

# Sensitivity of Foodborne Isolates of *Salmonella* serovars, *Cronobacter sakazakii*, and *Listeria monocytogenes* to Mild Hydrostatic Pressure and Heat in Phosphate Buffered Saline Medium



Akilyah Sumlin, Edward Daniels, Karimah Preston, Abimbola Allison, Shahid Chowdhury, and Aliyar Fouladkhah  
Public Health Microbiology Laboratory, Tennessee State University, Nashville, TN



## ABSTRACT

**Introduction.** Application of high pressure processing in food manufacturing had been gaining increasing momentum in recent years due to advances in engineering of commercially available units. The technology is emerging response of the private industry for manufacturing of minimally processed products with clean label, extended shelf-life, and fresh-like qualities. In the United States the market size of pressure-treated products are estimated to surpass \$9B annually.

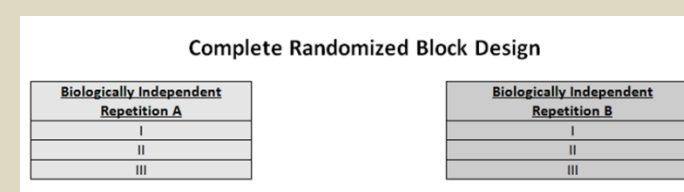
**Method.** Hydrostatic pressure of 103 to 380 MPa (15k PSI to 55K PSI) were applied at various time intervals (0 to 10 minutes) for inactivation of five strains of *Salmonella* serovars (at 35 and 55°C), four strains of *Listeria monocytogenes* (at 25°C), and four strains of *Cronobacter sakazakii* (at 25 and 55°C), inoculated at target population of 7.0 log CFU/mL in phosphate buffered saline medium. The pressure processing unit was equipped with water jacket and circulating water bath surrounding the reaction chamber for precise application of hydrostatic pressure at controlled temperature. Experiments were conducted in Barocyler Reaction PULSE Tubes, with internal pressure, temperature, and compression rate monitored every 3 seconds using Barocyler HUB PBI Software. Results were analyzed using LSD-based ANOVA by OpenEpi software.

**Results.** *Salmonella* serovars were reduced ( $P < 0.05$ ) below detection limit after 3, 6, and 9 minutes of treatment at 35 °C and after 1, 3, 6, and 9 minutes of treatment at 55 °C. At ambient temperature, *Listeria monocytogenes* was not reduced ( $P \geq 0.05$ ) after a 1-minute treatment at 380 MPa, and were reduced ( $P < 0.05$ ) by >4 log CFU/mL after a 10 minute treatment at 380 MPa. *Cronobacter sakazakii* was reduced ( $P < 0.05$ ) by 3.1 and 5.6 log CFU/mL after a 9-minute treatment at 380 MPa, at 25 and 55 °C, respectively.

