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BEEF CATTLE RESEARCH



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Evaluation of Two Implants for Steers on Early-Intensively Grazed Tallgrass Native Range

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Abstract

Commercial implants can have different coating technologies, carriers, and hormone amounts resulting in different payout characteristics and impacts on cattle growth. Revalor-G (Merck Animal Health, Madison, NJ) and Synovex One Grass (Zoetis Inc., Kalamazoo, MI) implants were used in stocker steers to evaluate calf gains during a 90-day summer grazing season. Revalor-G contains 40 mg of trenbolone acetate and 8 mg of estradiol, is uncoated, and has a cholesterol carrier. Synovex One Grass contains 150 mg of trenbolone acetate and 21 mg of estradiol benzoate, and has a porous polymer coating that extends payout window. Steers (n = 242) were assigned to one of seven pastures, implanted on day 0, and then weighed with an overnight shrink on days 0, 44, and 91 of grazing. Total gains and average daily gains during each half of the grazing season were determined. Average daily gain and total body weight gain were not different based on implant type. Cattle with the Revalor-G implant had an average daily gain of 2.6 lb/day, while cattle with the Synovex One Grass implant gained 2.5 lb/day. Cattle with the Revalor-G implant had a total body weight gain of 222 lb, while cattle with the Synovex One Grass implant gained 220 lb. Body weight gain and average daily gain were not different between implants in either section of the grazing period. Cattle performance was similar regardless of hormone amount and coating technology for these implants when used during a short-duration grazing period with stocker steers.

Introduction

Growth-promoting steroids in the form of an implant can increase average daily gain by 5% in suckling calves and 14% in stocker cattle (Reinhardt and Thompson, 2016). Implants have been approved for usage since the 1950s. Most approved implants utilize a carrier that results in a biphasic payout pattern of hormone, where there is a rapid spike in blood hormone concentrations in a few days after administration of the implant that slowly dissipates over a period of several months. This pattern is seen when using implants such as Revalor-G that utilize cholesterol as their carrier. In the case of Synovex One Grass, a porous polymer coating is used in the implant which extends the payout period of the implant up to 200 days.

Given the short duration of the grazing period associated with a 90-day intensive early season grazing system and the declining grass quality at the end of the grazing period, implant payout pattern may impact performance response. The objective of the study was to evaluate stocker cattle gains on intensive early double-stocked native tallgrass prairie between two implants that have different lengths of effective use. The test hypothesis is that a quicker release of hormone from Revalor-G will result in greater gains early in the season, with no difference in gains between implants overall.

¹Merck Animal Health, Madison, NJ.

Experimental Procedures

Stocker steers that were 71% black hided ($n = 281$) were purchased from auctions, vaccinated for respiratory pathogens (Bovi-Shield Gold One Shot, Zoetis Inc., Kalamazoo, MI), and wormed with an oral (Valbazen, Zoetis Inc.) and an injectable dewormer (Dectomax, Zoetis Inc.). Steers were weighed individually using electronic scales at the start, midpoint, and end of the 2017 summer grazing period after an overnight shrink on April 24, June 7, and July 24. Steers were randomly assigned to be implanted with Revalor-G or Synovex One Grass and assigned to a pasture with an equal number of calves receiving each of the implants within the pasture. The number of head in each pasture was different so as to stock appropriately for available biomass. The steers were pastured at the Bressner Research Range Unit near Yates Center, KS. The Bressner Unit was divided into eight individual pastures (approximately 79 acres each), with four pastures on the north side and four pastures on the south side. Pastures were burned April 5, 2017.

One pasture of calves was removed from the analysis ($n = 38$) due to inaccurate final weights as a result of excessive shrink associated with a water tank malfunction within 2 days of weighing. Within the Revalor-G treatment, one calf died while on pasture and one calf was not weighed on the final date because he escaped into a neighboring pasture. Therefore, 242 weights were analyzed for the intermediate time point and 241 weights recorded at the end of the study were used in analysis.

Data were analyzed as a randomized complete block design with pasture as the blocking factor and individual animal as the experimental unit. The MIXED procedure of SAS (Version 9.3, SAS Institute Inc., Cary, NC) was used to evaluate treatment effects on average daily gain and body weight gain for the first half of grazing season, second half of grazing season, and total season grazing. Treatment was used as a fixed effect and pasture was used as a random effect in the model. Initial weight was included as a covariate when analyzing midpoint and final body weight as initial weights tended to be different by treatment ($P = 0.10$; Table 1). Initial weight was not significant in the models for average daily gain and body weight gains and thus was not included as a covariate. A Kenward-Rogers denominator degree of freedom was applied to all analyses. Means were considered different when the P -value was ≤ 0.05 with a tendency reported when $0.05 < P \leq 0.10$.

Results and Discussion

No differences ($P > 0.05$) were observed between Revalor-G and Synovex One Grass for season-long average daily gain and total body weight gain (Table 1). Average daily gain and body weight gains were not different ($P > 0.05$) between implants from the beginning of the trial through the midpoint or from the midpoint until the end of grazing. In addition, steer weights were not different ($P > 0.05$) at weigh dates (Table 1).

The Revalor-G treatment produced gain more cost-effectively during a 90 day grazing season. Based on 2017 pricing, the actual purchase price was \$1.39 per dose for Revalor-G while Synovex One Grass was \$4.95 per dose. Since body weight gains were similar

for each implant treatment, the cost of gain was less with the Revalor-G implant. Some payout likely remained on the Synovex One Grass implant and could be utilized prior to marketing cattle, but is a loss to the stocker cattle enterprise.

Forage quality affects implant weight gain responses, with higher quality forages providing a greater response. As summarized in a stocker calf implant review, other studies in Kansas tallgrass prairie rarely find differences in steer performance between implants, but do result in increased gains above non-implanted steers (Kuhl, 1997). Nutritional quality of cool season C3 grasses is generally assumed to be greater than warm season C4 grasses, as C3 grasses have greater nonstructural carbohydrates and protein with less fiber. In a review of the literature, differences in cattle gain based on type of implant occurred more frequently in longer duration grazing studies and in cool season grasses.

Implications

Steers implanted with Revalor-G or Synovex One Grass performed the same for average daily gain and total body weight gain in an early intensive double-stocked grazing system utilized on native Flint Hills pastures.

References

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- Reinhardt, C. D., and D. U. Thomson. 2016. Growth promotant implants in suckling calves and stocker cattle: mode of action, performance response, and practical recommendations. *Bov. Pract.* 50: 40-46. doi: 10.1016/j.cvfa.2007.03.004.

Table 1. Stocker steer (n = 281) weights and gains at the start, midpoint, and end of study while grazing intensive early double-stocked native tallgrass prairie after being implanted with either Revalor-G or Synovex One Grass

Item	Revalor-G ¹	Synovex One Grass ²	Standard error of the mean	<i>P</i> - value
Season long grazing				
Initial weight (day 0), lb	554	567	6.0	0.10
Midpoint weight (day 44), lb	666	666	3.7	0.42
Final weight (day 91), lb	781	782	7.7	0.77
Average daily gain, lb	2.6	2.5	0.04	0.35
Body weight gain, lb	223	221	5.1	0.65
Gain from beginning of grazing through midpoint (day 0–44)				
Average daily gain, lb	2.5	2.6	0.10	0.45
Body weight gain, lb	106	108	3.7	0.58
Gain from midpoint through end of grazing period (day 45–91)				
Average daily gain, lb	2.6	2.5	0.10	0.47
Body weight gain, lb	119	115	3.1	0.48

¹Merck Animal Health (Madison, NJ) implant treatment.

²Zoetis, Inc. (Kalamazoo, MI) implant treatment.

Trends in “Natural” Value-Added Calf Programs at Superior Livestock Video Auction

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Abstract

The objective of this study was to determine changes in enrollment of calf lots in natural programs at Superior Livestock Video Auction over the last 9 years. The trend for all natural programs was up; however, the trend for non-hormone treated cattle was markedly up. This is likely due to the fact that non-hormone treated cattle lots were higher ($P < 0.05$) in price for 7 of the 9 years.

Introduction

The word “natural” has been used in beef marketing for many years. While the word “natural” is defined by the entities that use it in beef marketing, it most commonly means no growth-promoting implants and no antibiotics.

Superior Livestock Video Auction is a large video auction company that sells calves, feeder cattle, and breeding cattle. Consignors of calves and feeder cattle to Superior Livestock can choose from four “natural” programs that are used when raising cattle. These are:

1. Certified Natural: no hormones, antibiotics, or animal by-products.
2. Certified Natural Plus: no growth-promoting hormones/steroids, antibiotics, ionophores, beta adrenoreceptors, or animal by-products. Seller will sign additional Natural Affidavit.
3. Verified Natural Beef: process verified natural by third-party auditors, free of antibiotics, growth promotants, or any type of animal by-product.
4. Non-hormone treated cattle: U.S. Department of Agriculture approved; created in 1999 when the European Union and the U.S. agreed to control measures to facilitate the trade of non-hormone treated beef, including veal.

The objective of this study was to determine trend lines for enrollment of calf lots in natural programs.

Experimental Procedures

Information describing the number of cattle in each program and the price of lots sold through a livestock video auction service (Superior Livestock Auction, Fort Worth, TX) was obtained from the auction service in an electronic format. These data were collected for lots of beef calves offered for sale during summer sales from 2010 through 2018.

¹Merck Animal Health, Kaysville, UT.

²Grassy Ridge Consulting, Aledo, TX.

Consignors of calves to Superior Livestock Video Auction can choose from four different natural programs, or they may choose to not enroll calves in a natural program. Consignors may enroll calves in more than one natural program. The unit of study in these analyses was a lot of beef calves. For each year of data obtained for this study, a separate multiple regression model was developed using a backwards selection procedure (Kleinbaum et al., 1988) to quantify the effects of independent factors on the sale price of beef calves. The MIXED procedure of SAS (Version 9.3, SAS Institute Inc., Cary, NC) was used for the analyses. The variable of interest in this study was the program for non-hormone treated cattle.

