



# Impact of Overcrowding Sous Vide Water Baths on the Thermal Process of Pork Loins

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# Literature Review

# Sous Vide Cooking



*“A process where vacuum-packaged foods are immersed in a temperature controlled water bath (or steam oven)”*

*– BCCDC (2016)*

# Sous Vide Pasteurization



- Total time required = CUT + Holding Time
- CUT (Come-up time)
  - Period of time food will take to reach to a specific internal core temperature
- Holding Time
  - Time (after CUT) in which food is held longer at a specific temperature to achieve required log reduction
    - 7 log reductions of *Salmonella* spp. for poultry
    - 6.5 log reductions of *Salmonella* spp. for all other foods

# Public Health Significance

# Microbiological Hazards

## Pathogens of concern:

- *Clostridium botulinum*
- *Clostridium perfringens*
- *Bacillus cereus*
- *Salmonella* spp.
- *Escherichia coli*
- *Staphylococcus aureus*
- *Listeria* spp.
- *Vibrio* spp.



# Food Premises Regulation



*Potentially Hazardous Food: “food in a form or state that is capable of supporting the growth of disease-causing micro-organisms or the production of toxins”*

*– Section 1 (1) of FPR*

*Potentially hazardous food is prescribed as a health hazard*

*– Section 2.1 (1) (b) of FPR*



# EHO Roles

- Should be well informed about sous vide practices
- Inspection
  - Assess food safety and sanitation plans
  - Observe and identify improper sous vide practices
  - Assess time and temperature records
- Education



# Overcrowding Water Baths

- Uneven heat distribution
  - Cold spots
- Prolongs time required to achieve full sous vide pasteurization
- Problem if food is taken out earlier

# Methods

# Methods

## *Preparation*



# Methods

Preparation

Cooking



Normal Condition

# Methods

Preparation

Cooking



Top view

Overcrowded  
Condition



Side view

# Methods

Preparation

Cooking

*Data  
Collection*



# Methods

Preparation

Cooking

Data  
Collection

*Data*  
*Analysis*



Microsoft®  
**Excel**



**NCSS**<sup>12</sup>  
Data Analysis



# American Meat Institute Process Lethality Determination Spreadsheet

T<sub>ref</sub> = 140 °F  
 z = 10.71 °F  
 D = 1.5 min

Log Reduction of Process

6.84

Data Table

Time (min)	Core Temp (°F)	F-value (min)
0	41	0.000
1	44.6	0.000
2	57.2	0.000
3	69.8	0.000
4	80.6	0.000
5	89.6	0.000
6	97.7	0.000
7	104	0.000
8	109.4	0.001
9	114.8	0.004
10	118.4	0.011
11	122	0.026
12	124.7	0.056
13	127.4	0.107
14	129.2	0.190
15	131	0.311
16	132.6	0.490
17	134.6	0.753
18	135.5	1.099
19	136.4	1.520
20	136.4	1.961
21	137.3	2.491
22	138.2	3.111
23	138.2	3.790
24	138.2	4.469
25	139.1	5.220
26	139.1	6.045
27	139.1	6.869
28	139.1	7.693
29	139.1	8.517
30	139.1	9.341
31	140	10.253

# Statistics, Results & Discussion

# Statistics & Results

Table 1. Descriptive statistics for  $\log_{10}$  reductions achieved in 31 minutes in pork loins cooked under normal and overcrowded conditions.

	Normal Condition	Overcrowded Condition
<b>Mean</b>	8.75 $\log_{10}$ reductions	1.76 $\log_{10}$ reductions
<b>Median</b>	8.25 $\log_{10}$ reductions	0.58 $\log_{10}$ reductions
<b>Mode</b>	12.88 $\log_{10}$ reductions	0.05 $\log_{10}$ reductions
<b>Standard deviation</b>	4.65 $\log_{10}$ reductions	2.24 $\log_{10}$ reductions
<b>Range</b>	20.56 $\log_{10}$ reductions	7.89 $\log_{10}$ reductions
<b>Minimum</b>	0.51 $\log_{10}$ reductions	0.04 $\log_{10}$ reductions
<b>Maximum</b>	21.07 $\log_{10}$ reductions	7.93 $\log_{10}$ reductions
<b>Count</b>	30	30

