

Understanding and Managing Risks Associated with Cooling Hot Foods

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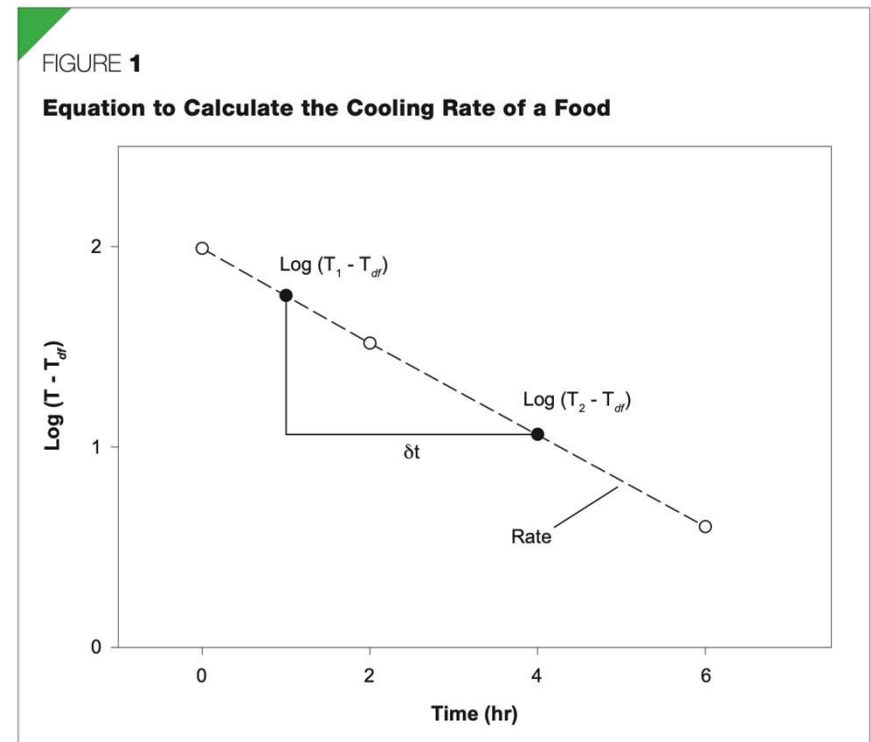
<http://riskyornot.co>

<http://foodsafetytalk.com>

Tools and Techniques to Promote Proper Food Cooling in Restaurants, JEH March 2022

- Cooling is faster at the beginning when the driving force is higher
- Newton published this idea in 1701

time (hr)	temp (°F)
0	135
2	70
6	41



Where my interest in restaurant cooling began

- We had been working on *C. perfringens* modeling in meat cooking since 2001

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Quantitative Data Analysis To Determine Best Food Cooling Practices in U.S. Restaurants[†]

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JFP 2015 summary

- Methods
 - EHS-Net had data at two times and temperatures, almost 600 foods. We used those two points to estimate cooling rate
- Results
 - Foods not being actively monitored by food workers were more than twice as likely to cool more slowly than recommended in the Food Code
 - Food stored at a depth greater than 7.6 cm (3 in.) was twice as likely to cool more slowly than specified in the Food Code guideline.
 - Unventilated cooling foods were almost twice as likely to cool more slowly than specified in the Food Code guideline.

Validation of a Simple Two-Point Method To Assess Restaurant Compliance with Food Code Cooling Rates

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ABSTRACT

Outbreaks from improperly cooled foods continue to occur despite clearly described Food Code cooling guidelines. It is difficult for regulators to enforce these guidelines because they are typically in an establishment for less than the 6 h needed to document proper cooling. Prior research proposed using a novel method to estimate cooling rates based on two time-temperature points, but this method has not yet been validated. Time-temperature profiles of 29 different foods were collected in 25 different restaurants during cooling. Cooling curves were divided into two categories: typical (21 foods) and atypical (eight foods) prior to further analysis. Analysis of the typical cooling curves used simple linear regression to calculate cooling rates. The atypical cooling profiles were studied using Monte Carlo simulations of the cooling rate. Almost all linearized typical cooling curves had high (>0.90) R^2 values. Six foods with typical cooling profiles that did not pass Food Code cooling times were correctly identified by the two-point model as having slow cooling rates. Three foods that did not pass Food Code cooling times were identified by the two-point model as having marginal cooling rates. Ten of 12 foods identified by the two-point model as having acceptable cooling rates met Food Code cooling times. Most (six of eight) foods that were considered to have atypical cooling curves failed to meet the Food Code cooling times. The two-point model was also able to determine whether these foods would fail based on Food Code guidelines depending upon the simulation criteria used. Our data show that food depth has a strong influence on cooling rate. Containers with a food depth ≥ 7.6 cm (3 in.) were more likely to have cooling rates slower than the U.S. Food and Drug Administration Model Food Code cooling rate. This analysis shows that the two-point method can be a useful screening tool to identify potential cooling rate problems during a routine restaurant inspection visit.

