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### **Funding Source**

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## Evaluation of Thawing Curves of Beef Strip Loin Steaks Using Various Thawing Methods

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### Abstract

The objective of this study was to evaluate and determine the thawing rate and time of strip steaks thawed using methods that are recommended by the U.S. Department of Agriculture and those commonly used by consumers. Strip loins were collected from a beef packing facility, cut, and vacuum packaged at Kansas State University, then frozen at  $-40^{\circ}\text{F}$  prior to further research. In this study, four different methods of thawing were utilized. Two methods were USDA-approved: thawing in a refrigerator (REF) and in cold water (CW); while the other two methods evaluated are commonly used by consumers: thawing on the countertop (CT) and in hot water (HW). As steaks were thawed, temperatures were recorded over different periods of time to track the thawing time and rate of thawing in the different environments. In this study, thawing time differed by method ( $P < 0.05$ ;  $\text{HW} > \text{CT} > \text{CW} > \text{REF}$ ). Additionally, thawing rates showed similar results ( $P < 0.05$ ;  $\text{HW} > \text{CT} > \text{CW} < \text{REF}$ ). However, CW and REF were similar ( $P > 0.05$ ) in terms of thawing rate. In conclusion, consumers and restaurants should take into consideration thawing rate and times to determine the best method of thawing for strip steaks and should strongly consider using CW and REF to eliminate food safety concerns.

### Introduction

In the meat industry, where products are mass produced, freezing is a crucial method to ensure a safe, preserved product in stores and in households for consumption. The process and time used to thaw beef varies and has been largely unstudied. However, thawing time and rate can play a large role in meat quality (Eastridge and Bowker, 2011). For example, drip loss can occur in steaks due to the rupturing of ice crystals formed during the freezing process (Eastridge and Bowker, 2011). Thawing is the final stage of chilling when meat is expected to return to a similar quality as fresh, never-frozen product. However, thawing may affect meat quality due to ice crystal reformation throughout the thawing process (Eastridge and Bowker, 2011). Consumers often choose the quickest and most efficient thawing methods, leading to thawing on countertops or in hot water as opposed to many of the slower USDA-approved methods. Therefore, the purpose of this study was to compare the thawing rate and time of strip steaks thawed using different thawing methods and to evaluate the speed and rate of different thawing methods.

## Experimental Procedures

Beef strip loins (Institutional Meat Purchase Specifications #180) were collected from a beef processing plant and brought to Kansas State University. At the university, the strip loins were fabricated into approximately 1-in thick steaks. The steaks were then vacuum-packaged and frozen at  $-40^{\circ}\text{F}$  until utilized for the study. Four different thawing methods were utilized in this study. Two methods were USDA-approved: thawing in a refrigerator (REF) and in cold water (CW); while the other two methods evaluated are commonly used by consumers: thawing on the countertop (CT) and in hot water (HW). Temperature probes (Q-Series Type K, American Fork, UT) were placed at the geometric center of the cut. Prior to the study, pilot studies were completed for each method to determine the approximate time the product would take to thaw. All steaks were thawed until the center reached a temperature of  $32^{\circ}\text{F}$ . Steaks assigned to REF were held at constant temperatures of  $35.6\text{--}37.4^{\circ}\text{F}$  in a refrigerator. Steak designated to CW were placed in individual containers with water held at a constant temperature of  $35.6\text{--}37.4^{\circ}\text{F}$ . To maintain the temperature of water, the containers were placed in the refrigerator throughout the thawing process. Steaks allocated to CT were thawed in plastic trays at  $62.6\text{--}68^{\circ}\text{F}$  for approximately 5 hours, or until the internal temperature reached  $32^{\circ}\text{F}$ . Steaks assigned to HW were placed in a water bath set at  $104^{\circ}\text{F}$ . In order to maintain consistent temperature for HW, a sous vide machine was used. Temperature probes were connected to temperature data loggers. Every 30 minutes, REF and CW temperatures were recorded for 24 hours or until  $32^{\circ}\text{F}$  was reached. The CT temperatures were recorded every 10 minutes for 5 hours or until  $32^{\circ}\text{F}$  was reached. The HW temperatures were recorded every 30 seconds and steaks were removed when internal temperatures reached  $32^{\circ}\text{F}$ . Data were analyzed as a completely randomized design.