# Statistics & Results

## Inferential statistics results:

1. The mean log reductions of *Salmonella* spp. in pork loins cooked under normal conditions at 31 minutes is statistically greater than 6.5 log reductions
2. The mean log reductions of *Salmonella* spp. in pork loins cooked under overcrowding conditions at 31 minutes is statistically less than 6.5 log reductions
3. There is no difference in the mean log reductions of *Salmonella* spp. between the pork loins placed on the bottom, middle and top layers of an overcrowded water bath at 31 minutes

# Discussion

- Normal conditions
  - Achieved at least 6.5 log reductions
- Overcrowded conditions
  - Did not achieve at least 6.5 log reductions

→ Experimental findings agree with the recommendation outlined in the guidelines

# Discussion

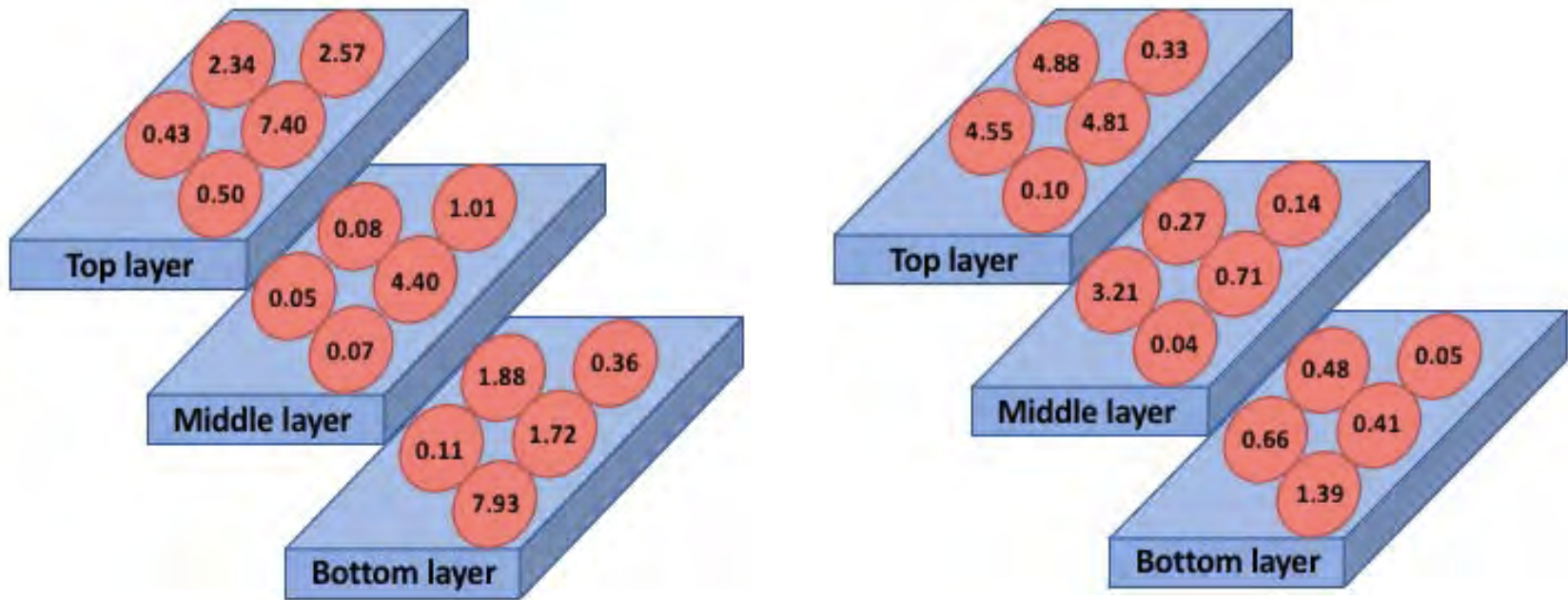


Figure 1. Cross-sectional diagram of log reductions achieved in pork loins cooked under overcrowded conditions at 31 min.

$$\mu_{\text{top}} = 2.791 \text{ log reductions}$$

$$\mu_{\text{middle}} = 0.998 \text{ log reductions}$$

$$\mu_{\text{bottom}} = 1.499 \text{ log reductions}$$

# Limitations

- Sample size
  - Budget and time constraints
- Setting of experiment
- Equipment used