Igo et al 2021 highlights

- Containers with food depth ≥ 3 inches were likely to have slow cooling rates.
- Most (21 of 29) foods had linearized cooling rates with high (>0.90) R^2 values.
- Most (15 of 17) slow cooling foods were identified by the two-point method.
- All (12 of 12) fast cooling foods were identified by the two-point method.
- The two-point method can be used to identify potential cooling rate problems.

Most recently...

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Research Paper

Cooling Uncovered Foods at a Depth of ~5.1 cm (2 in.) or Less Poses Little Risk of Pathogen Growth



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Food depth matters

- Covered foods, solid symbol
- 2 inches is vertical line
- Food code rate is horizontal line

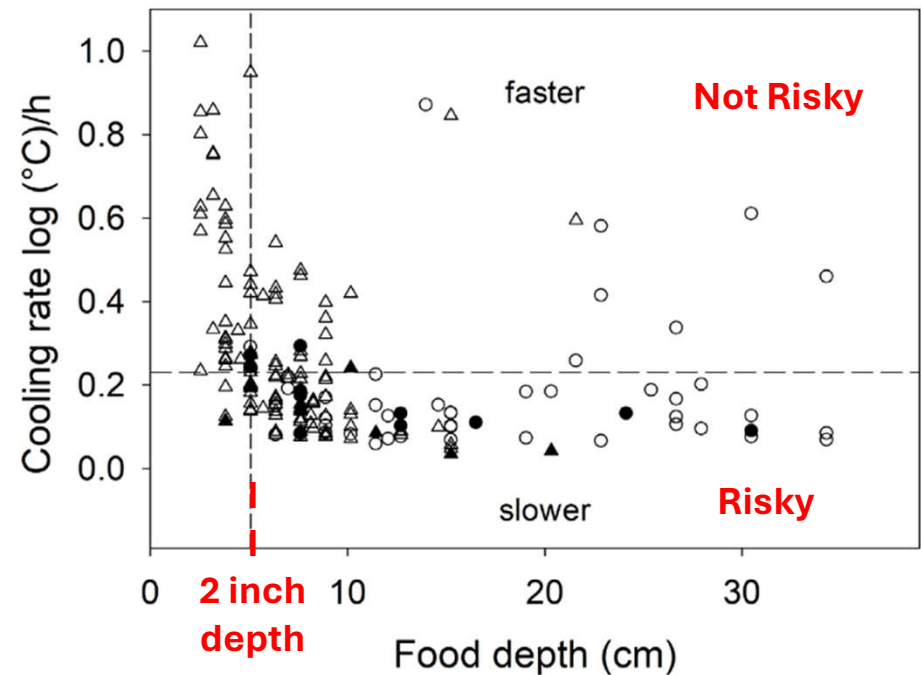


Figure 1. Relationship between cooling rate and food depth, indicating metal (triangle) or plastic (circle) containers that are covered (solid) or not (open). Food depth of 5.1 cm (2 in.) is indicated by the vertical dotted line. The recommended Food Code cooling rate of 0.23 log(°C)/h is indicated by the horizontal dotted line.

What matters (statistically)

- Linear regression model parameters and their statistical significance in predicting cooling rate in $\log(^{\circ}\text{C})/\text{h}$, where the adjusted R^2 is 0.155, and $p = 4.139\text{e}-07$
- Highly significant p-value but low R^2 means there are variables for which we can't account

Parameter	<i>P</i> value
Intercept	$< 2.00\text{E} - 16$
Food depth (cm)	$8.86\text{E} - 08$
Ice bath use	0.00219
Ice wand use	0.00350

Ice bath and cooling wands help...

- But they are not magic
- The stars are both wands and baths together, and can move foods to “not risky”
- But see the gray shaded items that are below the horizontal line in the risky area
 - Some stars (both) but also wands (∇) and baths ($\square$)

