

FATE OF *ESCHERICHIA COLI* ATCC 25922 IN BEEF STEAKS DURING SOUS VIDE COOKING AT DIFFERENT HOLDING TIME AND TEMPERATURE COMBINATIONS

H. B. Hunt^{1*}, S. C. Watson¹, B. D. Chaves², and G. A. Sullivan¹,

¹Department of Animal Science, University of Nebraska, Lincoln, NE, USA,

²Department of Food Science and Technology, University of Nebraska, Lincoln, NE, USA,

[*heather.hunt@huskers.unl.edu](mailto:heather.hunt@huskers.unl.edu)

I. OBJECTIVES

Sous vide cooking, a method of preparing food in hot water baths, can be used to achieve a precise degree of doneness throughout a steak. Due to ease of use, there is increased popularity of sous vide cooking in domestic and food service food preparation. For cooking safety, United States Department of Agriculture Food Safety and Inspection Service Appendix A guidance for the control of *Salmonella* is commonly referenced for the prevention of pathogenic *Escherichia coli* adulteration of cooked beef products. The lowest temperature included in Appendix A is 54°C. Some sous vide manufacturers' cooking recipes suggest cooking nonintact beef products to an internal temperature as low as 46°C. Thus, this experiment was designed to validate a 5 log₁₀ thermal reduction of generic *E. coli* in sous vide cooked beef steaks.

II. MATERIALS AND METHODS

The experiment was conducted in 3 independent replications. Beef *semitendinosus* muscles were cut into 2.54-cm slices, vacuum packaged, and frozen until use. For each replication, steaks were thawed (48 h, 4°C) and exposed to ultraviolet light for 15 min on each side. Steaks were submerged in liquid inoculum (2 L of *E. coli* ATCC 25922 overnight culture) and internally inoculated with a pin pad inserted 5 times into each side of each steak. After inoculation, steaks were air-dried (30 min, 23°C), individually vacuumed sealed, and cooked in sous vide water baths. Duplicate steak samples were taken from raw, inoculated steaks and at the following hold time, temperature combinations: 150 min/46°C, 420 min/46°C, 150 min/51°C, 193.5 min/51°C, 258 min/51°C, 322.5 min/51°C, 64.5 min/54°C, 86 min/54°C, 107.5 min/54°C, 2.25 min/62°C, 3 min/62°C, and 3.75 min/62°C. The median sampling times for 54°C and 62°C were taken directly from the Appendix A 5 log₁₀ reduction table, and the other times were ±25% of the median time. The median sampling time for 51°C was extrapolated from the table. The 46°C sampling times represented potential worst-case scenarios. Core samples (25 g) were homogenized, serially diluted, and plated onto Charm EC Peal plates. *E. coli* colonies were counted after incubation (24 h, 35°C) according to manufacturer guidelines and reported as log₁₀ CFU/g. Reductions were determined by subtracting concentrations at given sampling times from the raw sample. Data were analyzed using PROC GLM contrasts in SAS 9.4 (SAS Institute Inc., Cary, NC).

III. RESULTS

The minimum time measured for a 5 log₁₀ reduction for 51°C, 54°C, and 62°C was 258 min, 64.5 min, and 2.25 min ($P < 0.01$), respectively. At 46°C, cooking achieved a final reduction of 1.07 log₁₀ ($P < 0.01$) after 420 min.

IV. CONCLUSION

The worst-case scenario conditions of this study confirm the utility of Appendix A time, temperature tables for a 5 log₁₀ reduction of generic *E. coli* at 62°C and 54°C, and suggest the possibility for safely sous vide cooking steaks at 51°C. Further experimentation is needed to determine the fate of pathogenic *E. coli* during sous vide cooking of steaks using time and temperature combinations at and below recommended USDA-FSIS values.

Keywords: beef, cooking temperature, sous vide