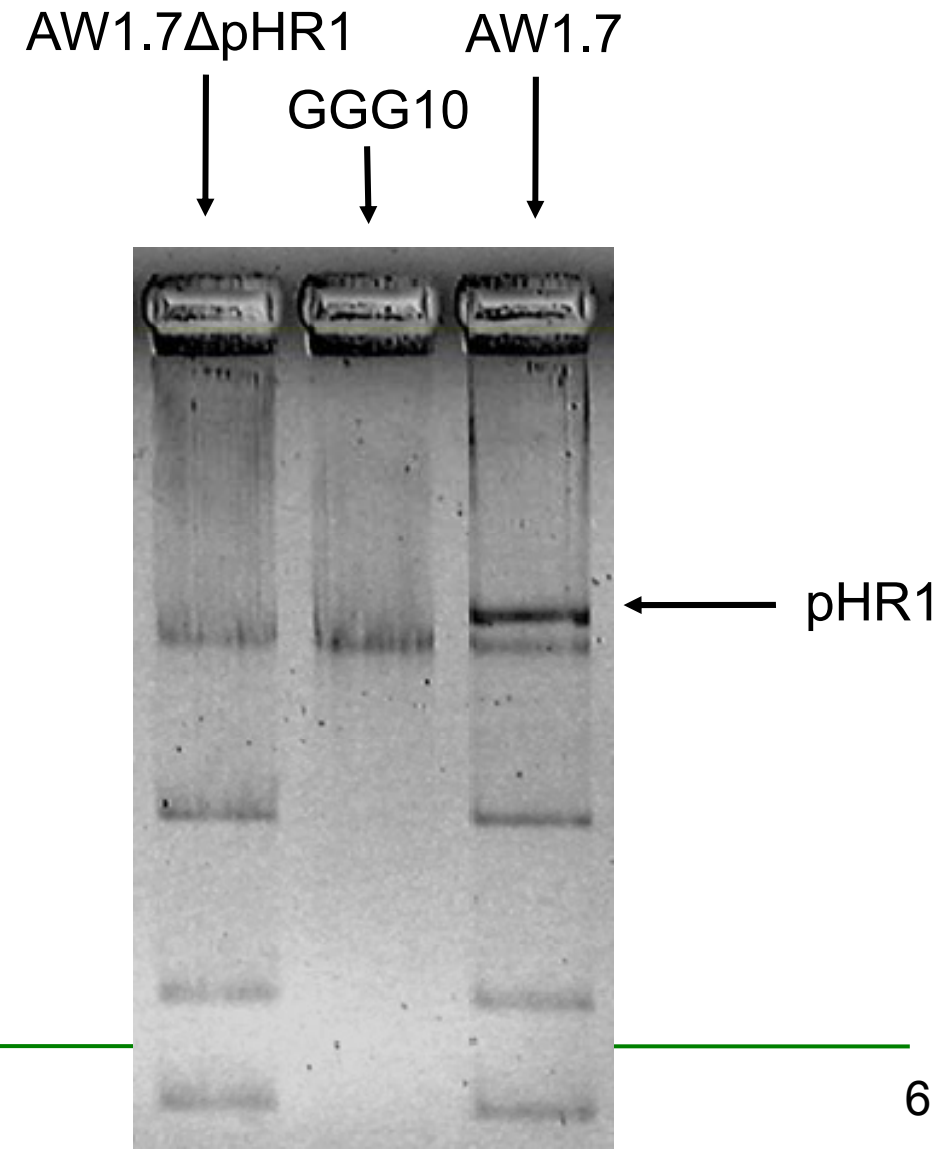


Research Objective

- Determine the mechanisms of heat resistance in *E. coli* AW1.7
  - Molecular characterization
  - Impact of salt (osmotic pressure) on heat resistance
  - Impact of heat on ribosomes

Genetic Elements of *E. coli* AW1.7

- Four plasmids present in *E. coli* AW1.7
- Application of harsh growth conditions results in plasmid curing
- Generation of heat sensitive mutant strain *E. coli* AW1.7ΔpHR1

