

Safety of shell eggs as affected by rate of heating during pasteurization to inactivate *Salmonella* Enteritidis

Yumin Xu, Ahmed Abdelhamid and Ahmed E. Yousef

INTRODUCTION

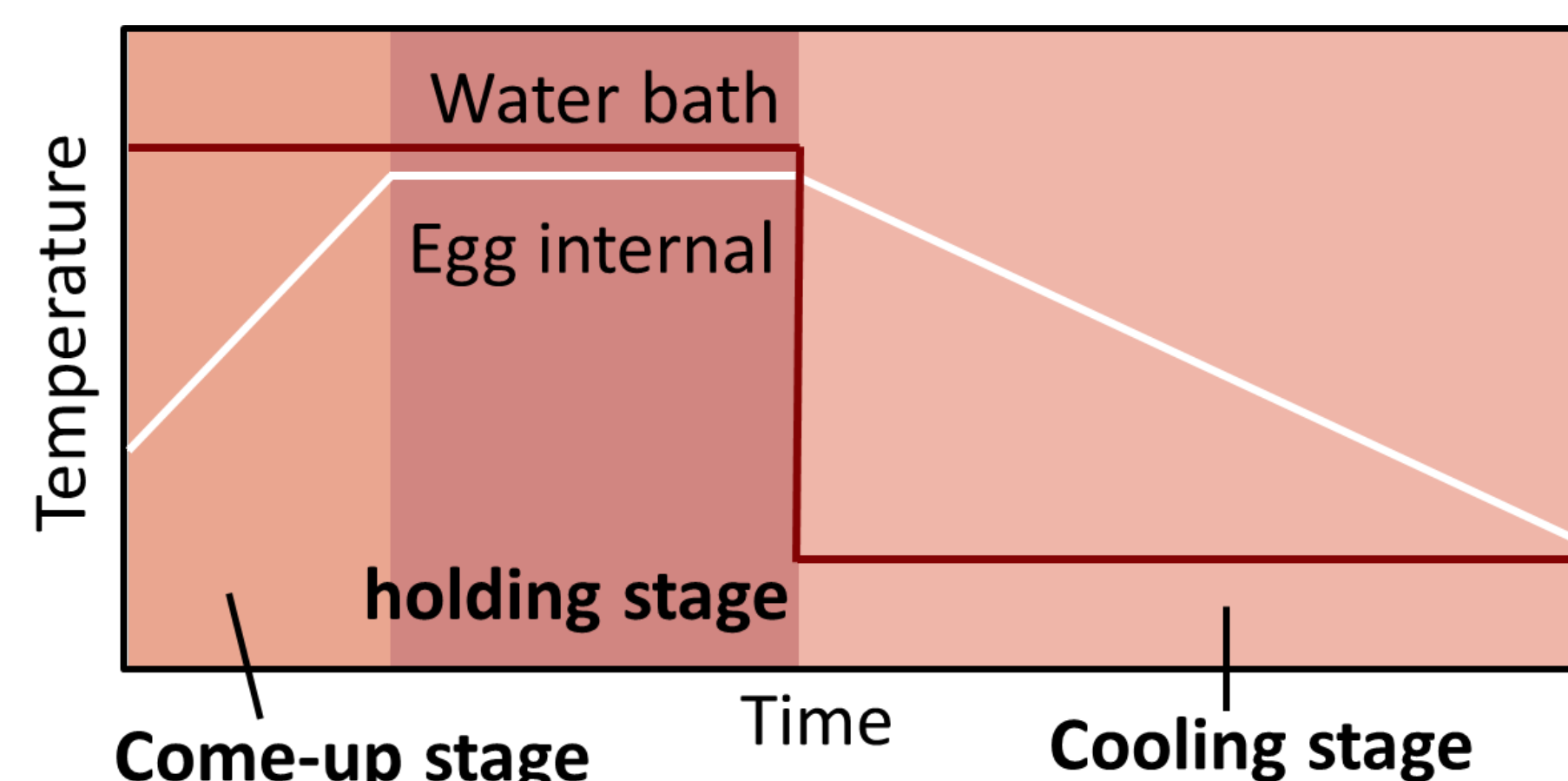


Figure 1. Demonstration on temperature profile of egg pasteurization.

- Salmonella enterica* serovar Enteritidis (*Salmonella* Enteritidis) in shell-eggs have caused numerous outbreaks in US (1–4).
- Egg pasteurization: 5-log reduction of *Salmonella* in the yolk of shell eggs.
- Due to quality concern, slow heating rate during temperature come-up stage is practiced in commercial pasteurization.