Results and Discussion

The total number of lots in the analysis was 36,856, representing 4,419,921 calves. The trend line for natural programs is shown in Figure 1. There was an increase in the percentage of lots enrolled in one or more natural programs. Over the 9-year period, the percentage increased from 35.3 to 42.0%.

The percentage of non-hormone treated cattle lots grew from 5.2 to 23.8% over the 9-year period (Figure 2). This growth was likely fueled by the higher prices that buyers were willing to pay (Table 1). The multiple regression analysis showed significant price advantages for non-hormone treated cattle lots in 7 of the 9 years. The magnitude of this price advantage ranged from \$1.02/cwt in 2013 to \$4.04/cwt in 2014. The added-value price signal appears to have been received by consignors, thus the increase in enrolled lots.

Implications

While there are significant price advantages for 7 of the 9 years in the analysis, the price advantages may not be sufficient to offset not using a growth-promoting implant in the calves.

Table 1. Regression coefficients for the non-hormone treated cattle program for beef calves sold through Superior Livestock Auction's summer sales: 2010 through 2018

Year	Regression coefficient ^a
2010	\$2.38 ^b
2011	\$2.28 ^b
2012	\$1.03 ^b
2013	\$1.02 ^b
2014	\$4.04 ^b
2015	$P = 0.51$
2016	$P = 0.71$
2017	\$2.40 ^b
2018	\$2.30 ^b

^aRegression coefficients represent price advantages for non-hormone treated cattle program calves compared with calves not in the non-hormone treated cattle program, controlling for all other significant sources of variation.

^bRegression coefficients with a superscript are higher ($P < 0.05$) than for calves not in the non-hormone treated cattle group.

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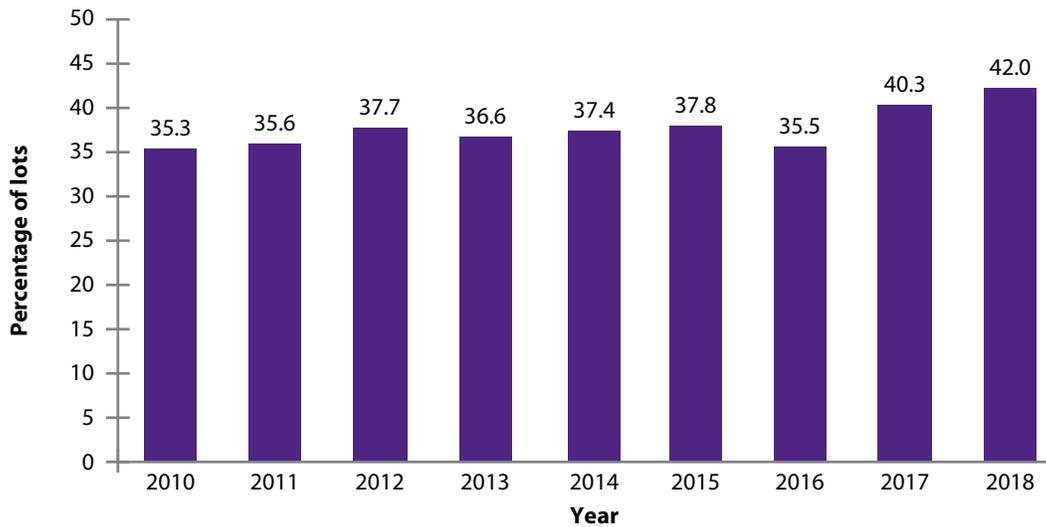


Figure 1. Percentage of lots of single-gender beef calves offered for sale in 67 summer video auctions from 2010 through 2018 that were in one or more natural programs.

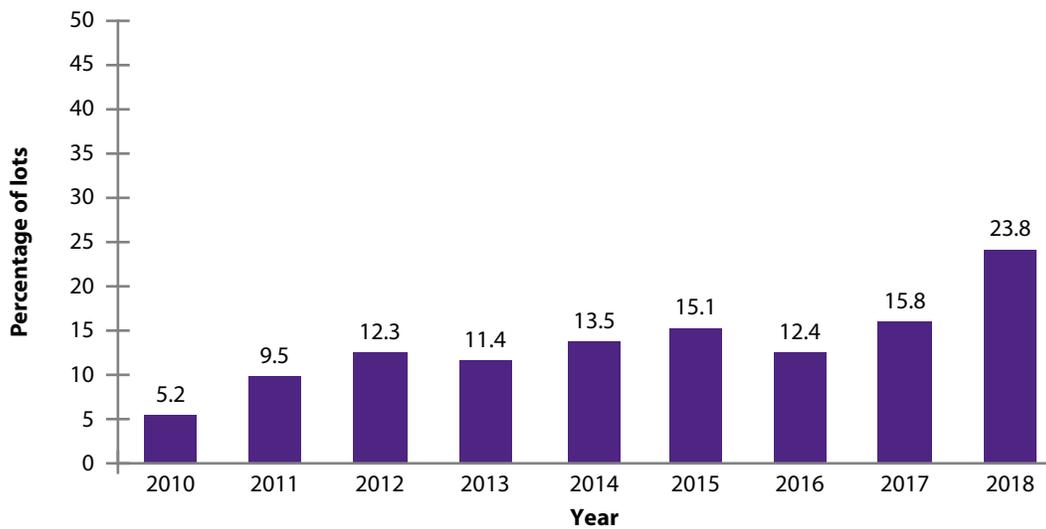


Figure 2. Percentage of lots of single-gender beef calves offered for sale in 67 summer video auctions from 2010 through 2018 that qualified for the non-hormone treated cattle program.

Syngenta Enogen Feed Corn Silage Containing an Alpha Amylase Expression Trait Improves Feed Efficiency in Growing Calf Diets

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Abstract

In 2017, a growing calf study conducted at the Kansas State University Beef Stocker Unit determined that feeding Enogen Feed corn as either dry-rolled or whole-shelled yielded a positive feed efficiency response of 5.50%. It is not known what the extent of the feed efficiency response is when the alpha amylase enzyme trait is present in either grain and/or silage. In order to determine the growing calf response to Enogen Feed corn silage when fed with Enogen Feed corn or control corn, 352 crossbred steers of Tennessee origin that were used on a previous study at the Kansas State University Beef Stocker Unit were reallocated to pens based on weight. Steers were fed a total mixed ration once daily for 90 days. The four treatment diets were formulated to provide 50 Mcal net energy for gain/100 lb. Cattle off-test weights tended to be greater for calves fed Enogen Feed corn silage. Overall, feed efficiency improved by 4.40% and average daily gain improved by 6.00% for calves fed Enogen Feed corn silage.

Introduction

Recent studies involving Enogen Feed corn, containing an alpha amylase enzyme trait, fed to finishing cattle have yielded positive outcomes in feed efficiency. Similar results were seen in a 2017 growing calf study conducted at the Kansas State University Beef Stocker Unit, which determined that feeding Enogen Feed corn as either dry-rolled or whole-shelled yielded a positive feed efficiency response of 5.50%. It is not known what the extent of the feed efficiency response is when the alpha amylase enzyme trait is present in either grain and/or silage. The objective of this study was to evaluate the performance of growing cattle when fed Enogen Feed corn silage.

Experimental Procedures

Crossbred steers of Tennessee origin ($n = 362$), averaging 656 lb, were allocated to pens based on weight. Animals were previously vaccinated for viral and clostridial diseases and treated for internal and external parasites. Thirty-two pens were used (8 for each treatment), composed of 11 animals each. Ten steers on the higher end of the weight range were removed from the research population. The remaining 352 steers were stratified by weight and randomly assigned to pens, which were randomly allocated to 1 of 4 treatments. The four treatment diets were formulated to provide 50 Mcal net energy for gain/100 lb dry matter and all were offered for ad libitum intakes. The experiment was a 2×2 factorial design with two varieties of corn silage [Enogen Feed (Syngenta) vs. control] and two varieties of dry-rolled corn (Enogen vs. control). Pen was the

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experimental unit. The steers were fed their respective diets once daily at approximately 7:00 a.m. for 90 days (Table 1). Individual animal weights were taken on days -6 (allocation), 0 (initial processing), 49 (fecal starch grab), and 91 (final weights). Fecal starch samples were obtained individually on day 49 and analyzed the same week. Pen weights were collected on days 14, 28, 42, 56, 70, 77, and 91. Feed delivery was adjusted based on daily refusals to ensure ad libitum intakes without an excess of leftover feed. Bunk and individual ingredient samples were taken weekly.

Results and Discussion

Over the entire 90-day trial, average daily gain for calves fed Enogen Feed corn silage was greater ($P < 0.01$) than for calves fed control silage (Table 2). Dry matter intake tended to be greater ($P < 0.07$) for calves fed Enogen Feed corn silage over the entire 90-day trial. This difference was especially apparent through day 42, where Enogen-fed calves consumed more ($P < 0.01$) than their control-fed counterparts. Feed efficiency was greater in calves fed Enogen Feed corn silage ($P < 0.02$). Toward the end of the study (days 77 and 90), feed efficiency was greater ($P < 0.02$) for calves fed Enogen Feed corn silage. Overall, the feed efficiency of calves receiving Enogen Feed corn was improved by 4.40%. No significant effects of corn grain type were noted over the entire 90-day trial, nor any significant interactions between corn silage type and corn grain type.

Implications

When fed in an ad libitum fashion to growing calves, Enogen Feed corn silage improves the efficiency of feed conversion by 4.40% and improves average daily gain by 6%. By day 77, this response became significant and continued throughout the remainder of the study. There were no negative observations regarding cattle health or behavior with the feeding of Enogen Feed corn silage.