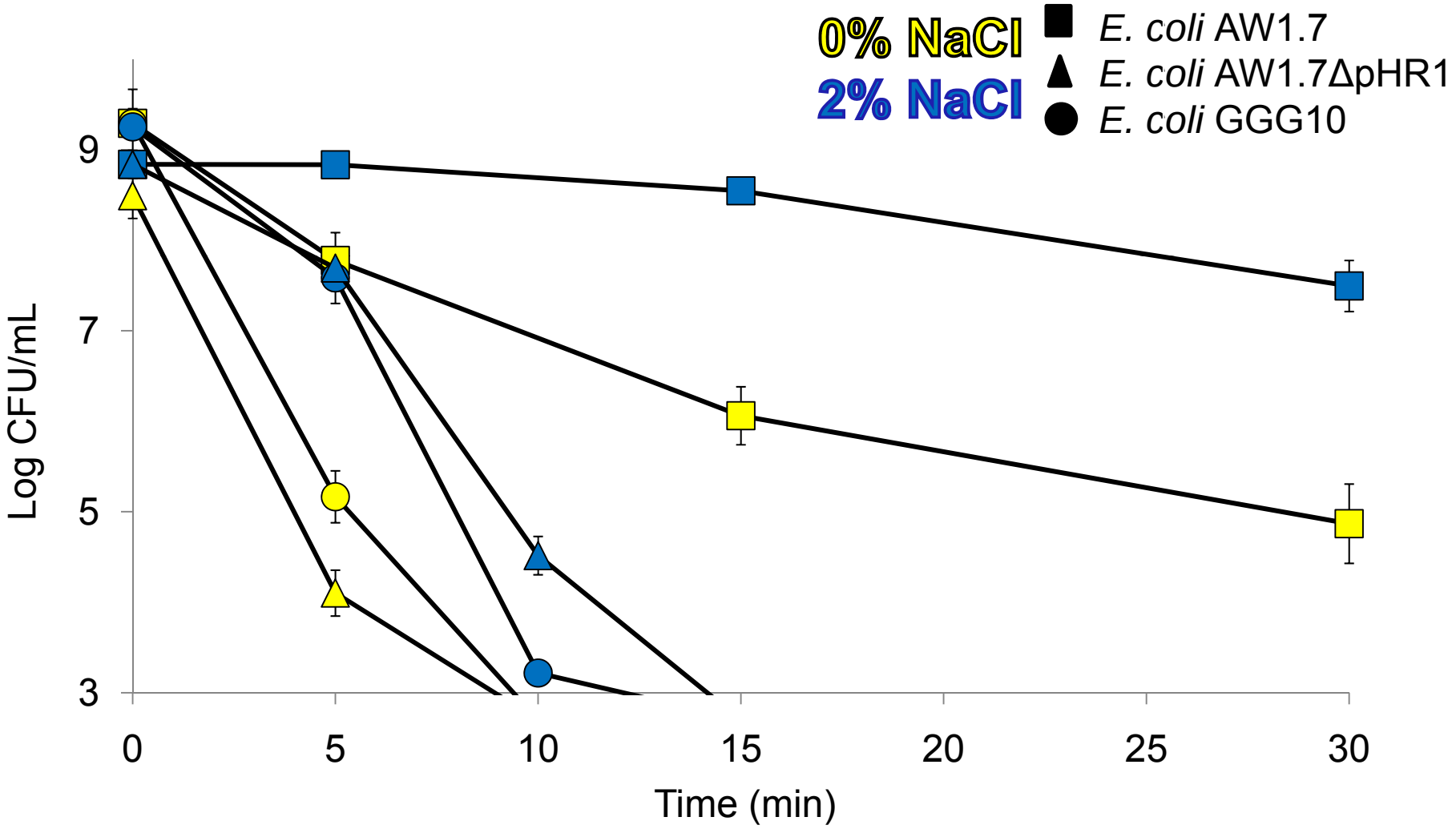


Impact of Salt on Heat Resistance

- Presence of NaCl applies osmotic stress to the microbial cell
- Osmotic stress is overcome by accumulation of compatible solutes
- Cross protection of compatible solutes towards high temperatures has been observed

Kempf et al. Arch. Microbiol. 170: 319-30.
Hengge-Aronis et al. J. Bacteriol.173(24):7918-24.