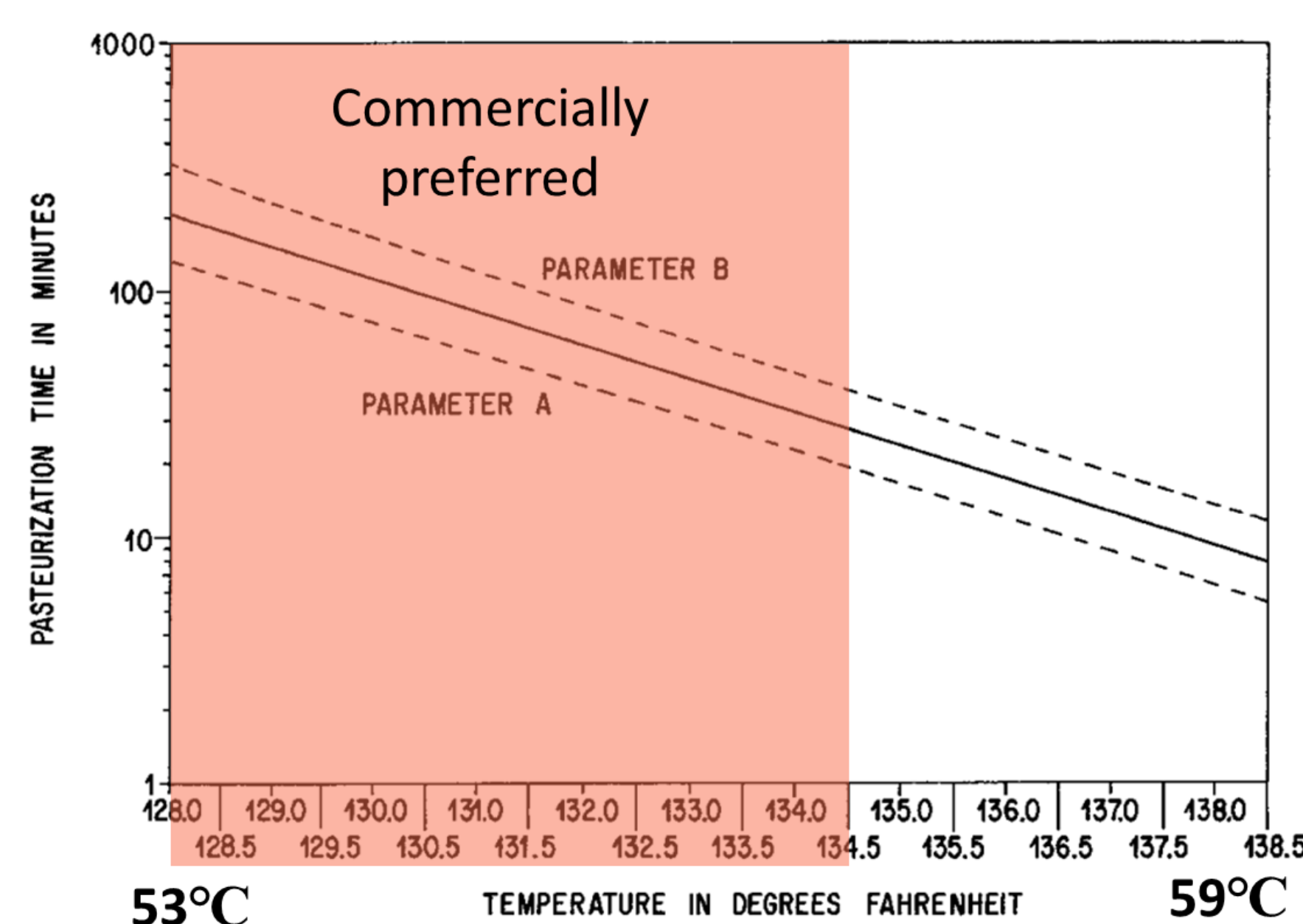


Figure 2. Various time and temperature combinations to achieve egg pasteurization (5).