Table 1. Experimental diets

Ingredient	Dry matter %
Corn ¹	38.50
Supplement	7.50
Alfalfa hay	7.00
Prairie hay	7.00
Corn silage ²	40.00
Total	100.00

Composition	100% Dry matter basis
Dry matter, %	54.60
Protein, %	12.86
Calcium, %	1.05
Phosphorus, %	0.32
Salt, %	0.40
Potassium, %	0.94
Magnesium, %	0.19
Fat, %	3.30
Acid detergent fiber, %	16.66
Net energy for maintenance, Mcal/100 lb	78.04
Net energy for gain, Mcal/100 lb	50.36

¹Corn type: Enogen Feed corn vs. control.

²Corn silage: Enogen vs. control.

Table 2. Effects of corn silage and corn source on performance

Item	Corn silage source				Standard error of the mean	P - value		
	Enogen ¹		Control			Corn	Silage	Corn × silage
	Control	Enogen ¹	Control	Enogen ¹				
Weight, lb								
Day								
0	654	655	663	659				
14	737	741	736	740	3.37	0.25	0.71	0.97
28	756	751	759	756	5.51	0.47	0.47	0.80
42	823	824	826	820	4.10	0.61	0.93	0.38
56	869	872	871	866	4.37	0.81	0.62	0.35
70	914	916	913	909	5.73	0.90	0.50	0.62
77	939	938	925	931	5.84	0.66	0.09	0.56
91	953	953	944	941	5.94	0.77	0.10	0.85

continued

Average daily gain, lb/day

Table 2. Effects of corn silage and corn source on performance

Item	Corn silage source				Standard error of the mean	P - value		
	Enogen ¹		Control			Corn	Silage	Corn × silage
	Dry-rolled corn source		Control	Enogen ¹				
	Control	Enogen ¹	Control	Enogen ¹				
Day								
0-14	5.92	6.16	5.18	5.80	0.21	0.06	0.02	0.39
0-28	3.65	3.43	3.42	3.49	0.19	0.70	0.67	0.47
0-42	4.02	4.04	3.88	3.85	0.09	0.96	0.07	0.76
0-56	3.84	3.88	3.71	3.70	0.08	0.84	0.06	0.70
0-70	3.71	3.73	3.57	3.58	0.08	0.83	0.08	0.95
0-77	3.70	3.68	3.40	3.54	0.08	0.47	0.01	0.34
0-91	3.29	3.27	3.09	3.11	0.07	0.97	0.01	0.82
Dry matter intake, lb/day								
Day								
0-14	16.86	17.25	16.88	17.54	0.25	0.04	0.53	0.60
0-28	19.10	19.71	18.89	19.30	0.43	0.25	0.48	0.83
0-42	22.19	22.14	20.22	20.93	0.40	0.42	<0.01	0.35
0-56	22.58	23.01	21.86	21.68	0.46	0.78	0.03	0.51
0-70	22.57	22.51	22.62	22.13	0.47	0.56	0.73	0.64
0-77	23.06	23.51	21.51	24.91	0.41	<0.01	0.85	<0.01
0-91	20.25	20.20	19.92	20.05	0.13	0.78	0.07	0.50
Feed-to-gain ratio, lb								
Day								
0-14	2.87	2.82	3.27	3.06	0.10	0.21	<0.01	0.42
0-28	5.38	5.92	5.56	5.61	0.32	0.37	0.84	0.45
0-42	5.53	5.51	5.22	5.45	0.12	0.41	0.14	0.31
0-56	5.89	5.97	5.89	5.87	0.15	0.85	0.74	0.74
0-70	6.09	6.05	6.34	6.19	0.12	0.47	0.12	0.64
0-77	6.26	6.41	6.32	7.04	0.14	<0.01	0.02	0.04
0-91	6.17	6.21	6.45	6.47	0.11	0.82	0.02	0.91
Gain-to-feed ratio, lb								
Day								
0-14	0.35	0.36	0.31	0.33	0.01	0.20	<0.01	0.45
0-28	0.19	0.17	0.18	0.18	0.01	0.36	0.92	0.40
0-42	0.18	0.18	0.19	0.18	<0.01	0.41	0.13	0.27
0-56	0.17	0.17	0.17	0.17	<0.01	0.91	0.76	0.93
0-70	0.16	0.17	0.16	0.16	<0.01	0.41	0.12	0.67
0-77	0.16	0.16	0.16	0.14	<0.01	0.01	0.02	0.08
0-91	0.16	0.16	0.16	0.15	<0.01	0.93	0.02	0.96

¹Syngenta.

Quality Grade Has No Effect on Top Sirloin Steaks Cooked to Multiple Degrees of Doneness

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Abstract

To evaluate the effect of cooking to multiple degrees of doneness (rare, medium, well-done) on top sirloin steak palatability, beef top sirloin butts ($n = 60$; 15/quality grade) from four U.S. Department of Agriculture quality grades [Prime, Top Choice (modest and moderate marbling), Low Choice, and Select] were selected from a Midwest beef processor. Top sirloin butts were transported to the Kansas State University Meat Laboratory, fabricated into 1-in steaks, vacuum packaged, and aged for 28 days at 39.2°F. Following aging, steaks were frozen, and then subjected to consumer sensory analysis and Warner-Bratzler shear force. No quality grade \times degree of doneness interactions ($P > 0.05$) were found for consumer ratings of palatability traits. No differences ($P > 0.05$) were observed among quality grades for consumer ratings of tenderness, flavor, and overall like. Prime top sirloin steaks had higher ($P < 0.05$) juiciness ratings than all other quality grades except for Top Choice. No differences ($P > 0.05$) were observed for juiciness ratings between Top Choice, Low Choice, and Select steaks. Additionally, steaks cooked to rare were rated higher ($P < 0.05$) than medium and well-done steaks for all palatability traits evaluated. Steaks cooked to a medium degree of doneness had higher ($P > 0.05$) ratings for all traits than well-done.

Introduction

Top sirloin steaks are one of the most popular steaks purchased due to their lower price point (Schmidt et al., 2002). Restaurants typically offer top sirloin steaks as a less expensive steak option in comparison to more expensive cuts. However, sirloin steaks have been shown to be tougher and have varying palatability characteristics. To date, there have been no studies directly evaluating top sirloin steaks of multiple quality grades cooked to various degrees of doneness. Therefore, the objective of this study was to evaluate the effect of cooking top sirloin steaks from four quality grades to multiple degrees of doneness (rare, medium, well-done).

Experimental Procedures

Beef top sirloin butts ($n = 60$; 15/quality grade; Institutional Meat Purchasing Specifications #184; North American Meat Processors, 2014) were collected from four U.S. Department of Agriculture quality grades [Prime, Top Choice (modest and moderate marbling), Low Choice, and Select]. Top sirloin butts were fabricated into 1-in steaks and randomly assigned to one of three degrees of doneness: rare (140°F), medium (160°F), or well-done (170°F). Steaks were vacuum packaged, aged for 28 days at 39.2°F, and then frozen until further analysis. Thawed steaks were cooked on a clamshell grill (Griddler Deluxe, Cuisinart, East Windsor, NJ) to one of the three preassigned degrees of doneness, with temperatures monitored using a probe thermom-

eter (Thermapen Mk4, ThermoWorks, American Fork, UT). Consumers ($n = 238$) were fed six samples representing differences in degree of doneness and quality grade. Consumers evaluated samples for tenderness, juiciness, flavor, and overall like on continuous 100 point line scales, in individual sensory booths under low intensity red incandescent lighting.

Additionally, panelists rated each evaluated trait as either unacceptable or acceptable, as well as rating each sample to one of four levels of quality: unsatisfactory, everyday quality, better than everyday quality, and premium quality. Warner-Bratzler shear force analysis was completed using the protocol described by American Meat Science Association Meat Cookery and Sensory Guidelines (AMSA, 2015). Six cores (0.5-in diameter) were taken parallel to the muscle fiber orientation and sheared perpendicular to the muscle fiber orientation using an Instron (Model 5569, Instron Corp., Canton, MA). Core measurements were averaged across all six cores per steak in pounds of peak force.

Results and Discussion

Table 1 contains least squares means for consumer palatability ratings. No quality grade \times degree of doneness interactions ($P > 0.05$) were found for consumer ratings of palatability traits. For quality grade, no differences ($P > 0.05$) were observed for consumer ratings of tenderness, flavor, and overall like; however, there was a significant effect ($P = 0.02$) on juiciness. Prime top sirloin steaks had higher ($P < 0.05$) juiciness ratings than all other quality grades except for Top Choice. Additionally, there were no differences ($P > 0.05$) in juiciness ratings among Top Choice, Low Choice, and Select steaks. For degree of doneness, steaks cooked to rare were rated higher ($P < 0.05$) than medium and well-done steaks for all palatability traits evaluated. Steaks cooked to a medium degree of doneness had higher ($P > 0.05$) ratings than well-done steaks.

No quality grade \times degree of doneness interactions ($P > 0.05$) were observed for the percentage of top sirloin steaks rated acceptable for tenderness, juiciness, flavor, and overall like (Table 2). There were no differences ($P > 0.05$) among quality treatments for the percentage of steaks rated acceptable for all palatability traits evaluated. Consistent with consumer ratings, rare samples had the greatest ($P < 0.05$) percentage of steaks rated acceptable for all palatability traits, followed by medium steaks having a higher ($P < 0.05$) percentage of samples rated acceptable than well-done steaks.

No ($P > 0.05$) quality grade \times degree of doneness interactions or quality grade effects were found for the percentage of steaks perceived at quality levels of unsatisfactory, better than everyday quality, and premium quality (data not shown). For degree of doneness, steaks cooked to rare had a higher ($P < 0.05$) percentage of steaks rated as better than everyday quality and premium quality compared to medium and well-done steaks. Conversely, the percentage of well-done steaks identified as unsatisfactory was greater ($P < 0.05$) than medium and rare steaks. There was a quality grade \times degree of doneness interaction ($P < 0.05$) for the percentage of steaks perceived as everyday quality. When cooked to a medium degree of doneness, Low Choice and Select steaks were perceived as everyday quality more often ($P < 0.05$) than Top Choice steaks, but were not different ($P > 0.05$) than Prime steaks. However, steaks cooked to rare and

well-done showed no differences ($P > 0.05$) among quality grades for the percentage of samples identified as everyday quality.