Cell Counts of *E. coli* Strains following Exposure to 60°C at Varying NaCl Concentrations



Impact of Heat on Ribosomes

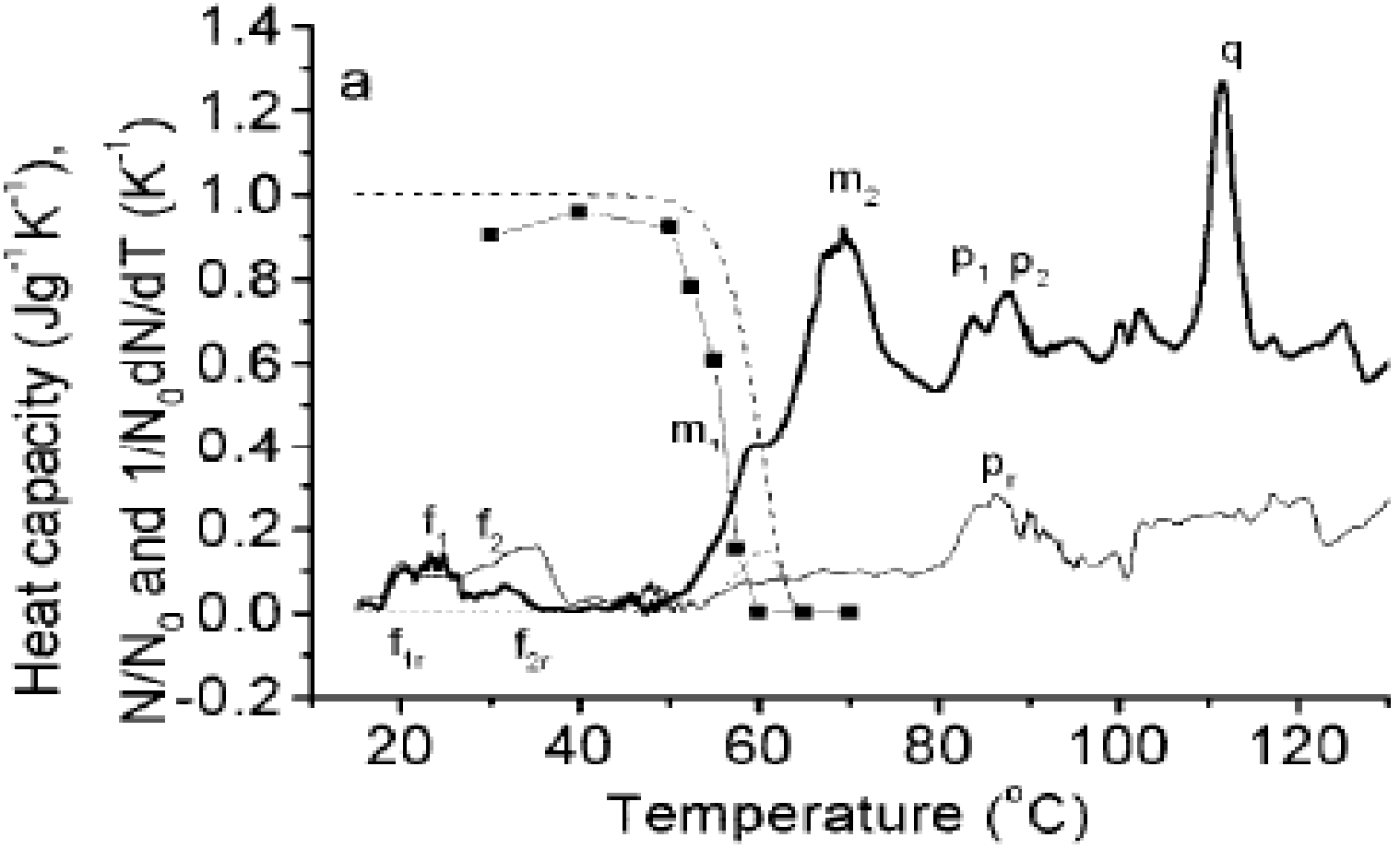
- Ribosomes – cellular component that degrades with heat
- Degradation of ribosome subunits can be measured with Differential Scanning Calorimetry

Tal. Biochemistry. 8(1): 424-35
Tolker-Nielsen & Molin. FEMS Micro. Letters. 142: 155-60