AIM

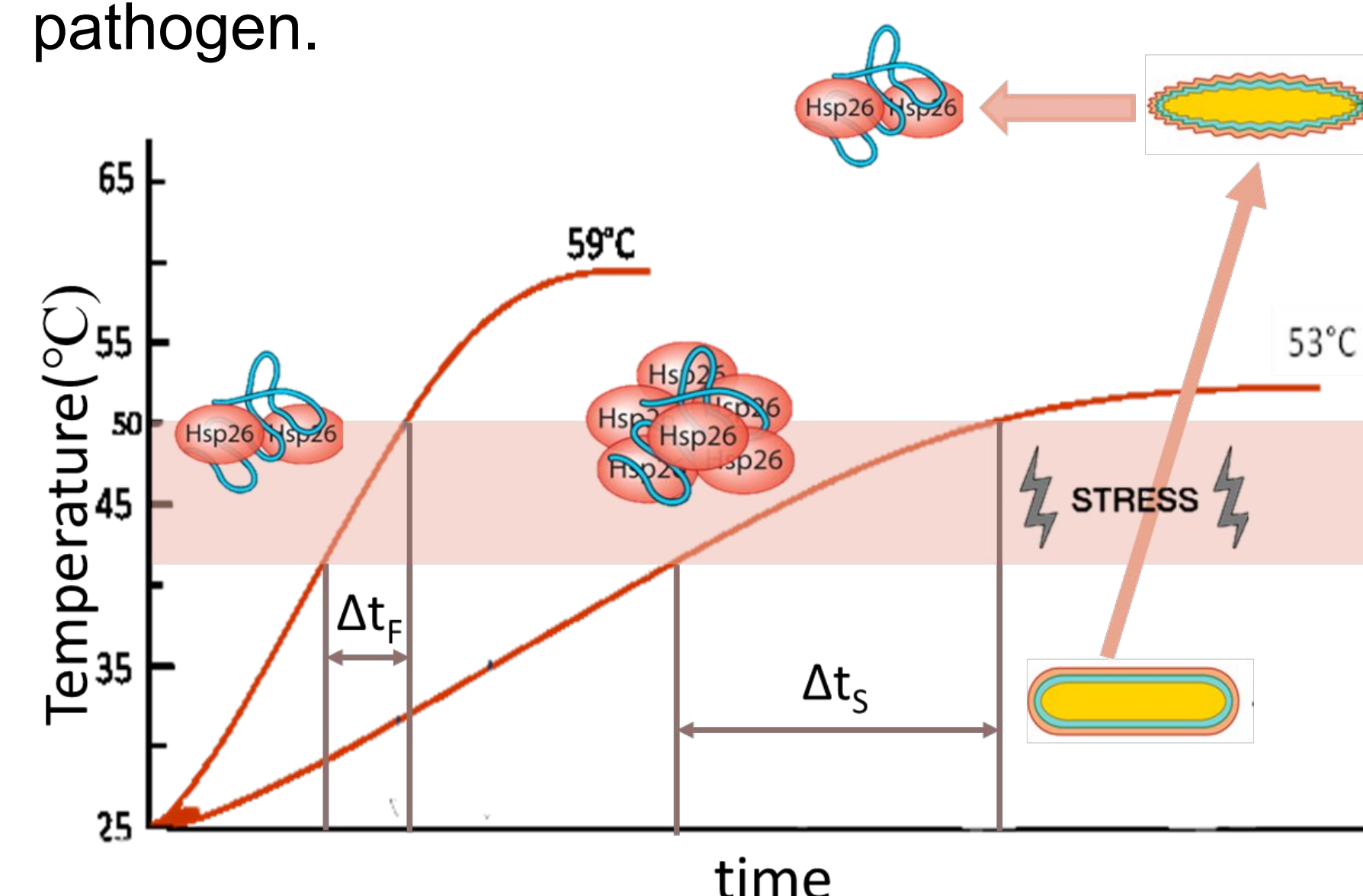
To understand how different heating rates during come-up stage could affect:

- The expression of *Salmonella* heat-resistance genes

- The heat resistance of *Salmonella* during the holding stage and cooling stage
- the expression of *Salmonella* virulence genes.