## Results and Discussion

Thawing time differed ( $P < 0.05$ ) among treatments in this study ( $\text{HW} < \text{CT} < \text{CW} < \text{REF}$ ), ranging from 10 minutes to 14 hours and 42 minutes (Table 1 and Figure 1). Additionally, thawing rates differed ( $P < 0.05$ ) among treatments with a similar trend ( $\text{HW} < \text{CT} < \text{CW} < \text{REF}$ ), ranging from  $33.46^{\circ}\text{F}$  per minute to  $32.01^{\circ}\text{F}$  per minute. The CW temperatures differed ( $P < 0.05$ ) from REF until 5 hours prior to the thaw point, at which point the temperatures were similar ( $P > 0.05$ ) for the remaining thawing period. Moreover, REF steaks were warmer ( $P < 0.05$ ) than CW steaks from 13 to 5 hours prior to the thaw point. In the final 5 hours, CW and REF steaks were similar ( $P > 0.05$ ) in temperature. Among all treatments, CT steaks were the coldest ( $P < 0.05$ ) from 5 to 2 hours prior to the thaw point. However, in the final 2 hours, CT steaks were at similar ( $P > 0.05$ ) temperatures as CW and REF. Due to the short period of thawing time and the observed rapid thawing rate, HW samples were the coldest ( $P < 0.05$ ) in the final 10 minutes prior to thaw point.

## Implications

Various methods can be used to thaw meat; however, this study evaluated approximate thawing rates and times for the four most common methods. Consumers can estimate the amount of time needed to thaw a steak and plan ahead of time to do so with the safest method possible.

## Acknowledgments

This project was funded by the National Cattlemen's Beef Association.

## References

Eastridge, J. S., and B. C. Bowker. 2011. Effect of rapid thawing on the meat quality attributes of USDA select beef strip loin steaks. *Journal of Food Science* 76:S156–S162. doi:10.1111/j.1750-3841.2010.02037.x.

**Table 1. Least squares means for thawing rate, time, and temperatures (°F) at times prior to thawed of strip loin steaks thawed using various methods**

Time prior to thawed <sup>1</sup>	Hot water	Countertop	Cold water	Refrigerator	<i>P</i> -value	SEM <sup>2</sup>
Thaw rate <sup>3</sup>	1.46 <sup>a</sup>	0.504 <sup>b</sup>	0.018 <sup>c</sup>	0.126 <sup>c</sup>	< 0.01	32.16
Thaw time <sup>4</sup>	10.3 <sup>a</sup>	264.0 <sup>b</sup>	637.5 <sup>c</sup>	882.0 <sup>d</sup>	< 0.01	51.26
0:00	32.54	32.36	32.0	32.18	0.21	32.18
0:05	24.98	---	---	---		33.49
0:10	25.52 <sup>a</sup>	31.28 <sup>b</sup>	---	---	< 0.01	32.76
0:30	---	30.2	30.56	33.62	0.31	32.22
1:00	---	29.66	29.84	30.02	0.47	32.2
1:30	---	29.12 <sup>a</sup>	29.48 <sup>ab</sup>	29.84 <sup>b</sup>	0.29	32.18
2:00	---	28.58 <sup>a</sup>	29.3 <sup>b</sup>	29.84 <sup>b</sup>	< 0.01	32.22
2:30	---	27.5 <sup>a</sup>	29.12 <sup>b</sup>	29.66 <sup>b</sup>	< 0.01	32.31
3:00	---	26.06 <sup>a</sup>	29.12 <sup>b</sup>	29.66 <sup>b</sup>	< 0.01	32.45
3:30	---	24.8 <sup>a</sup>	28.94 <sup>b</sup>	29.48 <sup>b</sup>	< 0.01	32.59
4:00	---	22.46 <sup>a</sup>	28.76 <sup>b</sup>	29.48 <sup>b</sup>	< 0.01	32.65
5:00	---	16.88 <sup>a</sup>	28.22 <sup>b</sup>	29.12 <sup>b</sup>	< 0.01	33.93
6:00	---	---	27.68 <sup>a</sup>	28.94 <sup>b</sup>	0.01	32.31
7:00	---	---	27.5 <sup>a</sup>	28.76 <sup>b</sup>	< 0.01	32.31
8:00	---	---	26.96 <sup>a</sup>	28.58 <sup>b</sup>	< 0.01	34.2
9:00	---	---	26.24 <sup>a</sup>	28.04 <sup>b</sup>	< 0.01	32.4
10:00	---	---	23.72 <sup>a</sup>	27.14 <sup>b</sup>	< 0.01	32.7
11:00	---	---	21.74 <sup>a</sup>	26.6 <sup>b</sup>	< 0.01	32.63
12:00	---	---	21.2 <sup>a</sup>	26.24 <sup>b</sup>	< 0.01	32.99
13:00	---	---	19.4 <sup>a</sup>	25.16 <sup>b</sup>	0.01	33.76
14:00	---	---	---	22.64		32.63
15:00	---	---	---	20.3		32.41

<sup>1</sup>(hours:minutes).