Monitoring Bacteria during Heating

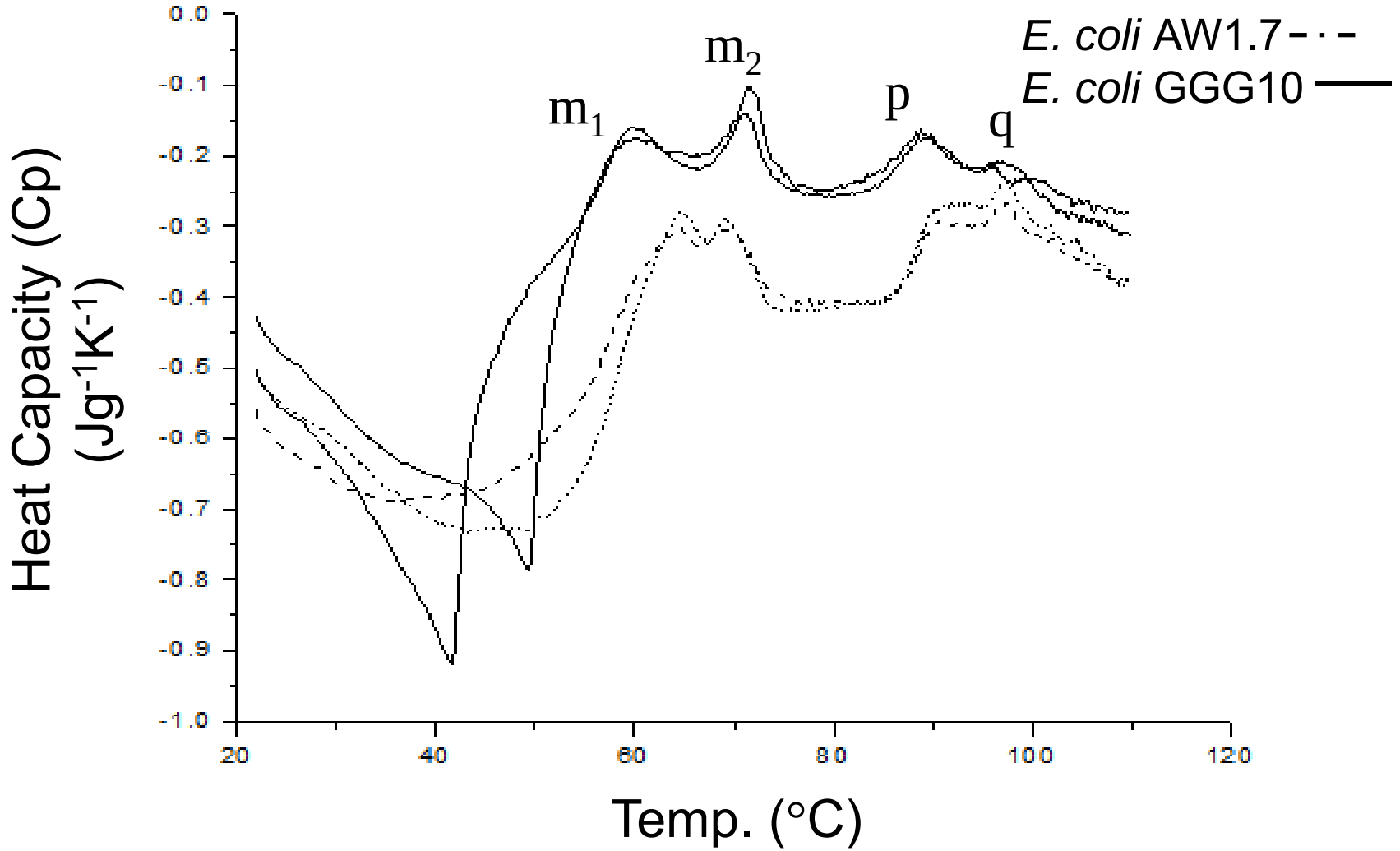
- Differential Scanning Calorimetry (DSC)
  - Calorimetric tool utilized to capture relative heat capacity of a sample
  - Measurement of latent heat generated through bacterial inactivation during heating