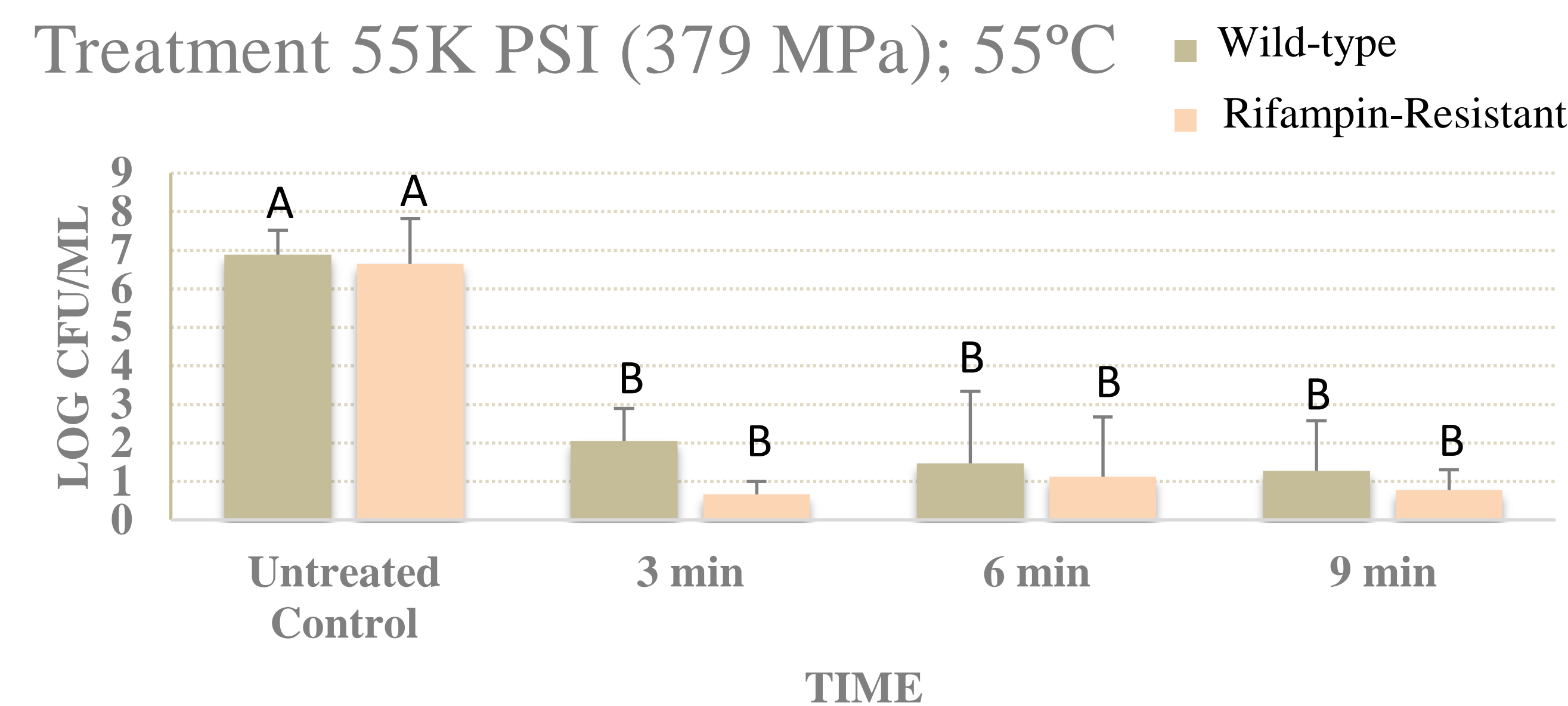
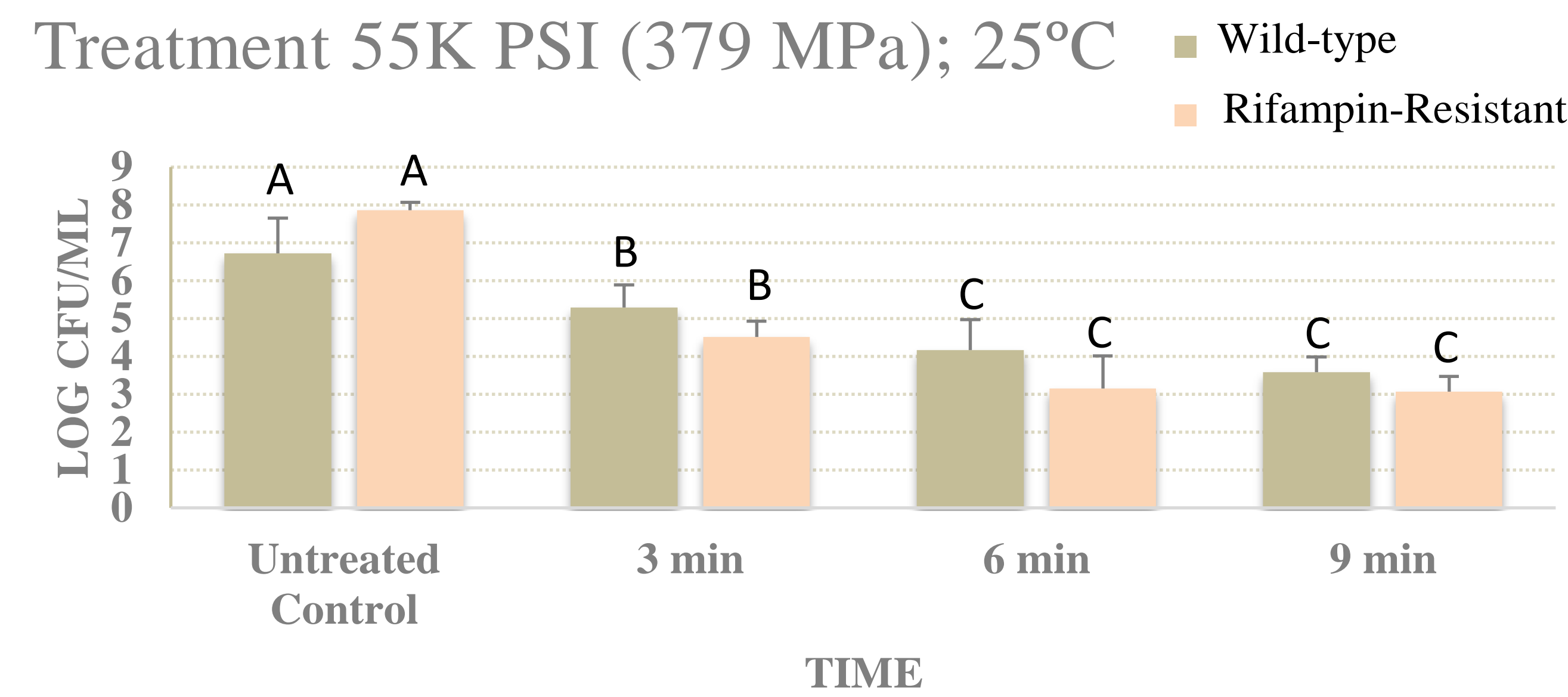
**Significance.** Application of hydrostatic pressure up to 380 MPa, reduced *Salmonella* serovars, *Listeria monocytogenes*, and *Cronobacter sakazakii* by more than 4 log CFU/mL in phosphate buffered saline medium when applied for more than 3 minutes. Addition of mild thermal treatments augmented ( $P < 0.05$ ) these reductions for up to 7 log CFU/mL. Extensive validation studies could assure safe and efficacious adoption of high pressure pasteurization in food manufacturing.