There were no quality grade \times degree of doneness interactions ($P > 0.05$) for Warner-Bratzler shear force (data not shown). Prime steaks had a lower ($P < 0.05$) Warner-Bratzler shear force value than Low Choice and Select steaks, but were similar ($P > 0.05$) to Top Choice steaks. Additionally, Top Choice, Low Choice, and Select steaks were all similar ($P > 0.05$) in Warner-Bratzler shear force values. For degree of doneness, rare steaks had the lowest ($P < 0.05$) Warner-Bratzler shear force value. Steaks cooked to a medium degree of doneness had higher ($P < 0.05$) Warner-Bratzler shear force values than well-done steaks.

Implications

These results indicate that quality grade has no effect on the eating quality of top sirloin steaks. Therefore, it is unnecessary for consumers, retailers, and foodservices to pay premium prices for higher quality top sirloin steaks, regardless of the degree of doneness they will be cooked to.

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Table 1. Least squares means for consumer (n = 238) ratings¹ of the palatability traits of four quality grades cooked to three degrees of doneness

Treatment	Juiciness	Tenderness	Flavor	Overall like
Quality grade				
Prime	63.3 ^a	60.5	59.7	60.3
Top Choice ²	61.5 ^{ab}	60.5	55.7	58.2
Low Choice	57.7 ^b	59.9	55.1	56.5
Select	56.5 ^b	56.6	54.1	54.3
SEM ³	2.0	2.0	1.9	2.1
<i>P</i> – value	0.02	0.41	0.09	0.16
Degree of doneness				
Rare (140°F)	75.8 ^a	71.6 ^a	63.8 ^a	67.3 ^a
Medium (160°F)	58.3 ^b	57.8 ^b	56.2 ^b	56.2 ^b
Well-done (170°F)	45.4 ^c	48.8 ^c	48.5 ^c	48.5 ^c
SEM ³	1.7	1.5	1.7	1.7
<i>P</i> – value	< 0.01	< 0.01	< 0.01	< 0.01
Quality grade × degree of doneness				
<i>P</i> – value	0.78	0.99	0.96	0.94

^{abc}Least squares means within the same main effect (quality grade or degree of doneness) without a common superscript differ ($P < 0.05$).

¹Sensory scores: 0 = extremely dry/tough/dislike; 50 = neither dry nor juicy, neither tough nor tender, neither like nor dislike; 100 = extremely juicy/tender/like extremely.

²U.S. Department of Agriculture marbling score of modest⁰⁰ - moderate¹⁰⁰.

³SEM (largest) = standard error of the least squares means.

Table 2. Percentage of top sirloin steaks of four quality grades cooked to three degrees of doneness rated as acceptable for juiciness, tenderness, flavor, and overall liking by consumers (n = 238)

Treatment	Juiciness	Tenderness	Flavor	Overall like
Quality grade				
Prime	90.5	88.4	83.1	87.2
Top Choice ¹	87.1	86.2	77.7	80.0
Low Choice	87.5	88.2	80.1	84.0
Select	80.5	86.0	75.9	78.8
SEM ²	3.5	2.7	3.4	3.2
<i>P</i> – value	0.10	0.85	0.38	0.14
Degree of doneness				
Rare (140°F)	96.1 ^a	94.5 ^a	86.5 ^a	91.1 ^a
Medium (160°F)	83.9 ^b	83.8 ^b	78.3 ^b	80.5 ^b
Well-done (170°F)	68.8 ^c	78.1 ^c	71.0 ^c	72.4 ^c
SEM ²	2.8	2.3	2.5	2.5
<i>P</i> – value	< 0.01	< 0.01	< 0.01	< 0.01
Quality grade × degree of doneness				
<i>P</i> – value	0.50	0.55	0.05	0.75

^{abc}Least squares means within the same main effect (quality grade or degree of doneness) without a common superscript differ ($P < 0.05$).

¹U.S. Department of Agriculture marbling score of modest⁰⁰ - moderate¹⁰⁰.

²SEM (largest) = Standard error of the least squares means.

Effect of Degree of Doneness, Quality Grade, and Time on Instrumental Color Readings from Beef Strip Loin Steaks Cooked to Six Degrees of Doneness

L.L. Prill, L.N. Drey, J.L. Vipham, M.D. Chao, J.M. Gonzalez, T.A. Houser, E.A.E. Boyle, and T.G. O'Quinn

Abstract

The effect of quality grade and time after cooking on the instrumental color of beef steaks cooked to varying degrees of doneness was determined using 24 beef strip loins from 12 animals representing five quality treatments [Prime, Top Choice (Modest⁰⁰ – Moderate¹⁰⁰ marbling), Low Choice, Select, Select Enhanced (108%)]. Each steak was cooked to a peak internal temperature of very-rare (130°F), rare (140°F), medium-rare (145°F), medium (160°F), well-done (170°F), or very well-done (180°F). Each cooked steak was cut in half, perpendicular to the long axis of the steak, and lightness (L*), redness (a*), and yellowness (b*) were evaluated on the internal face of the medial side at 0, 1, 2, 3, 6, 9, and 12 minutes post-cutting. There was an interaction ($P < 0.05$) between quality treatment and time for L* values. There was no difference ($P > 0.05$) among quality treatments for L* value at any time point, except at 12 minutes where Top Choice samples were lighter ($P < 0.05$) than Select Enhanced samples. Additionally, there was an interaction ($P < 0.05$) between time and degree of doneness for L*, a*, and b*. The impact of time on cooked color was dependent on degree of doneness, with steaks cooked to lower degrees of doneness becoming lighter and more red in color with time and steaks cooked to higher degrees of doneness becoming darker. Quality grade had no impact ($P > 0.05$) on cooked color measures of non-enhanced samples.

Introduction

An increase in internal temperature results in greater myoglobin denaturation and a subsequent cooked-brown color. Previous research has demonstrated cooked color has a large impact on consumer perception. Therefore, the objective of this study was to determine the effect of quality grade and time after cooking on the instrumental color of steaks cooked to varying degrees of doneness.

Experimental Procedures

Beef strip loins [n = 24, Institutional Meat Purchase Specifications #180; North American Meat Institute (2014)] from 12 animals representing five quality treatments [Prime, Top Choice (Modest⁰⁰ – Moderate¹⁰⁰ marbling), Low Choice, Select, Select Enhanced (108%)] were collected from a Midwest beef processor and transported to the Kansas State University Meat Laboratory. Select Enhanced loins were enhanced with a solution of water, salt, and alkaline phosphate to 108% of raw weight. Sub-primals were cut into 1-in thick steaks and aged 21 days. Steaks were assigned to a degree of doneness so that each animal would be represented by a single steak within each degree of doneness. Steaks were stored at -40°F and thawed at 36–39°F for 24 hours

prior to cooking. Each steak was cooked to a peak internal temperature of very-rare (130°F), rare (140°F), medium-rare (145°F), medium (160°F), well-done (170°F), or very well-done (180°F) on electric clamshell grills [Griddler; Cuisinart, Stamford, CT; NCBA (2008); AMSA (2015)]. Cooked steaks were rested for three minutes, then cut in half, perpendicular to the long axis of the steak. Color was immediately measured on the internal face of the medial side for lightness (L^*), redness (a^*), and yellowness (b^*) using a Hunter Lab Miniscan spectrophotometer (Illuminant A, 2.54-cm aperture, 10° observer; Hunter Associates Laboratory, Reston, VA) at three locations and averaged. Instrumental color was also evaluated at 1, 2, 3, 6, 9, and 12 minutes post-cutting. Statistical analysis was conducted in SAS (Version 9.4, SAS Inst. Inc., Cary, NC) using PROC GLIMMIX with $\alpha = 0.05$. Data were analyzed as a split-split-plot design with quality treatment as the whole plot factor, degree of doneness as the subplot factor, and post-cut time as a repeated sub-subplot measure.

Results and Discussion

There was an interaction for L^* ($P < 0.05$) between quality treatment and time (Table 1) due to Top Choice samples being lighter ($P < 0.05$) than Select Enhanced samples at 12 minutes. There were no other differences ($P > 0.05$) among any of the other quality treatments for L^* value at any other time point. Additionally, there was an interaction ($P < 0.05$) between time and degree of doneness for L^* , a^* , and b^* . Within very-rare, rare, and medium-rare steaks, internal color lightened ($P < 0.05$) from time 0 to 2 or 3 minutes (Figure 1), while the internal color of well-done and very well-done steaks darkened ($P < 0.05$) from time 0 to 2 minutes. The internal color of very-rare, rare, medium-rare, and medium steaks became more red ($P < 0.05$) over time (Figure 2). However, time had only a minimal impact on redness changes in well-done and very well-done steaks. Steak internal yellowness values increased ($P < 0.05$) within each degree of doneness. However, these changes were more prevalent at lower degrees of doneness, with increased ($P < 0.05$) yellowness values at each successive time point within very-rare steaks, but no change ($P > 0.05$) in yellowness from 6 to 12 minutes for well-done and very well-done steaks (Figure 3). Quality treatment had an effect on redness ($P < 0.05$), with Select Enhanced steaks being less red than all treatments except Prime steaks (Table 2). Select Enhanced steaks were less yellow ($P < 0.05$) than all other quality treatments.

Implications

The impact of time on internal cooked color was dependent on degree of doneness, with steaks cooked to lower degrees of doneness becoming lighter and more red in color with time and steaks cooked to higher degrees of doneness becoming darker. Additionally, quality treatment had no impact on cooked color measures of non-enhanced steaks. These results provide insight into cooked beef color changes related to time and how this might impact degree of doneness perceptions by consumers.