Interpretation of an Example DSC Thermogram

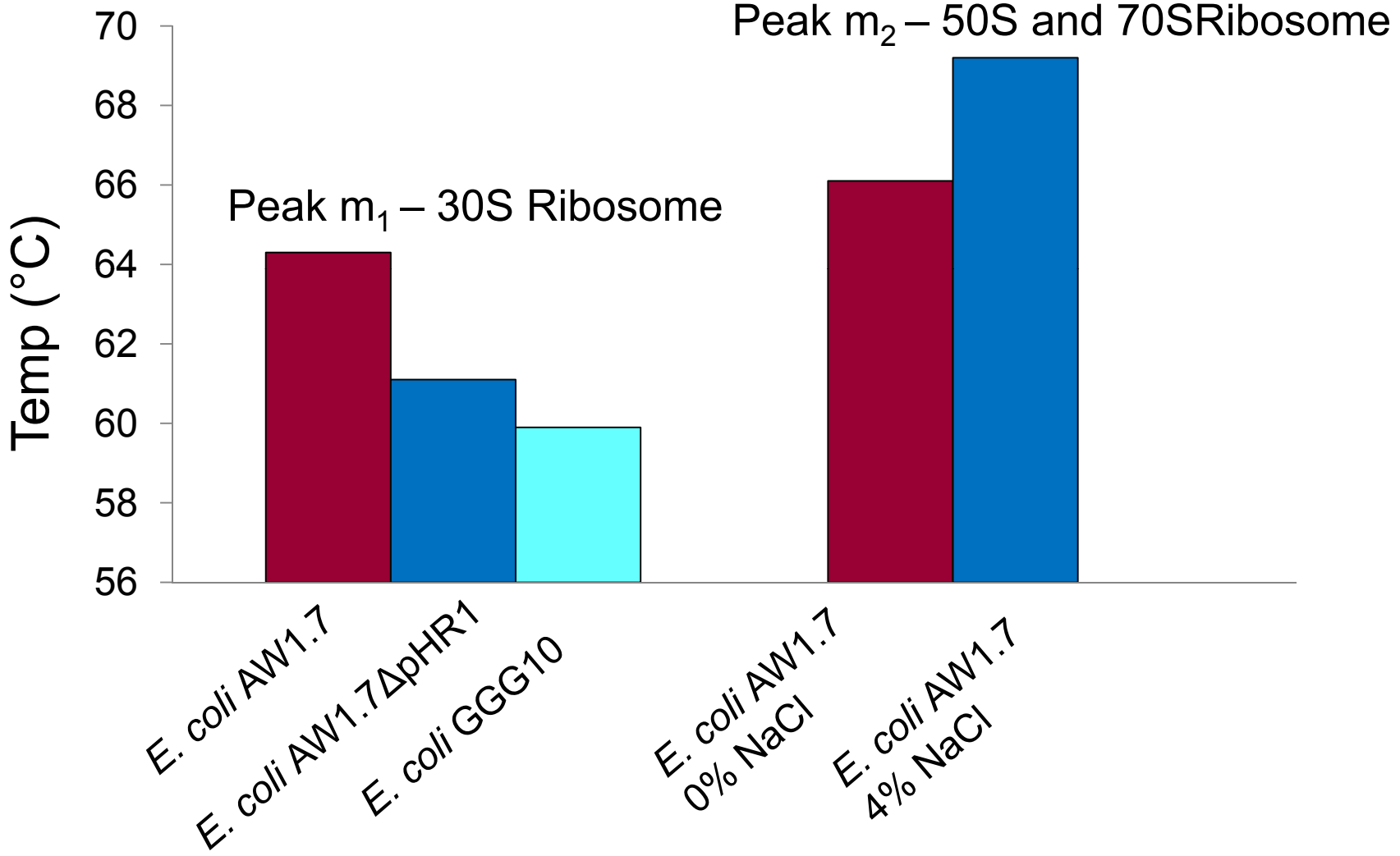


Nguyen et al . Appl. Environ. Microbiol. 72(1): 908-13

DSC Thermograms



Temperature of Ribosome Denaturation for Varying Strains and Varying Salt



Conclusions

- Osmotic stress (2% NaCl) enhances heat resistance in all three *E. coli* strains
- Heat resistance in *E. coli* AW1.7 is in part attributable to the plasmid pHR1
- Heat resistance in *E. coli* AW1.7 is reflected by increased thermal stability of ribosomes

Recognition

- Alberta Livestock and Meat Agency (ALMA)
- CMC/CMSA Education Committee
- Elena Dlusskaya