## Design, Methods, and Analyses

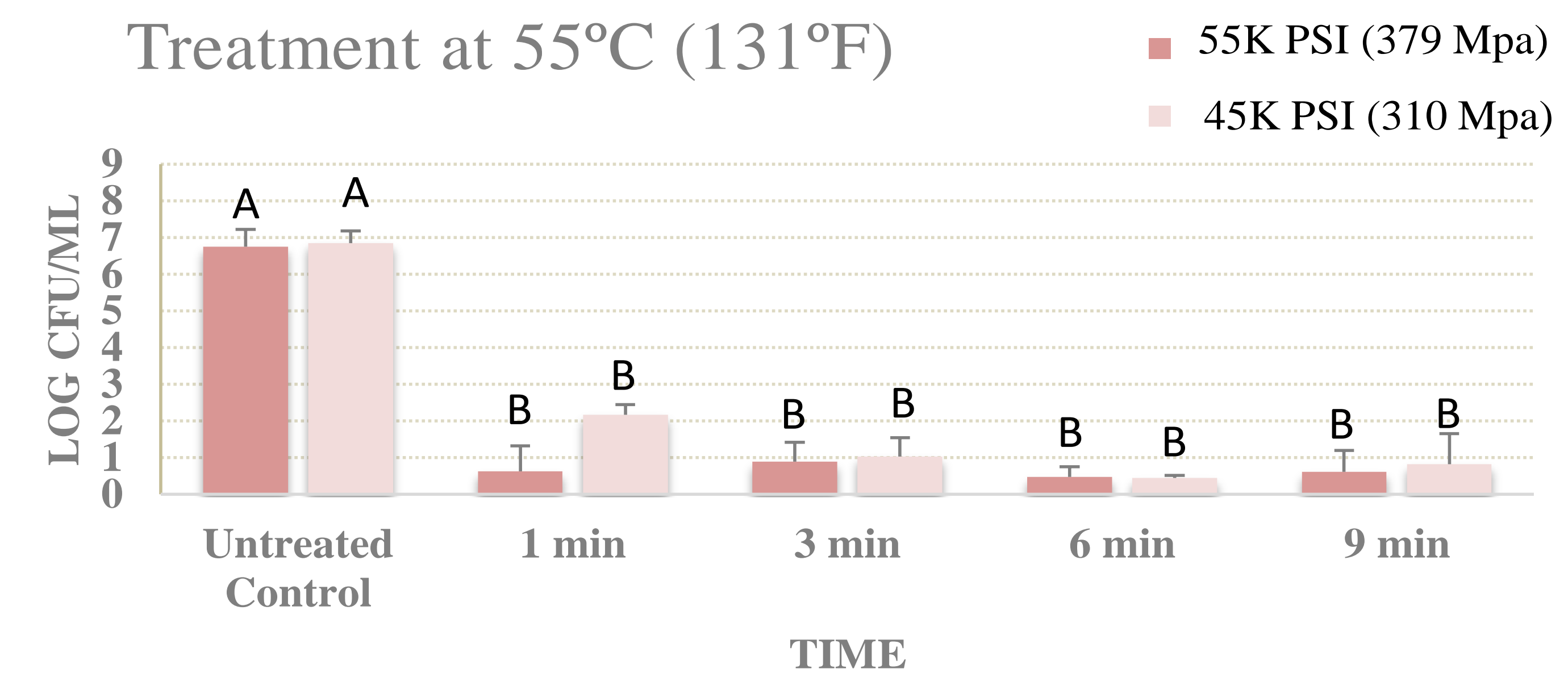
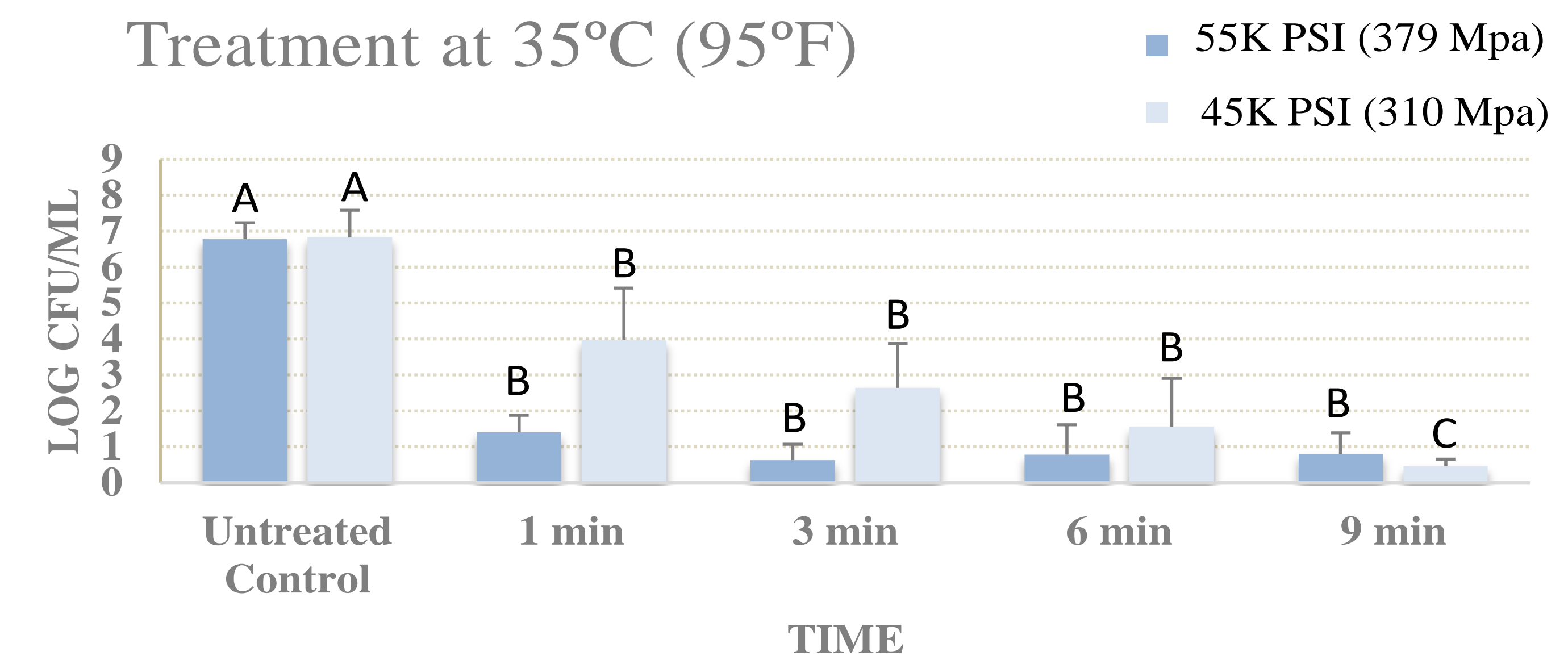
- ❑ Two biologically independent repetitions (i.e., two blocking factor).
- ❑ Each block, containing three instrumental replications.
- ❑ Each instrumental replication had two microbiological repetitions.
- ❑ Inoculation, microbiological analyses, and enumeration of the bacteria were based on Bacteriological Analytical Methods (BAM) of the U.S. Food and Drug Administration (FDA).
- ❑ Hydrostatic pressure (Barocyler Hub440, Pressure BioScience Inc., South Easton, MA) of 55,000 PSI (379 MPa) were applied at various time interval for decontamination of the inoculated pathogen.
- ❑ Analysis of Variance (ANOVA) followed by Tukey- and Dunnett-adjusted mean separations were conducted at type I error level of 5% using Open Epi Software. Values were log-transformed prior to the analysis.