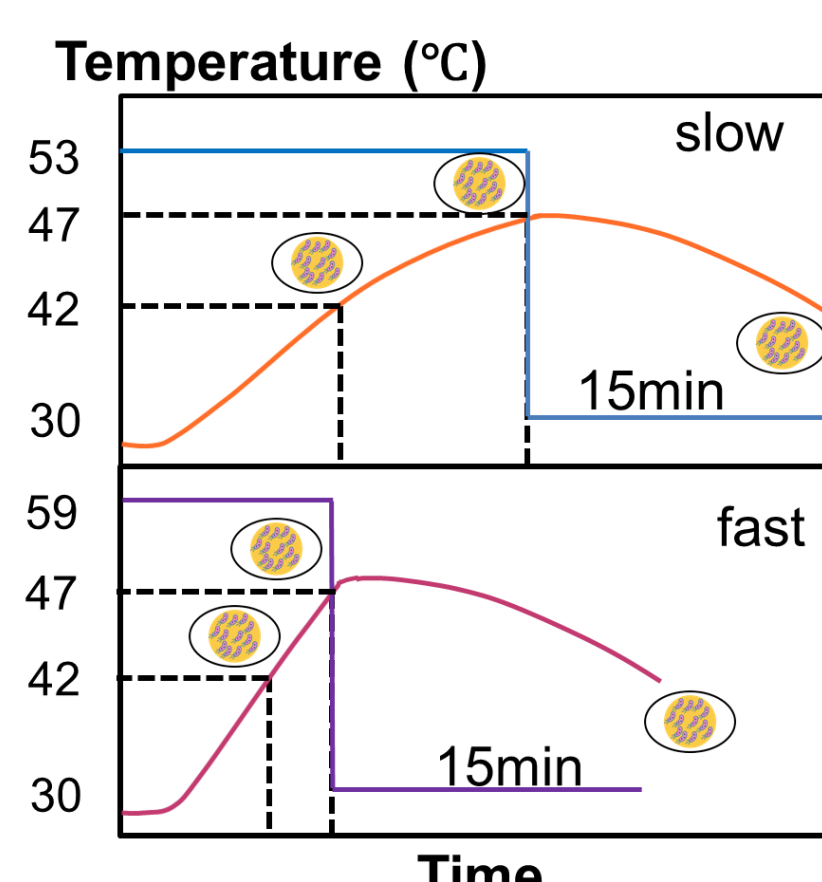
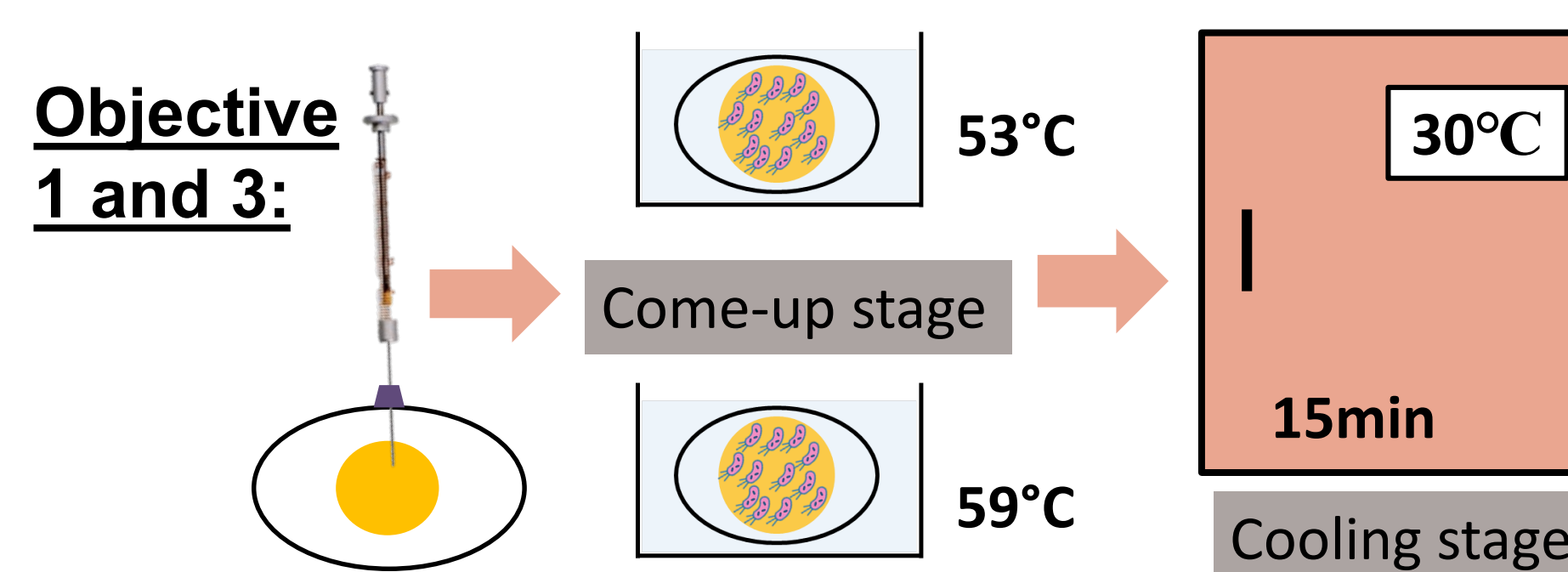
HYPOTHESIS

Slow heating rate during temperature come-up stage constitutes a thermal stress that triggers hazardous responses in the *Salmonella*. Such response could increase *Salmonella* resistance to further processing and could be associated with increased virulence of the pathogen.



METHODS

Objective 1 and 3:

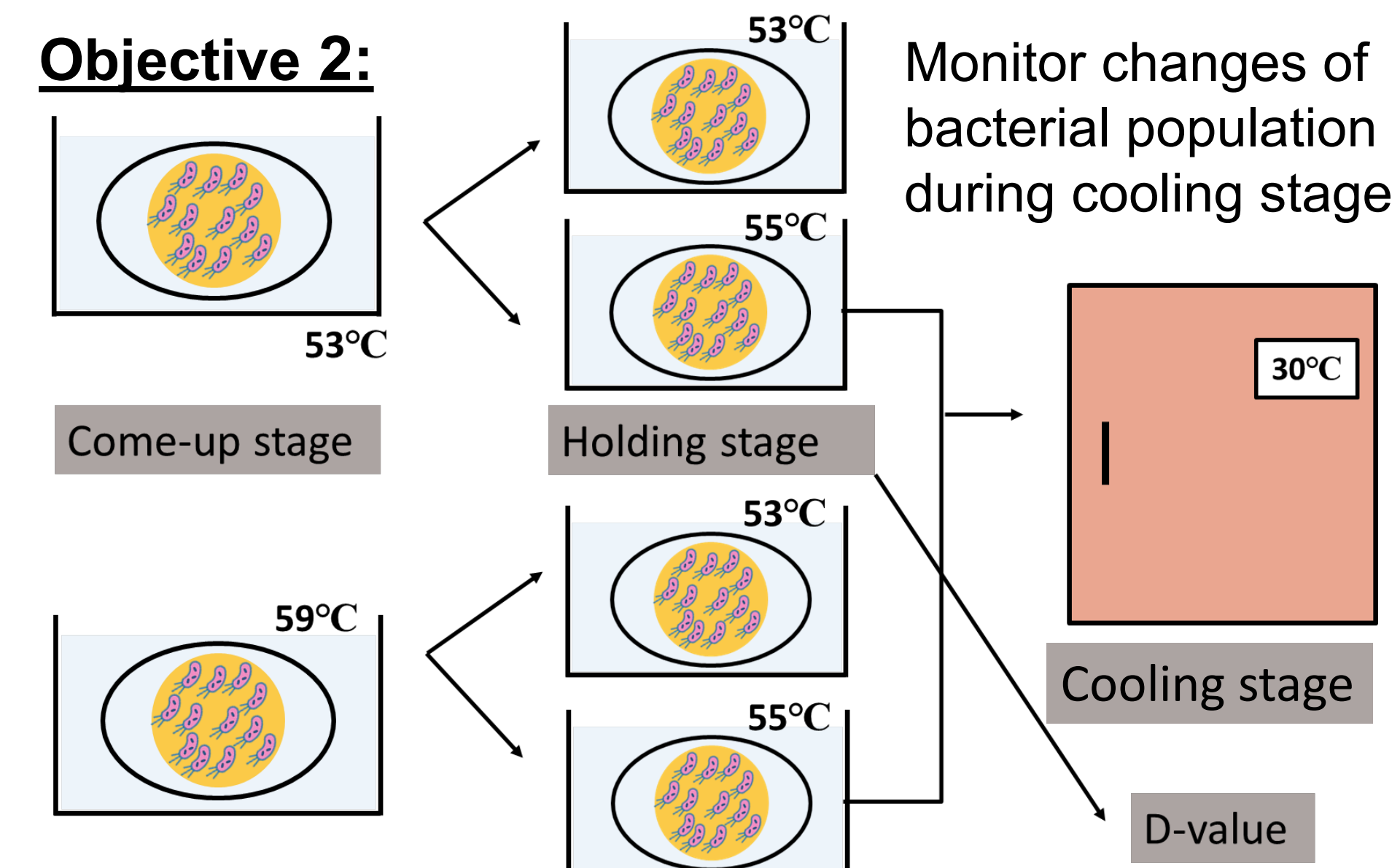


Remove eggs from incubators for transcriptomic analysis using RT-qPCR

Table 1. Genes of interest for transcriptomic analysis

Gene	Function	References
Virulence		
<i>hilC</i>	A Transcriptional regulator for SPI-1 genes	Fabrega & Vila, 2013
<i>slpA</i>	Stabilization and localization of actin filaments during invasion	
<i>pipB</i>	development of systemic infection	
Stress		
<i>htrA</i>	chaperone that degrades misfolded proteins	Dawoud et al., 2017
<i>clpP</i>	Protease that degrades regulatory proteins	
<i>grpE</i>	Thermosensor	

Objective 2:



RESULT

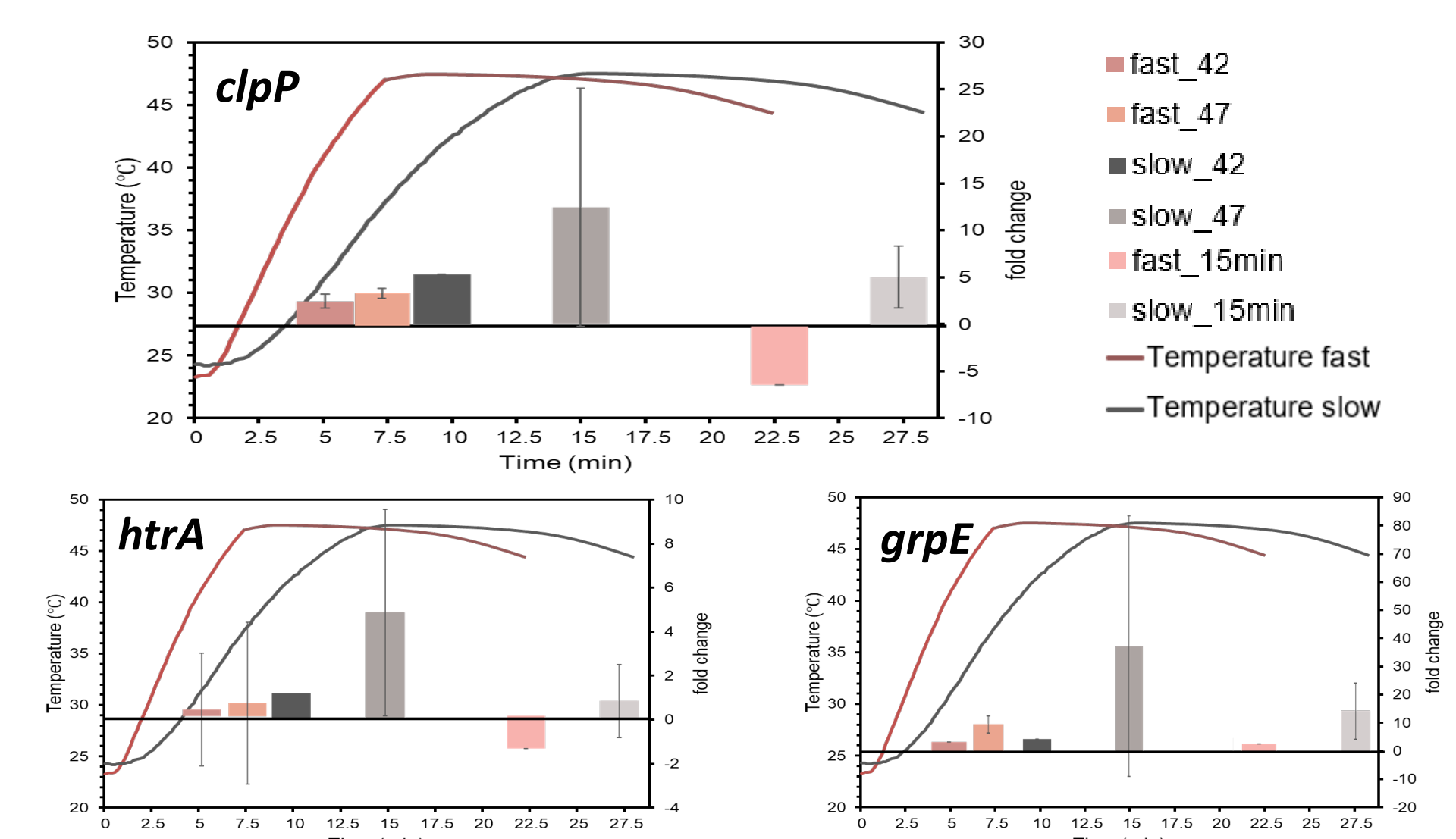


Figure 3. Expression of stress response genes when egg internal temperature reached 42°C and 47°C, and after eggs were cooled at 30°C for 15min.

- Slow heating rate during come-up stage caused more profound heat stress response