<sup>2</sup>Standard error of the mean (largest) of the least square means.

<sup>3</sup>Degrees / minutes to reach 32°F.

<sup>4</sup>Minutes to reach 32°F.

<sup>abc</sup>Least square means in the same row without a common superscript differ ( $P < 0.05$ ).

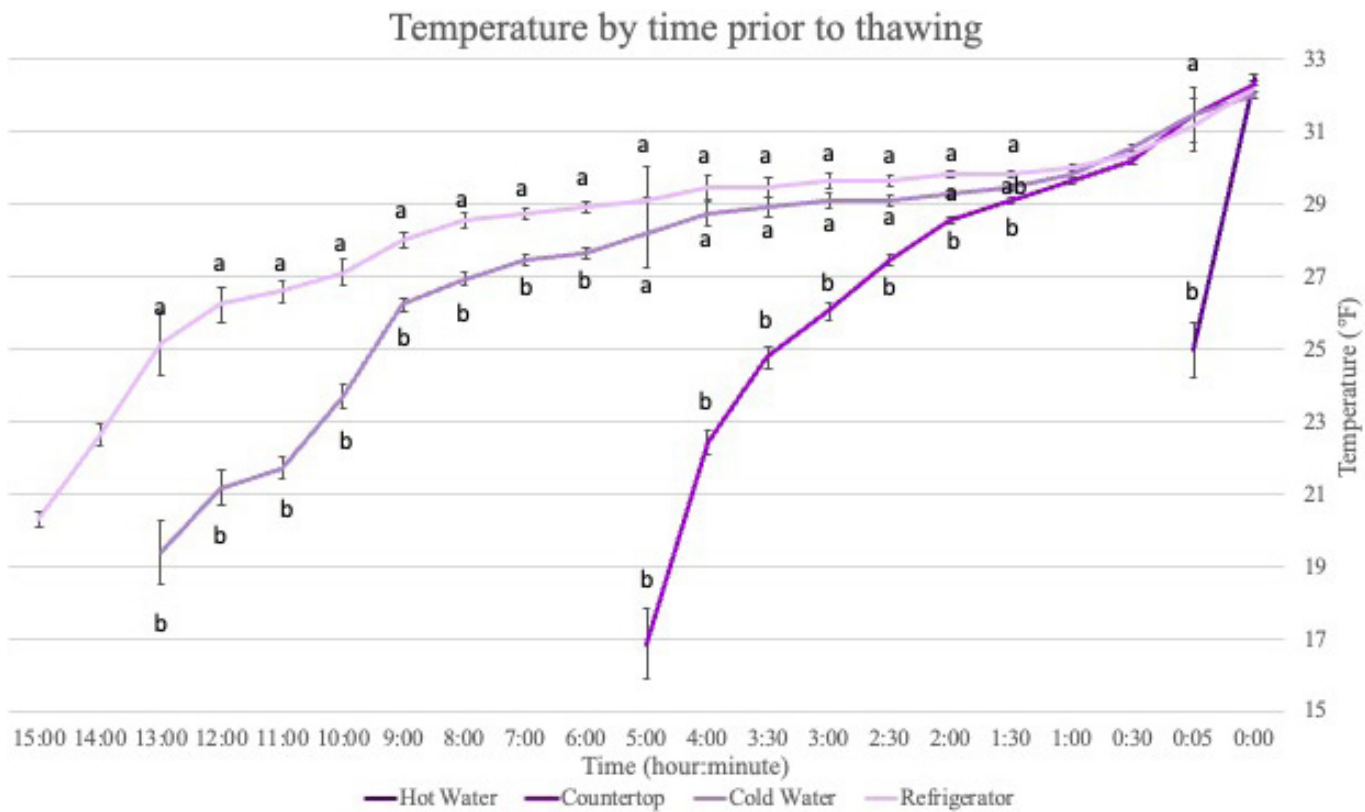


Figure 1. Thaw curves of various thawing methods where time equals hours until thawed.