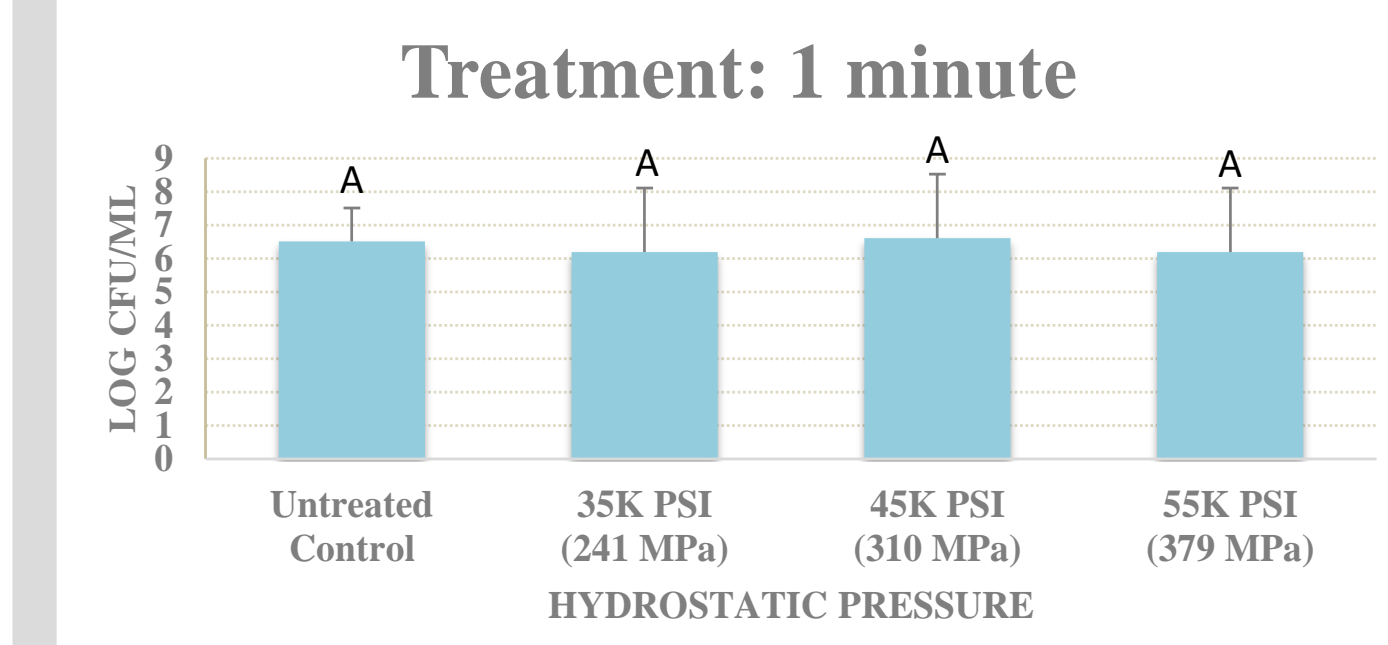
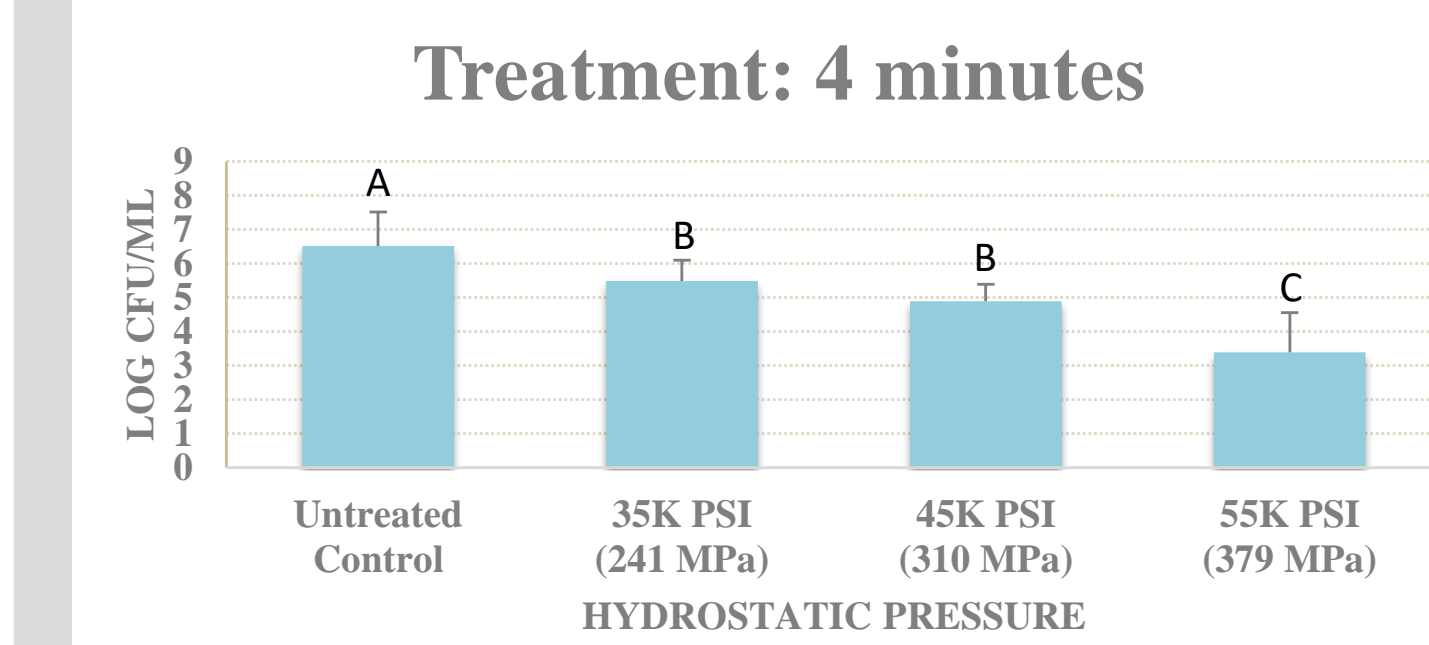