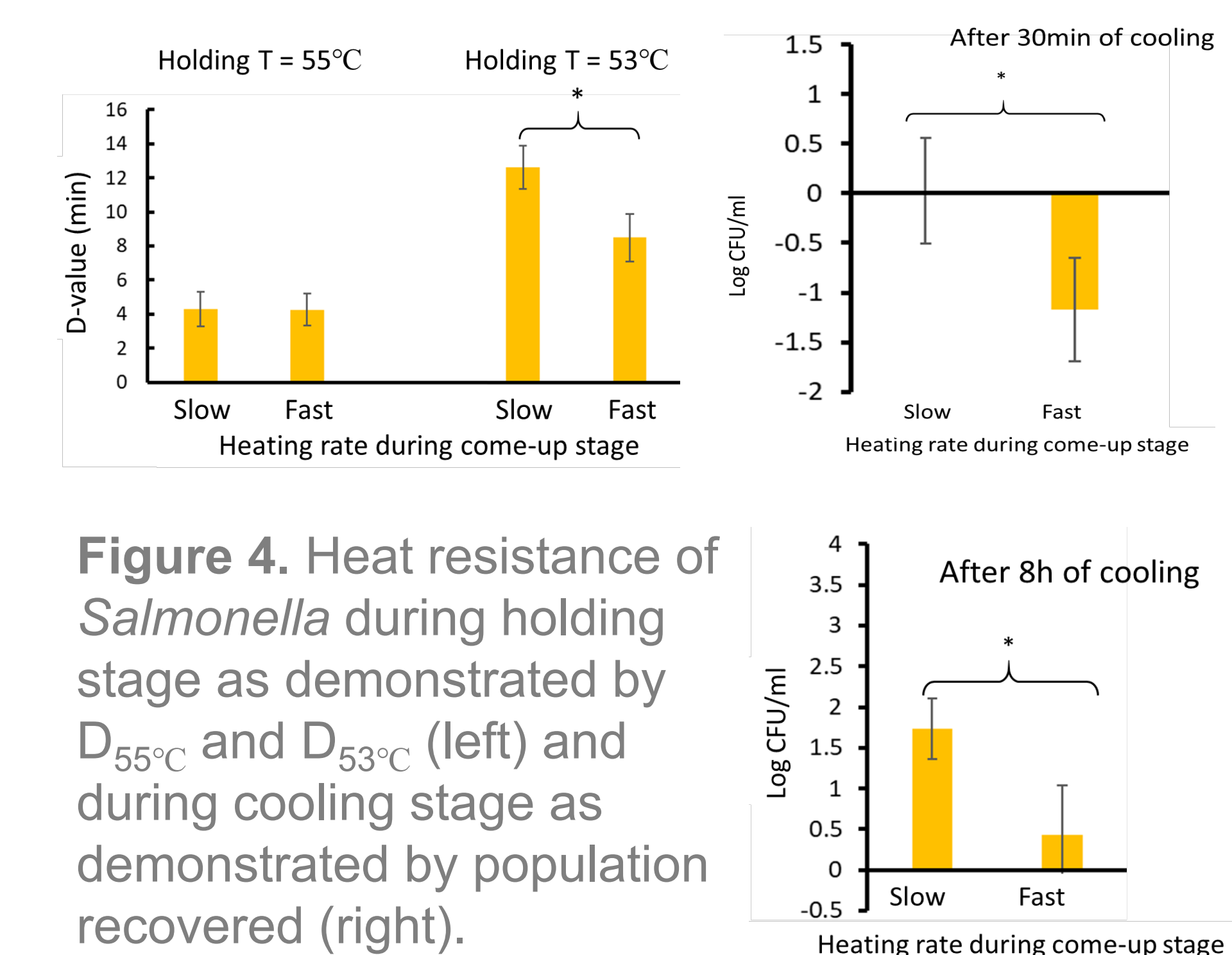


Figure 4. Heat resistance of *Salmonella* during holding stage as demonstrated by $D_{55^{\circ}\text{C}}$ and $D_{53^{\circ}\text{C}}$ (left) and during cooling stage as demonstrated by population recovered (right).

- Slow heating rate during come-up stage increased heat resistance of *Salmonella* at holding stage and at cooling stage.

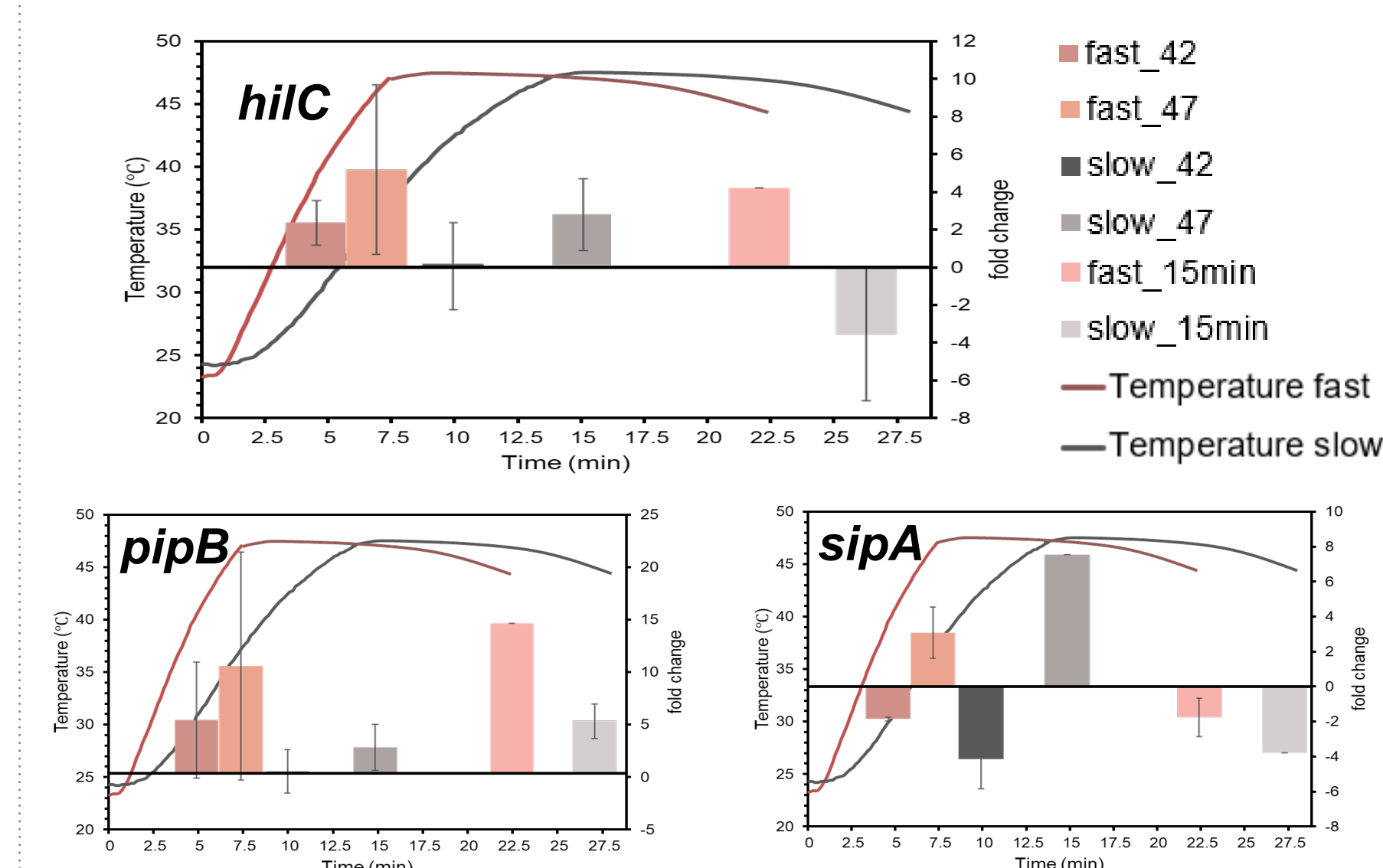


Figure 5. Expression of virulence when egg internal temperature reached 42°C and 47°C, and after eggs were cooled at 30°C for 15min.