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Table 1. Least squares means for the interaction ($P = 0.02$) between quality treatment and time on L^{*1} of beef steaks from five quality grades

Bloom time, minutes	Quality treatment				
	Select Enhanced ²	Select	Low Choice	Top Choice	Prime
0	50.80	50.40	50.81	51.35	51.12
1	51.02	51.03	51.33	51.74	51.46
2	50.84	51.16	51.37	52.00	51.69
3	51.08	51.64	51.62	52.25	51.75
6	51.05	51.50	51.66	52.31	51.70
9	50.75	51.44	51.26	52.05	51.58
12	50.40 ^b	51.34 ^{ab}	51.30 ^{ab}	52.13 ^a	51.75 ^{ab}
Standard error	0.58	0.59	0.61	0.61	0.58
P – value	0.02	0.02	0.02	0.02	0.02

^{ab}Within a row, means without a common superscript differ ($P < 0.05$).

¹ L^* : 0 = black, 100 = white.

²Enhanced to 108% of raw weight with water, salt, and alkaline phosphate solution.

Table 2. Effect of quality grade on a^* and b^* instrumental color of beef steaks

Quality treatment	Instrumental color	
	a^*1	b^*2
Select Enhanced ³	19.05 ^b	17.61 ^b
Select	20.47 ^a	19.24 ^a
Low Choice	20.50 ^a	19.39 ^a
Top Choice	20.06 ^a	19.26 ^a
Prime	19.82 ^{ab}	19.30 ^a
Standard error	0.35	0.21
P – value	0.02	< 0.01

^{ab}Within a column, means without a common superscript differ ($P < 0.05$).

¹ a^* : -60 = green, 60 = red.

² b^* : -60 = blue, 60 = yellow.

³Enhanced to 108% of raw weight with water, salt, and alkaline phosphate solution.

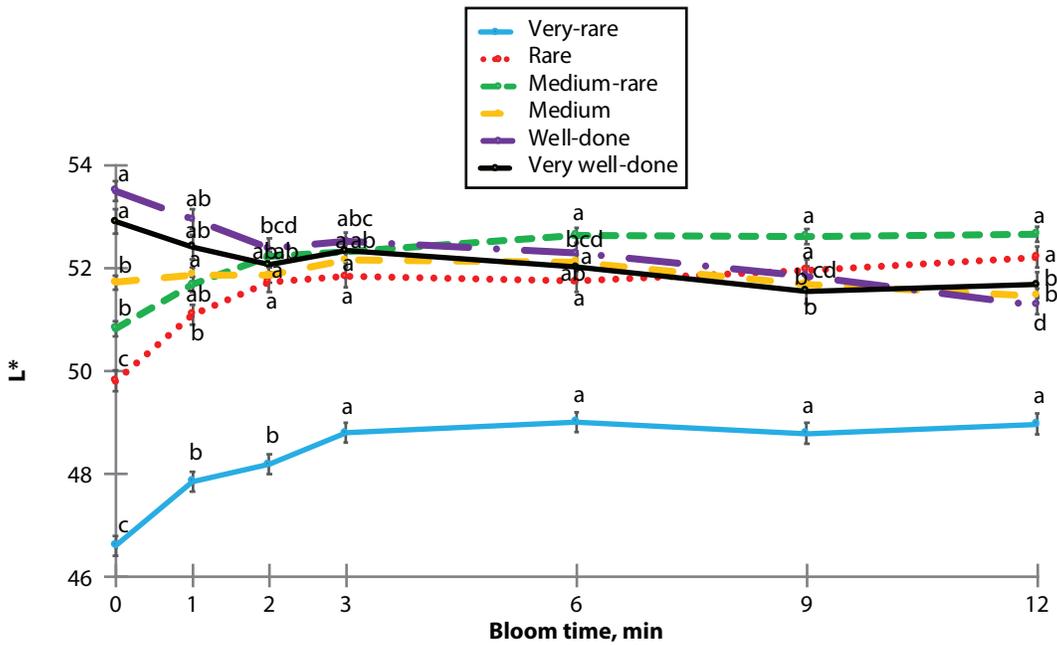


Figure 1. Least squares means for the interaction ($P < 0.01$) between time and degree of doneness on L*¹ color readings of beef steaks.

¹0 = black, 100 = white.

^{abcd}Means within a degree of doneness without a common superscript differ ($P < 0.05$).

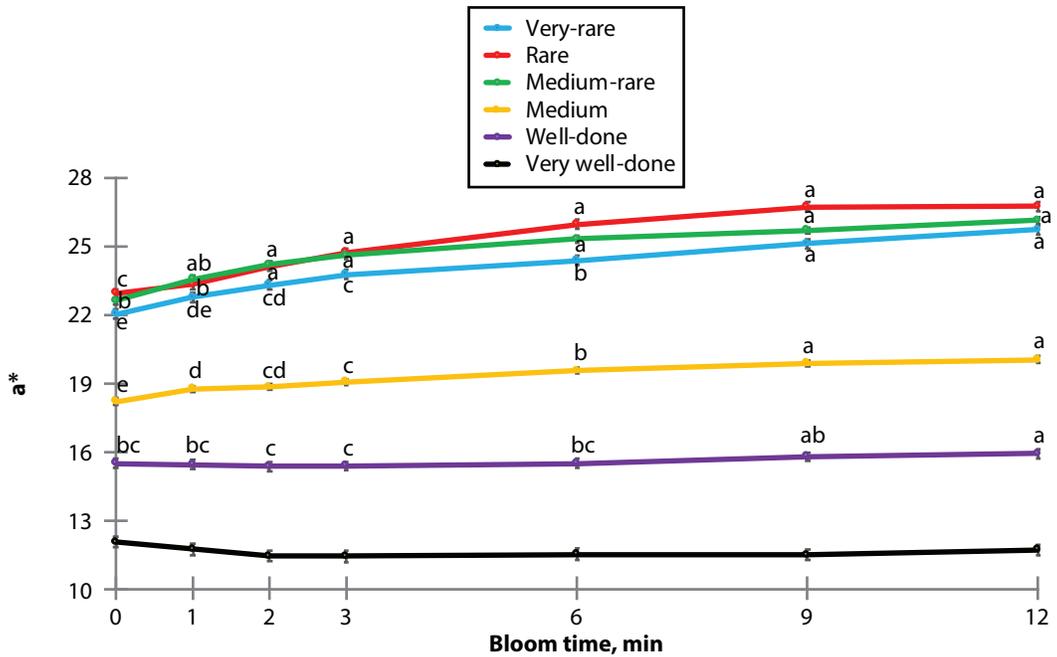


Figure 2. Least squares means for the interaction ($P < 0.01$) between time and degree of doneness on a*¹ color readings of beef steaks.

¹60 = green, 60 = red.

^{abcde}Means within a degree of doneness without a common superscript differ ($P < 0.05$).

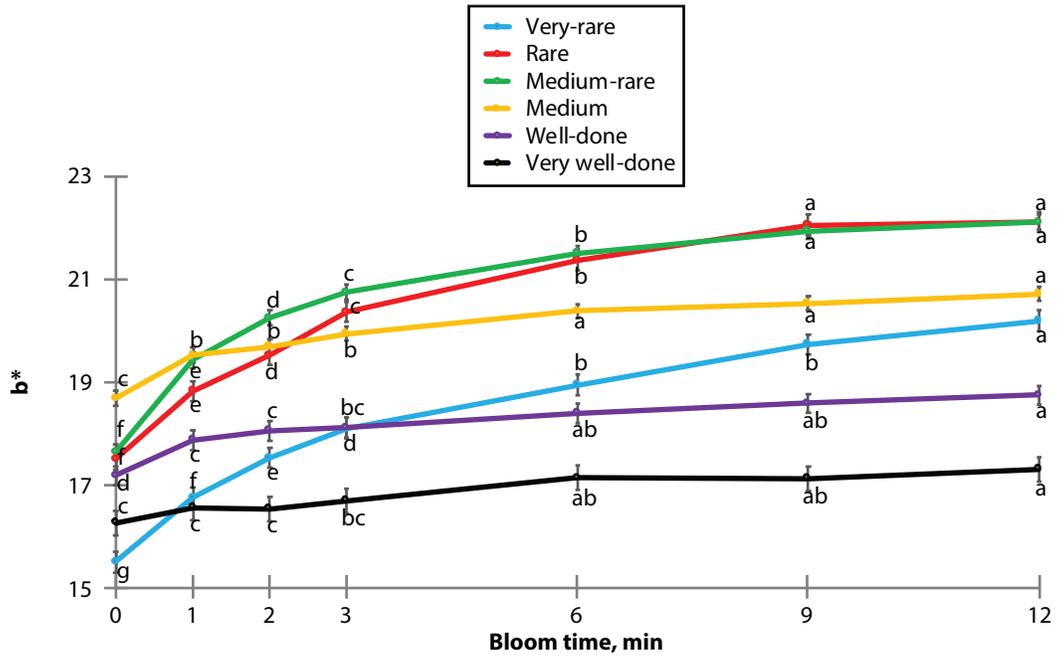


Figure 3. Least squares means for the interaction ($P < 0.01$) between time and degree of doneness on b^{*1} color readings of beef steaks.

¹-60 = blue, 60 = yellow.

^{abcdefg}Means within a degree of doneness without a common superscript differ ($P < 0.05$).