# Conclusion & Recommendations

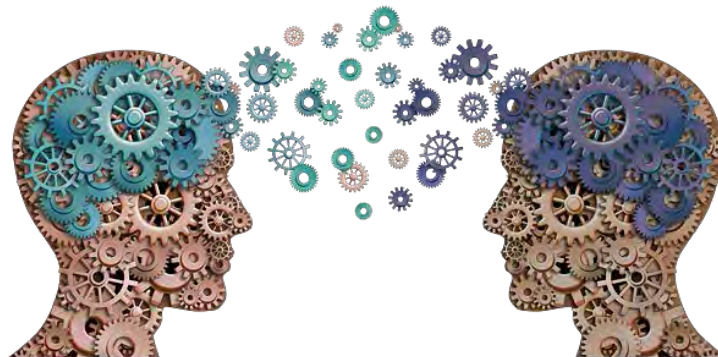
- Overcrowding sous vide water baths does have an impact on the thermal process of pork loins.
  - Food products cooked under overcrowded conditions will require a longer cook time
- EHOs and operators should become familiarized with proper and improper sous vide practices
- Inconclusive that inadequate water circulation will cause cold spots → further research using more samples is recommended



# Knowledge Translation



1. Inform guidelines
2. Knowledge enhancement



# Future Research Ideas



1. Determine effects of overcrowding in steam ovens
2. Determine maximum optimal food to water bath volume ratio to define overcrowding in sous vide

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# Any questions?



# References

- American Meat Institute. (2010). AMI process lethality determination spreadsheet. Retrieved November 26, 2017, from <http://meatpoultryfoundation.org/content/process-lethality-spreadsheet>
- Anova Applied Electronics. (2014). Anova precision cooker manual.
- B.C. Laws. (2017a). Food Premises Regulation. Retrieved October 24, 2017, from [http://www.bclaws.ca/Recon/document/ID/freeside/11\\_210\\_99#section14](http://www.bclaws.ca/Recon/document/ID/freeside/11_210_99#section14)
- B.C. Laws. (2017b). Food Safety Act. Retrieved October 22, 2017, from [http://www.bclaws.ca/EPLibraries/bclaws\\_new/document/ID/freeside/00\\_02028\\_01#section2](http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_02028_01#section2)
- B.C. Laws. (2017c). Public Health Act. Retrieved October 24, 2017, from [http://www.bclaws.ca/civix/document/id/complete/statreg/08028\\_01](http://www.bclaws.ca/civix/document/id/complete/statreg/08028_01)
- Baer, A. A., Miller, M. J., & Dilger, A. C. (2013). Pathogens of interest to the pork industry: A review of research on interventions to assure food safety. *Comprehensive Reviews in Food Science and Food Safety*, 12(2), 183–217. <https://doi.org/10.1111/1541-4337.12001>
- Baldwin, D. E. (2012). Sous vide cooking: A review. *International Journal of Gastronomy and Food Science*, 1(1), 15–30. <https://doi.org/10.1016/j.ijgfs.2011.11.002>
- BC Centre for Disease Control Environmental Health Services and Sous Vide Working Group. (2016). Guidelines for restaurant sous vide cooking safety in British Columbia. Retrieved from [http://www.bccdc.ca/resource-gallery/Documents/Guidelines and Forms/Guidelines and Manuals/EH/FPS/Food/SVGuidelines\\_FinalforWeb.pdf](http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/EH/FPS/Food/SVGuidelines_FinalforWeb.pdf)
- Borch, E., & Arinder, P. (2002). Bacteriological safety issues in red meat and ready-to-eat meat products, as well as control measures. *Meat Science*, 62(3), 381–390. [https://doi.org/10.1016/S0309-1740\(02\)00125-0](https://doi.org/10.1016/S0309-1740(02)00125-0)
- Canadian Food Inspection Agency. (2013). Annex D: Cooking Time/Temperature Tables - Canadian Food Inspection Agency. Retrieved October 17, 2017, from <http://www.inspection.gc.ca/food/meat-and-poultry-products/manual-of-procedures/chapter-4/annex-d/eng/1370527526866/1370527574493#t1>