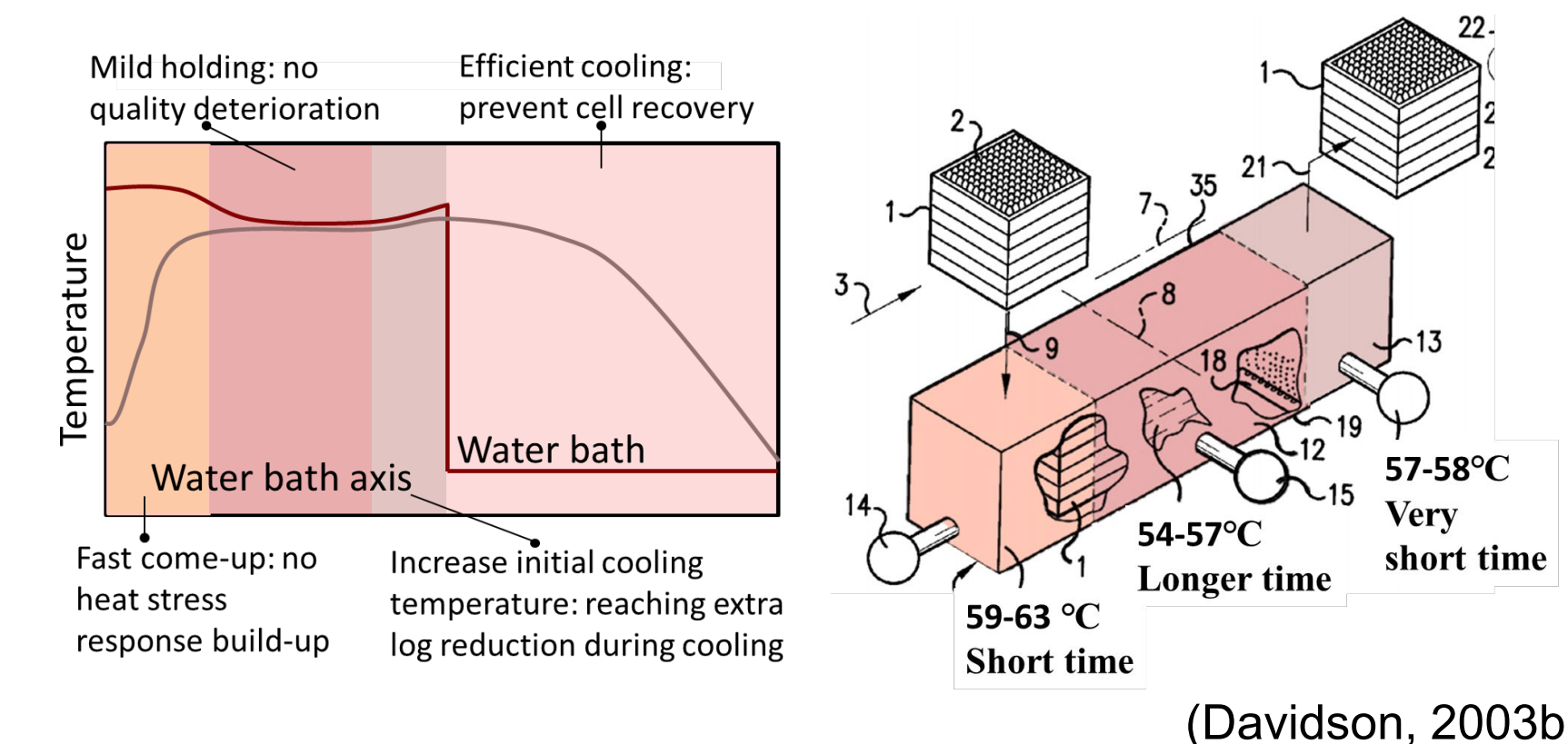
- Effect of heating rate on virulence varied.

CONCLUSION1

Fast heating rate at come-up stage could result in safer pasteurized shell eggs.

SIGNIFICANCE

- New egg pasteurization design is required.



BIBLIOGRAPHY

- CDC. 2010. <https://www.cdc.gov/salmonella/2010/shell-eggs-12-2-10.html>
- CDC. 2016. <https://www.cdc.gov/salmonella/oranienburg-10-16/index.html>
- FDA. 2018. <https://www.fda.gov/food/outbreaks-foodborne-illness/fda-investigated-multistate-outbreak-salmonella-braenderup-linked-shell-eggs-rose-acre-farms>
- CDC. 2018. <https://www.cdc.gov/salmonella/enteritidis-09-18/index.html>
- Davidson LJ. 2003a. US Patent 6,632,464 B2.
- Davidson LJ. 2003b. US Patent 6,692,784 B2.
- Dawoud et al. 2017. Front Vet Sci 4:93.
- Fabrega A, Vila J. 2013. Clin Microbiol Rev 26:308-341.

ACKNOWLEDGEMENTS

Lab members: Emily Campbell, Michelle Gerst, Walaa Hussein, Xu Yang, Mustafa Yesil and Yue Yi