Chef Evaluation of the Degree of Doneness of Beef Strip Loin Steaks Cooked to Six End-Point Temperatures

L.L. Prill, L.N. Drey, J.L. Vipham, M.D. Chao, J.M. Gonzalez, T.A. Houser, E.A.E. Boyle, and T.G. O'Quinn

Abstract

Foodservice steak preparation practices and chefs' abilities to identify degrees of doneness were assessed. Beef strip loins ($n = 24$) were collected from 12 animals representing five quality treatments (Prime, Top Choice, Low Choice, Select, and Select Enhanced). Steaks were cooked to an end-point temperature of very rare (130°F), rare (140°F), medium-rare (145°F), medium (160°F), well-done (170°F), or very well-done (180°F). Each cooked steak was cut in half, perpendicular to the long axis of the steak, and photographs were taken immediately of the internal face of the lateral side. A digital survey was developed for chefs to evaluate the cooked steak images. Chefs were recruited via email from around the U.S. using an established database of chefs from all segments of the industry. Of the 83 respondents, 66% of chefs reported using feel or firmness for degree of doneness determination, whereas 28% stated they use a thermometer. The degree of doneness for which a steak was cooked was correctly categorized by 13.6 to 44.2% of chefs. Chefs did not report they use end-point temperatures consistent with currently published recommendations. Additionally, chefs commonly rated steaks one degree of doneness above the degree of doneness category commonly associated with the end-point temperature.

Introduction

Previous literature has defined the importance of degree of doneness on consumer palatability ratings (Lorenzen et al., 2005; Lucherker et al., 2016). Preparation of steaks by foodservice chefs provides a critical link between the beef industry and consumers. To our knowledge, little published research exists evaluating chefs' cooking methods and thermometer use to assess degree of doneness of cooked beef steaks. The objective of this study was to assess foodservice steak preparation practices and chefs' abilities to identify degrees of doneness.

Experimental Procedures

Beef strip loins [$n = 24$, Institutional Meat Purchasing Specifications #180; (North American Meat Institute, 2014)] from 12 animals representing four quality grades [Prime, Top Choice (Modest⁰⁰–Moderate¹⁰⁰ marbling), Low Choice (Small⁰⁰–Small¹⁰⁰ marbling), and Select] were collected from a Midwest beef processor and transported to the Kansas State University Meat Laboratory. Strip loins from an additional 12 Select grade animals were collected and designated for enhancement with water, salt, and alkaline phosphate to 108% of raw weight. Procedures described by Drey (2018) were used for sub-primal fabrication, enhancement, and steak allocation. All steaks were vacuum packaged and stored at -40°F until further analysis.

Steaks were cooked on clam-style grills (Griddler; Cuisinart, Stamford, CT) set to a surface temperature of 350°F. A probe thermometer (Super-Fast Thermopen, ThermoWorks, American Fork, UT) was inserted into the geometric center of each steak and remained in place during the cooking process. Steaks were removed following cooking so that the peak end-point temperature was very-rare (130°F), rare (140°F), medium-rare (145°F), medium (160°F), well-done (170°F), or very well-done (180°F) (NCBA, 2008; American Meat Science Association, 2015). Steaks rested for 3 minutes before being cut for evaluation. Cooked steaks were cut in half, perpendicular to the long axis of the steak, and photographs ($n = 357$; Figure 1) were taken immediately using a digital camera (Canon PowerShot SX620 HS) of the internal face of the lateral side. A digital survey (Qualtrics Software, Provo, UT) for chefs was made for the electronic evaluation of the cooked steak images. The survey included questions on demographics, determination on the degree of doneness, how temperature is measured, and what consumers typically order. Additionally, chefs were asked to assess the degree of doneness of 30 digital images representing multiple degrees of doneness. Chefs ($n = 83$) were recruited via email from around the U.S. using an established database of chefs from all segments of the industry. Statistical analysis was conducted in SAS (Version 9.4, SAS Inst. Inc., Cary, NC) using PROC GLIMMIX with $\alpha = 0.05$. Data were analyzed using a completely randomized design.

Results and Discussion

Survey results showed that the chefs who responded to the survey were evenly dispersed across the U.S. When chefs were asked what type of establishment they associated with, 18.1% were in independent restaurants, 13.3% in casual dining, 13.3% with distributors, and 12.1% with fine dining. Of the 83 chefs respondents, 60% reported their education as formal culinary school, while 25% was informal, on the job training. Additionally, 69% reported most commonly working with a Premium Choice beef product.

To assess steak degree of doneness, 66% of chefs reported using feel or firmness (Figure 2), whereas 28% stated they use a thermometer. Within the chefs that reported use of thermometers, 14.5% indicated the specific temperature they used was pull-off the heat temperature and 13.3% used carry-over cooking temperature. Of the chefs that reported using carry-over temperature, 63.6% used a temperature of less than 120°F for rare, whereas 36.4% of chefs that reported pull-off temperatures described rare being less than 120°F. Of the chefs using carry-over temperature, 54.6% reported a well-done steak corresponded to a final temperature of 156 to 160°F. Additionally, only 1% of chefs reported determining degree of doneness using color.

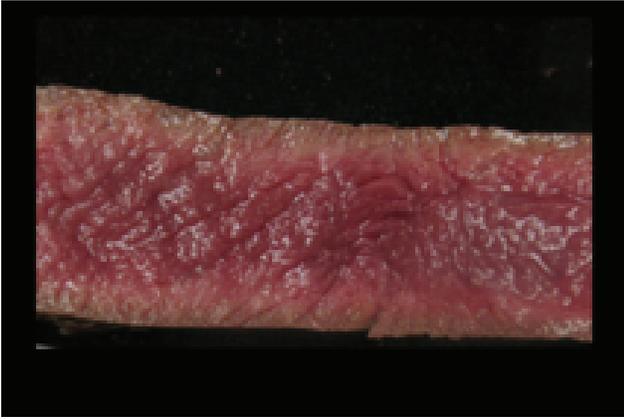
There were no quality treatment effects ($P > 0.05$) for any degrees of doneness for the images evaluated. Between 13.6 and 44.2% of chefs correctly categorized steak images for the degree of doneness to which it was cooked (Figure 3). For all degrees of doneness, 9.0 to 47.5% of chefs classified the steak images as two or more degrees of doneness from what the steak was actually cooked. Previously, Lehmuller and Hunt (2000) reported that chefs had difficulty correctly identifying steaks cooked to a medium degree of doneness, commonly identifying them as underdone; however, in our study, a greater ($P < 0.05$) number of chefs classified steaks cooked to rare as medium-rare and steaks cooked to medium as medium-well.

Implications

Chefs do not consistently use the same method when determining degrees of doneness and are unable to consistently or accurately identify degrees of doneness of steaks cooked to specified end-point temperatures. This can create challenges for foodservice establishments to deliver consumer degree of doneness preferences.

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Very rare 130°F



Medium 160°F



Rare 140°F



Well-done 170°F



Medium-rare 145°F



Very well-done 180°F

Figure 1. Beef steak degree of doneness.

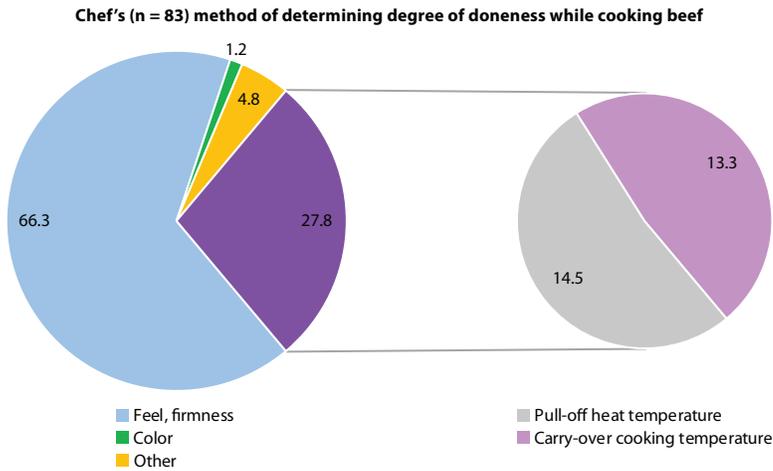


Figure 2. Percentage of chefs that use certain methods of determining degree of doneness while cooking beef.

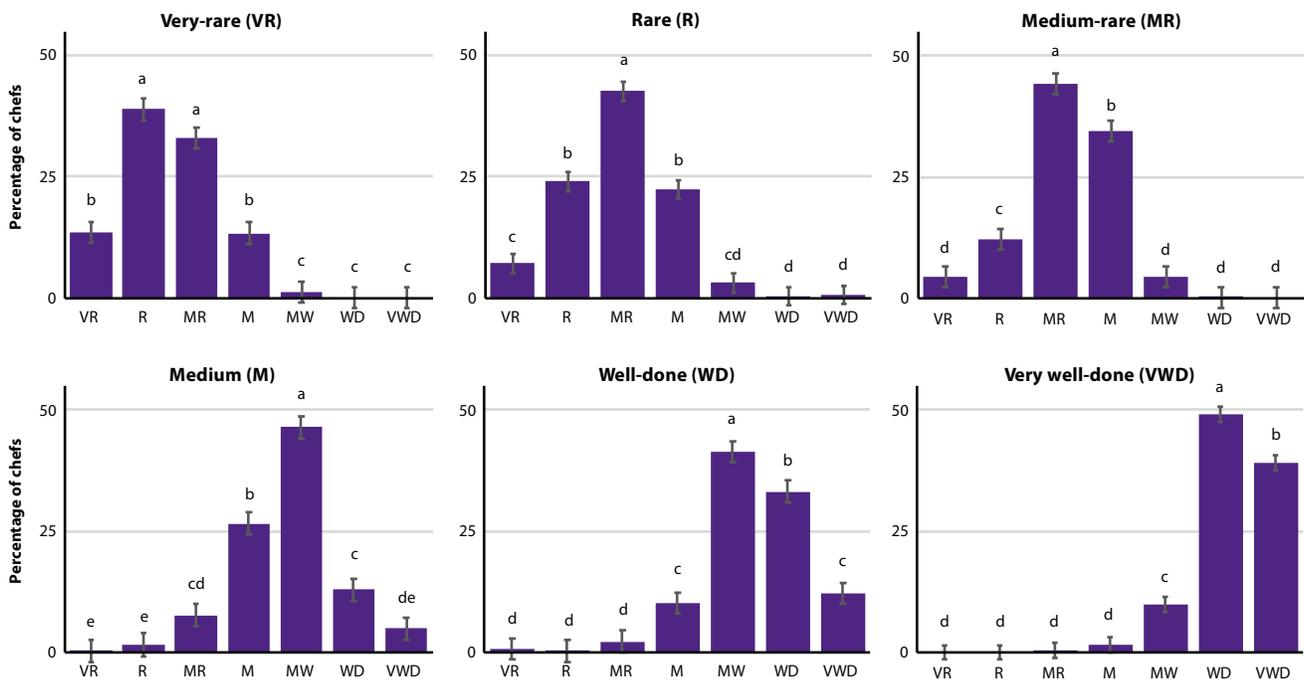


Figure 3. Percentage of chefs that correctly identified the represented degree of doneness on photographs of cooked beef strip loin steaks.