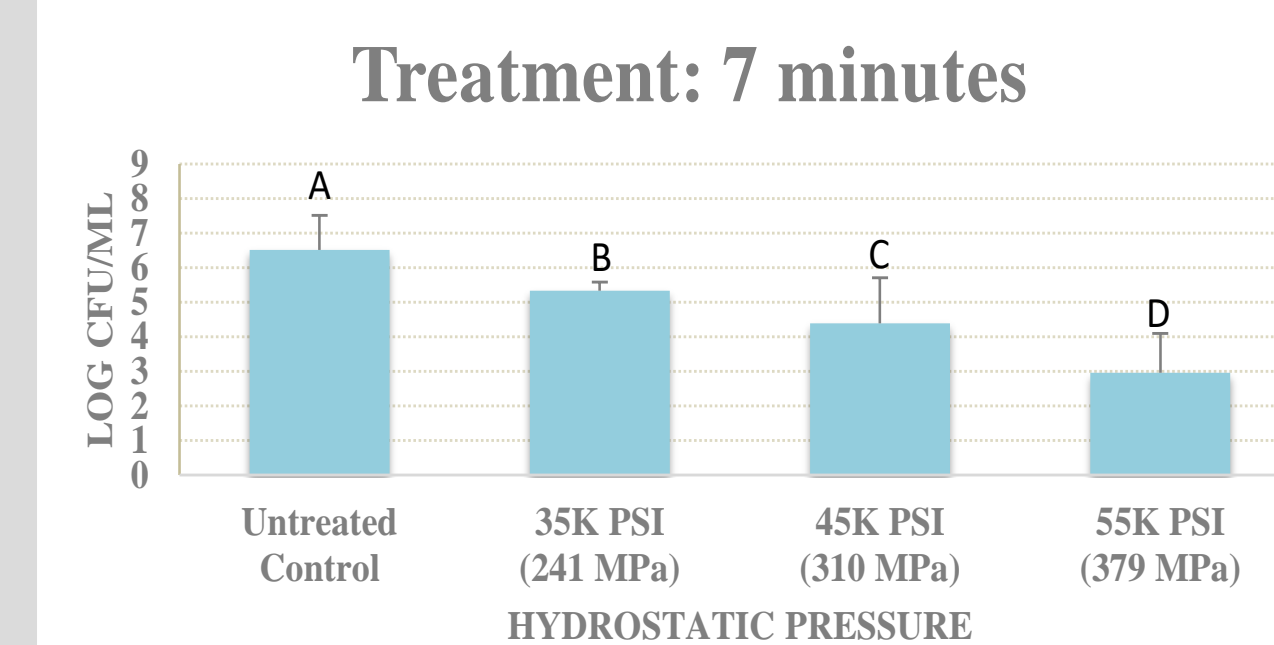