# References

- Canadian Food Inspection Agency. (2016). Cooking - Chapter 4 - Meat Processing Controls and Procedures - Food - Canadian Food Inspection Agency. Retrieved March 18, 2018, from <http://www.inspection.gc.ca/food/meat-and-poultry-products/manual-of-procedures/chapter-4/eng/1367622697439/1367622787568?chap=6#s8c6>
- Centers for Disease Control and Prevention. (2012). CDC - Trichinellosis. Retrieved October 21, 2017, from <https://www.cdc.gov/parasites/trichinellosis/>
- Centers for Disease Control and Prevention. (2013). CDC - Taeniasis. Retrieved October 21, 2017, from <https://www.cdc.gov/parasites/taeniasis/>
- Davies, P. R. (2011). Intensive\_swine\_production\_and.PDF. *Foodborne Pathogens and Disease*, 8(2). <https://doi.org/10.1089/fpd.2010.0717>
- Do, N. (2013). Sous vide chicken pasteurization temperatures. *BCIT Student Research Project for ENVH 8410*, 1–49.
- Federal/Provincial/Territorial Food Safety Committee. (2016). Food Retail and Food Services Code. Retrieved October 17, 2017, from <http://www.hss.gov.yk.ca/pdf/foodservicescode.pdf>
- Fidalgo, T. (2016). TrendReader for SmartButton software reference guide, 59. <https://doi.org/10.1002/ejoc.201200111>
- Heacock, H. (2017). Introduction to inferential statistics [lecture notes]. Burnaby: BCIT.
- Health Canada. (2015). Policy on Listeria monocytogenes in ready-to-eat foods (2011). Retrieved October 23, 2017, from <https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/policies/policy-listeria-monocytogenes-ready-eat-foods-2011.html>
- Huang, C. (2015). Assessment of Sous Vide Knowledge and Inspection / Cooking Practices. *BCIT Environmental Health Journal*. Retrieved from [https://circuit.bcit.ca/repository/islandora/object/repository%3A49?solr\\_nav%5Bid%5D=e25c628390bebc062f82&solr\\_nav%5Bpage%5D=0&solr\\_nav%5Boffset%5D=1](https://circuit.bcit.ca/repository/islandora/object/repository%3A49?solr_nav%5Bid%5D=e25c628390bebc062f82&solr_nav%5Bpage%5D=0&solr_nav%5Boffset%5D=1)
- Li, R. C. (2015). Sous vide salmon pasteurization temperature. *BCIT Environmental Health Journal*, 1–17. Retrieved from [https://circuit.bcit.ca/repository/islandora/object/repository%3A64?solr\\_nav%5Bid%5D=e25c628390bebc062f82&solr\\_nav%5Bpage%5D=0&solr\\_nav%5Boffset%5D=0](https://circuit.bcit.ca/repository/islandora/object/repository%3A64?solr_nav%5Bid%5D=e25c628390bebc062f82&solr_nav%5Bpage%5D=0&solr_nav%5Boffset%5D=0)

# References

McIntyre, L. (2017). Personal communication.

McIntyre, L., Jorgenson, V., & Ritson, M. (2017). Sous vide style cooking practices linked to Salmonella enteritidis illnesses. *Environmental Health Review*, 60(2), 42–49. <https://doi.org/10.5864/d2017-014>

NCSS Statistical Software. (2018). NCSS 12 data analysis. Retrieved November 25, 2017, from <https://www.ncss.com/software/ncss/>

NSW Government Food Authority. (2012). Sous vide - Food safety precautions for restaurants. Retrieved October 18, 2017, from [http://www.foodauthority.nsw.gov.au/\\_Documents/scienceandtechnical/sous\\_vide\\_food\\_safety\\_precautions.pdf](http://www.foodauthority.nsw.gov.au/_Documents/scienceandtechnical/sous_vide_food_safety_precautions.pdf)

Plain, S. (2016). Examining the safety of duck breast prepared the sous vide method. *BCIT Environmental Health Journal*, 1–11. Retrieved from [https://circuit.bcit.ca/repository/islandora/object/repository%3A410?solr\\_nav%5Bid%5D=e25c628390bebc062f82&solr\\_nav%5Bpage%5D=0&solr\\_nav%5Boffset%5D=2](https://circuit.bcit.ca/repository/islandora/object/repository%3A410?solr_nav%5Bid%5D=e25c628390bebc062f82&solr_nav%5Bpage%5D=0&solr_nav%5Boffset%5D=2)

Schellekens, M. (1996). New research issues in sous-vide cooking. *Trends in Food Science and Technology*, 7(8), 256–262. [https://doi.org/10.1016/0924-2244\(96\)10027-3](https://doi.org/10.1016/0924-2244(96)10027-3)

Sindelar, J. J., Glass, K., & Hanson, R. (2013). Developing validated time-temperature thermal processing guidelines for ready-to-eat deli Meat and poultry products, (July).

Vikraman, V. (2011). Investigation of food safety issues associated with sous-vide practices observed in Vancouver restaurants. Faculty of Land and Food Systems. Vancouver, University of British Columbia. *Master of Food Science.*, 1–31.