Consumer Evaluation of the Degree of Doneness of Beef Strip Loin Steaks Cooked to Six End-Point Temperatures

L.L. Prill, L.N. Drey, J.L. Vipham, M.D. Chao, J.M. Gonzalez, T.A. Houser, E.A.E. Boyle, and T.G. O'Quinn

Abstract

The objective of this study was to assess consumers' degree of doneness practices in addition to their ability to identify beef steak degrees of doneness. Beef strip loins ($n = 24$) were collected from 12 animals representing five quality treatments [Prime, Top Choice, Low Choice, Select, and Select Enhanced (108%)]. Steaks were cooked to an end-point temperature of very-rare (130°F), rare (140°F), medium-rare (145°F), medium (160°F), well-done (170°F), or very well-done (180°F). Each cooked steak was cut in half, perpendicular to the long axis of the steak, and photographs were taken immediately of the internal face of the lateral side. A digital survey was developed for consumers to evaluate the cooked steak images. Of the 1,134 respondents, 27.3 to 35.1% of consumers correctly categorized steaks for the appropriate degree of doneness. Medium-rare was reported by 41% of consumers as their preferred degree of doneness and only 16% of consumers reported using temperature or a food thermometer for determining degree of doneness when cooking beef. Consumers do not have a good understanding of beef degrees of doneness, and are unable to consistently and accurately identify degrees of doneness of steaks cooked to specified end-point temperatures.

Introduction

Degree of doneness is important to achieving optimal palatability of beef (Lorenzen et al., 1999; Lucherker et al., 2016). Additionally, consumers' perception of the degree of doneness of the steak they are served can influence eating satisfaction (Cox et al., 1997; Schmidt et al., 2002). The objective of this study was to assess consumers' degree of doneness cooking practices in addition to their ability to identify steak degrees of doneness.

Experimental Procedures

Beef strip loins [$n = 24$, Institutional Meat Purchasing Specifications #180; (North American Meat Institute, 2014)] from 12 animals representing four quality grades [Prime, Top Choice (Modest⁰⁰ – Moderate¹⁰⁰ marbling), Low Choice (Small⁰⁰ – Small¹⁰⁰ marbling), and Select] were collected from a Midwest beef processor and transported to the Kansas State University Meat Laboratory. Additional Select loins were collected and designated for enhancement with water, salt, and alkaline phosphate to 108% of raw weight. Procedures described by Drey (2018) were used for sub-primal fabrication, enhancement, and steak allocation. All steaks were vacuum packaged and stored at -40°F until further analysis.

Steaks were cooked on clam-style grills (Griddler; Cuisinart, Stamford, CT) set to a surface temperature of 350°F. A probe thermometer (Super-Fast Thermopen; Ther-

moWorks, American Fork, UT) was inserted into the geometric center of each steak and remained in place during the cooking process. Steaks were removed following cooking so that the peak end-point temperature was very-rare (130°F), rare (140°F), medium-rare (145°F), medium (160°F), well-done (170°F), or very well-done (180°F) (NCBA, 2008; American Meat Science Association, 2015). Cooked steaks were cut in half, perpendicular to the long axis of the steak, and photographs ($n = 357$) were taken immediately using a digital camera (Canon PowerShot SX620 HS) of the internal face of the lateral side. A digital survey for consumers was developed for electronic evaluation (Qualtrics Software, Provo, UT). Consumers ($n = 1,134$) answered a demographics questionnaire, followed by questions pertaining to temperature and determining degree of doneness. Finally, 10 steak images depicting six degrees of doneness were randomly selected by Qualtrics Software for each consumer to identify the degree of doneness of the steak pictured. Statistical analysis was conducted in SAS (Version 9.4, SAS Inst. Inc., Cary, NC) using PROC GLIMMIX with $\alpha = 0.05$. Data were analyzed using a completely randomized design.

Results and Discussion

There were no quality treatment effects ($P > 0.11$) for any degree of doneness of the pictures evaluated. Of the 1,134 respondents, 27.3 to 35.1% of consumers correctly categorized steaks as the appropriate degree of doneness (Figure 1). For all degrees of doneness, 16.4 to 35.6% of consumers identified steaks as two or more degrees of doneness higher or lower than the actual degree of doneness shown in the picture.

Medium-rare was identified as the preferred degree of doneness for beef steaks by 41% of consumers, followed by 23% preferring steaks cooked to medium (Figure 2). Previous studies found 61 to 70% of consumers preferred beef steaks cooked to at least a medium degree of doneness (Branson et al., 1986; Schmidt et al., 2002; Reicks et al., 2011). Our study found when in a restaurant setting, 59.9% of consumers determined degree of doneness after the first cut into the steak, while 18.7% of consumers determined the degree of doneness on the first bite (Figure 3).

When consumers were asked how they determined degree of doneness when cooking beef at home, 54% reported they used color, 15.7% used feel or firmness, and 10.4% used time (Figure 4). Additionally, 2.5% of consumers responded that they do not determine degree of doneness and 1.6% had another response. Responses for the other category included luck, juice, and fat texture.

Only 16% of consumers reported using temperature or a food thermometer for accurately determining the degree of doneness when cooking beef. As a follow-up question to those consumers that reported using temperature or a thermometer, 69% conveyed that the temperature they use is correlated to the temperature when a steak is pulled off the heat. The remaining 31% said the temperature correlates to post-cooking temperature rise or carry-over cooking. Of the consumers that stated they use a carry-over temperature, 61% then reported that they did not know the temperatures that corresponded with each degree of doneness. For carry-over cooking temperatures, 40.8% of consumers reported using 136 to 145°F to correspond to a rare degree of doneness, while 20% reported that 166 to 175°F corresponded to a well-done degree of doneness. Likewise, within consumers that stated they relied on pull-off the heat temperatures,

47.6% were unaware of specific temperatures. Of the consumers that reported a temperature, 27.6% reported using a temperature less than 120°F to correspond to a rare degree of doneness, while 51.5% reported using 156 to 165°F to determine well-done pull-off temperature.

Implications

Consumers do not have a good understanding of beef degrees of doneness, and are unable to consistently and accurately identify degrees of doneness of steaks cooked to specified end-point temperatures. This can create challenges when consumers communicate their degree of doneness preferences at foodservice establishments.

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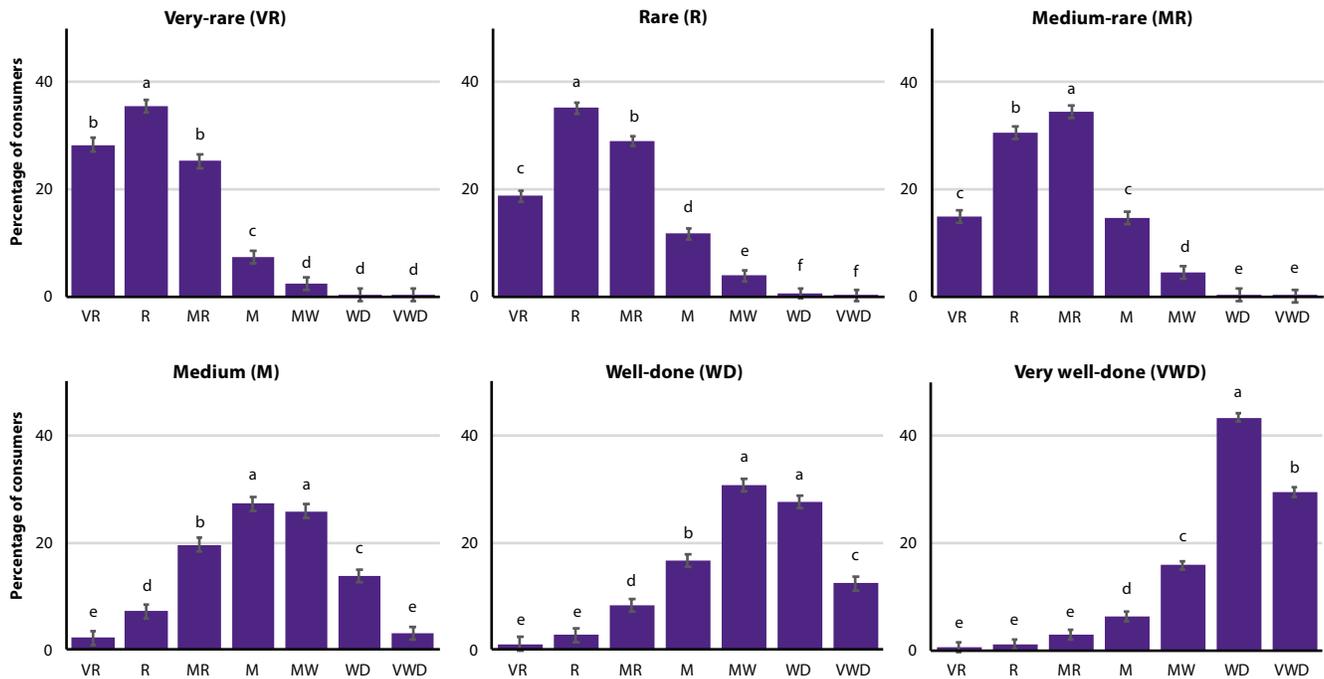


Figure 1. Percentage of consumers that correctly identified the represented degree of doneness on photographs of cooked beef strip loin steaks.