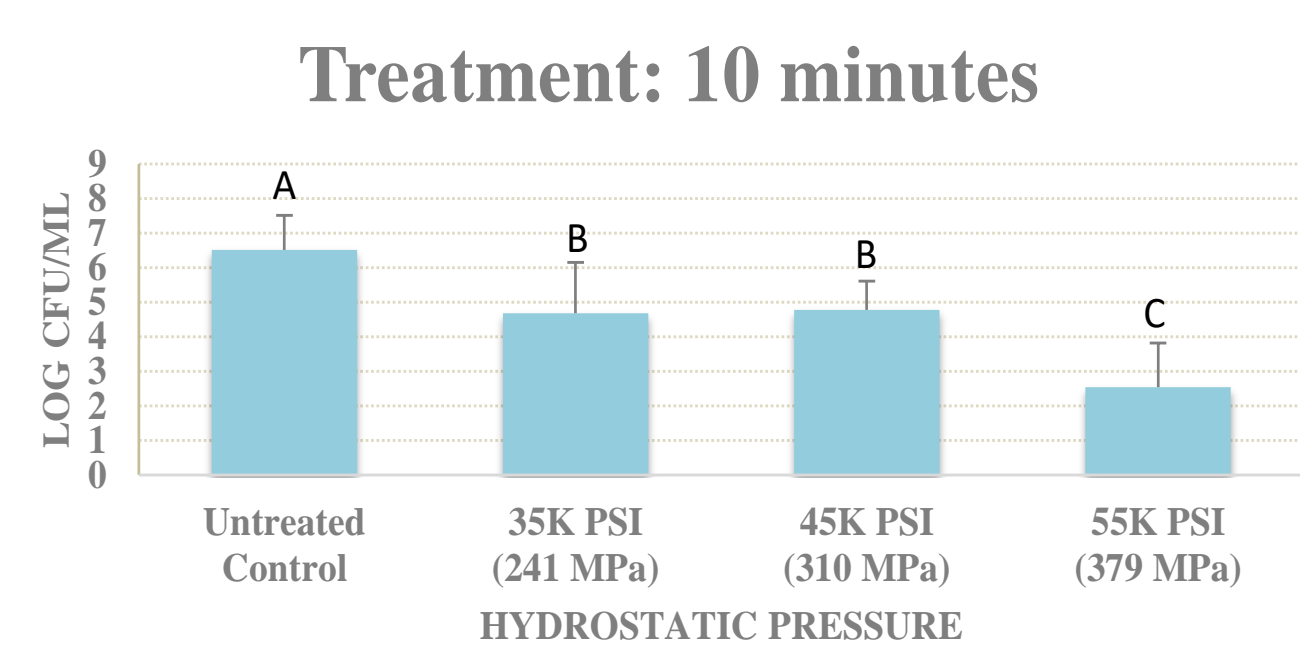
## *Cronobacter sakazakii* Inactivation