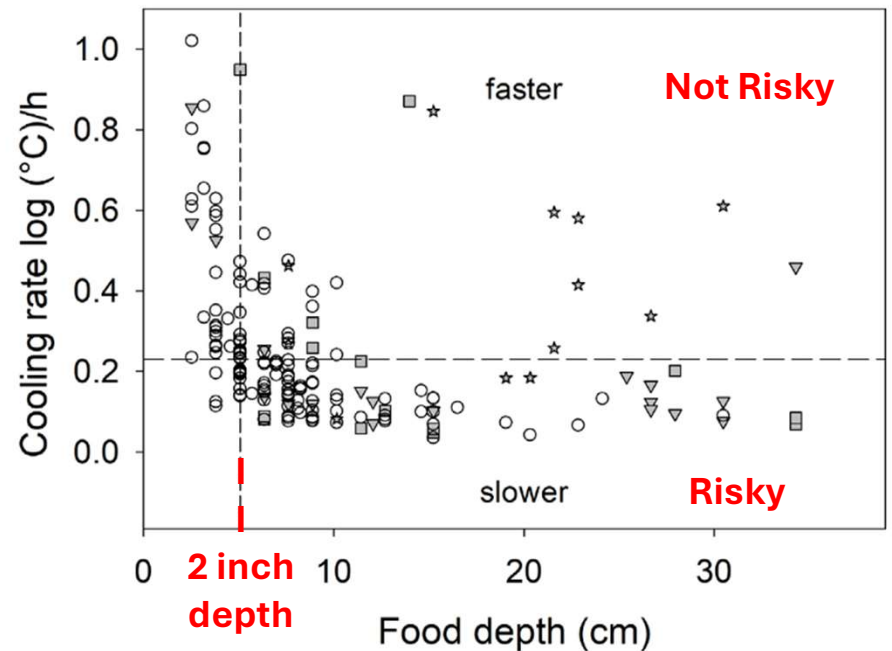


Figure 2. Relationship between cooling rate and food depth indicating the use of ice wand (upside down triangle), ice bath (square) or both ice wand and ice bath (star). Food depth of 5.1 cm (2 in.) is indicated by the vertical dotted line. The recommended Food Code cooling rate of 0.23 log(°C)/h is indicated by the horizontal dotted line.

Why did “deep” items cool fast?

- Passive

- Cooled in blast chiller
- Cooled in blast chiller (partially)
- Cooled in freezer
- Cooled in freezer (partially)
- Protein pieces (breasts)
- Protein pieces (diced)
- Protein pieces (wings)

- Active

- Ice bath
- Ice bath, probe error, combined to double depth
- Wand and Ice bath
- Wand and partially cooled in freezer
- Wand, Ice bath, ice as ingredient
- Two Wands

Why did “shallow” items cool slow?

- Met the code but not -0.23 log(°C)/h
 - Cooling temperature > 41 °F (partially)
 - Spent less than 2 hours in high-risk zone (120 to 80 °F), <1 log C. perfringens predicted
- Did not meet the code
 - Cooling temperature > 41 °F
 - Cooling temperature > 41 °F (partially), covered, stacked
 - Covered
 - Covered (partial, assumed)
 - Covered (partial, assumed), probe error
 - Covered (partial)
 - Less than 7 hours total, <1 log C. perfringens predicted

How “safe” is food code cooling?

- It's quite safe
- Food code cooling is dotted line
- USDA FSIS allows less than a 1 log increase for *Clostridium perfringens* (black dots)
- *Bacillus cereus* has an even higher margin of safety

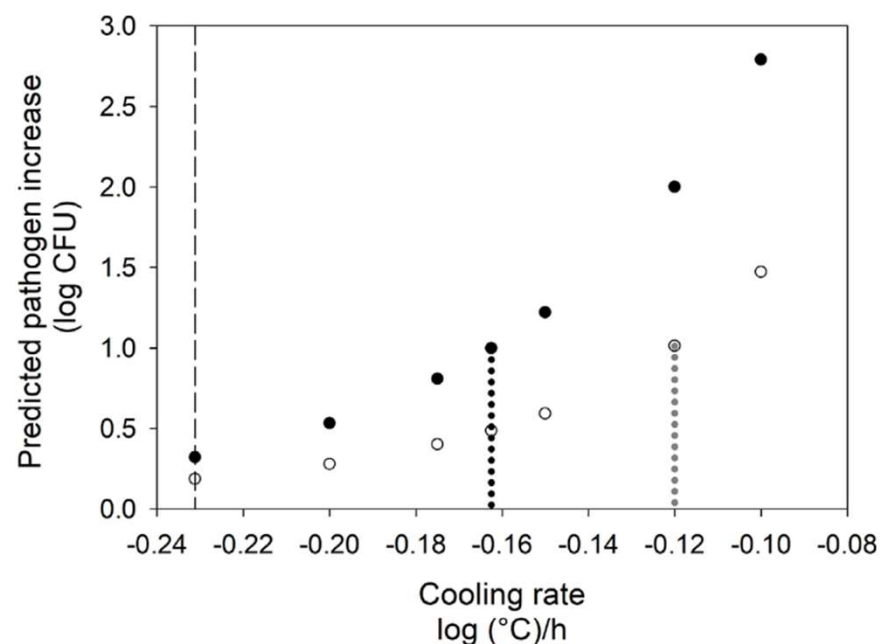


Figure 3. Relationship between cooling rate and the predicted increases in pathogen concentration for *C. perfringens* Perfringens Predictor, assuming pH 7 and 0.5% NaCl (closed circles) and *B. cereus* using [Juneja et al. \(2019\)](#) model (open circles). The vertical dashed line at $-0.23 \log(^{\circ}\text{C})/\text{h}$ represents the cooling rate suggested in the model food code.

Future work and activities

- We are collaborating with a well-known fast-food company that sells chicken and are analyzing some of their cooling data
- We've been working with industry and regulators to change the FDA model code to allow foods that are
 - uncovered
 - with a food depth of 2 inches or less and
 - placed in proper refrigeration
- ... to be compliant with a code without monitoring

Questions and comments



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