## *Salmonella* serovars Inactivation



## *Listeria monocytogenes* Inactivation



## Study Highlights and Summary

- ❑ *Salmonella* serovars were reduced ( $P < 0.05$ ) below detection limit after 3, 6, and 9 minutes of treatment at 35 °C and after 1, 3, 6, and 9 minutes of treatment at 55 °C.
- ❑ At ambient temperature, *Listeria monocytogenes* was not reduced ( $P \geq 0.05$ ) after a 1-minute treatment at 380 MPa, and were reduced ( $P < 0.05$ ) by >4 log CFU/mL after a 10 minute treatment at 380 MPa.
- ❑ *Cronobacter sakazakii* was reduced ( $P < 0.05$ ) by 3.1 and 5.6 log CFU/mL after a 9-minute treatment at 380 MPa, at 25 and 55 °C, respectively.
- ❑ Application of hydrostatic pressure up to 380 MPa, reduced *Salmonella* serovars, *Listeria monocytogenes*, and *Cronobacter sakazakii* by more than 4 log CFU/mL in phosphate buffered saline medium when applied for more than 3 minutes.
- ❑ Addition of mild thermal treatments augmented ( $P < 0.05$ ) these reductions for up to 7 log CFU/mL. Extensive validation studies could assure safe and efficacious adoption of high pressure pasteurization in food manufacturing.



High Pressure Processing Unit (Barocyler Hub440, Pressure BioScience Inc., South Easton, MA) equipped with water jacket and circulating water bath for precise application of hydrostatic pressure at controlled temperature. Public Health Microbiology Laboratory, TSU.

## Acknowledgements

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