^{abcde}Means within a degree of doneness without a common superscript differ ($P < 0.05$).

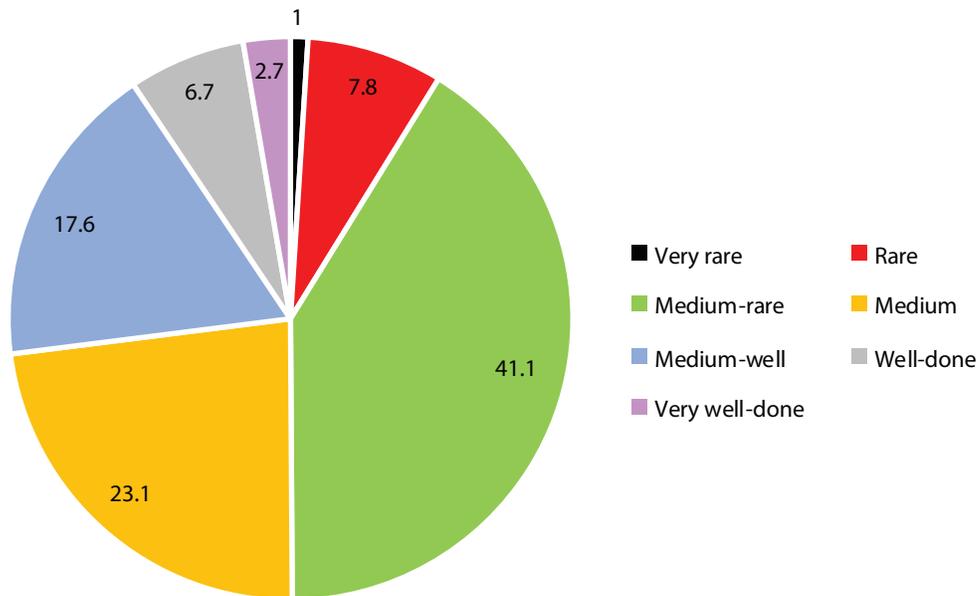


Figure 2. Consumers' (n = 1,134) preferred degree of doneness of beef steaks.

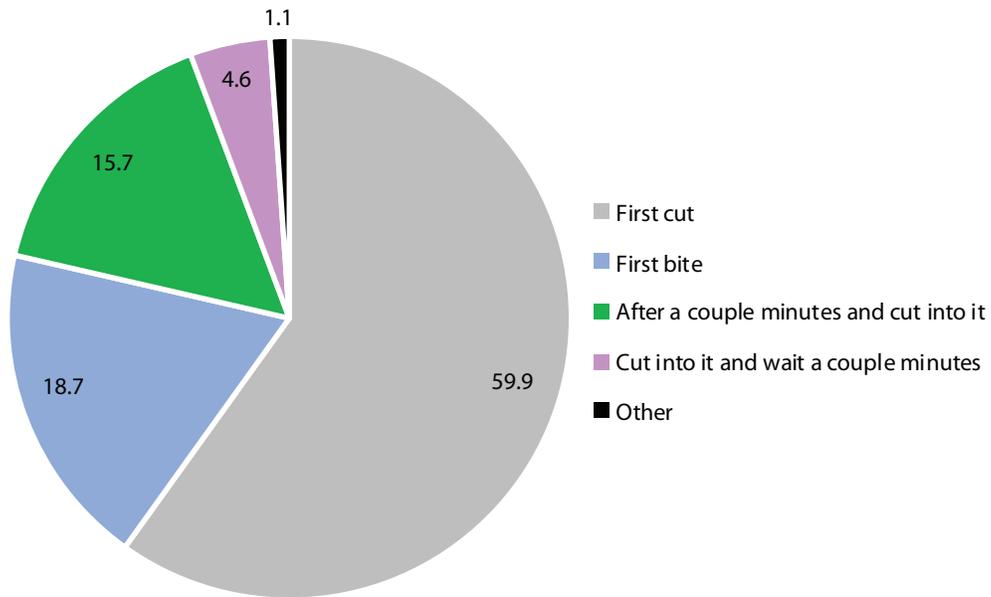


Figure 3. Consumers' (n = 1,134) method of determining degree of doneness of beef steaks in a restaurant.

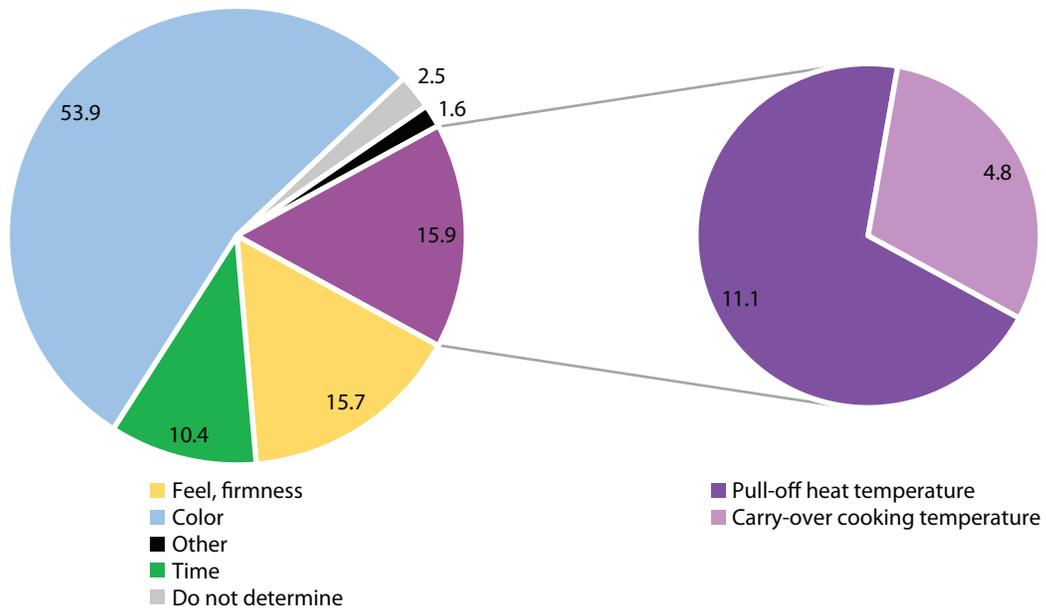


Figure 4. Consumers' (n = 1,134) method of determining degree of doneness while cooking beef.

Visual Degree of Doneness Has an Impact on Palatability Ratings of Consumers Who Had Differing Degree of Doneness Preferences

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Abstract

The objective of this study was to determine how beef palatability ratings are impacted by consumer degree of doneness preference. Paired Low Choice (Small⁰⁰ to Small¹⁰⁰ marbling) frozen steaks used were from the posterior half of strip loins. Each pair of steaks were randomly assigned a degree of doneness of rare (140°F), medium-rare (145°F), medium (160°F), medium-well (165°F), or well-done (170°F). Consumer panelists were prescreened to participate in panels based on their degree of doneness preference for rare, medium, or well-done steaks. Steak samples were served in two rounds. In the first round, consumers were served one sample from each of the five degrees of doneness, in random order, under low-intensity red incandescent lighting to mask any degree of doneness differences among samples. Round two testing procedures were identical to round one, except consumers were served under white incandescent lights, with white fluorescent background lighting turned on. There were no consumer preference × steak degree of doneness interactions ($P > 0.05$) or consumer preference effects for tenderness, juiciness, and flavor when steaks were evaluated under both lighting types. Within the white-lighting test, the consumer preference × degree of doneness interaction for overall liking was marginally significant ($P = 0.078$). When steaks were overcooked, palatability ratings decreased; however, undercooking had a positive effect on palatability perception, regardless of the consumer's degree of doneness preference.

Introduction

Consumers typically visually appraise beef steaks to determine degree of doneness, primarily using internal cooked color. To our knowledge, no study has extensively evaluated the impact of serving consumers steaks cooked to a degree of doneness not preferred by the consumer on beef palatability. The objective of this study was to determine the impact of feeding consumers steaks cooked to multiple degrees of doneness on their perception of beef palatability.

Experimental Procedures

Low Choice (Small⁰⁰ to Small¹⁰⁰ marbling) frozen steaks ($n = 360$) from the posterior half of the strip loin were selected from steaks remaining from studies conducted by Drey (2018) and Vierck et al. (2018). Paired steaks used in this study were selected from steaks that were consecutively cut from the same strip loin. Each pair of steaks were randomly assigned a degree of doneness of rare (140°F), medium-rare (145°F), medium (160°F), medium-well (165°F), or well-done (170°F). Consumer panelists ($n = 283$; 95/rare; 95/medium; 93/well-done preference) were prescreened to participate in panels based on their degree of doneness preference. Panels were conducted with

all panelists in a session preferring steaks cooked to rare, medium, or well-done. Steaks were cooked on clam-style grills (Griddler, Cuisinart, Stamford, CT) set to a surface temperature of 350°F and removed following cooking so that the peak end-point temperature would correspond to the assigned degree of doneness (NCBA, 2008; American Meat Science Association, 2015). Steak samples were served in two rounds. In the first round, consumers were served one sample from each of the five degrees of doneness, in a random order, under low-intensity red incandescent lighting to mask any degree of doneness differences among samples. Round two testing procedures were identical to round one, except consumers were served under white incandescent lights, with white fluorescent background lighting turned on. This allowed the consumers to visually evaluate the degree of doneness of samples during testing. Samples evaluated in round two were paired with samples cooked to the same degree of doneness from round one, allowing for a direct comparison of consumer ratings between the rounds. Screening the consumers beforehand for degree of doneness preference allowed for a measure of the impact of “missing” the consumer’s ideal degree of doneness and quantification of the impact of both undercooking and overcooking steaks on consumer beef palatability ratings. Statistical analysis was conducted in SAS (Version 9.4, Cary, NC) using PROC GLIMMIX with $\alpha = 0.05$. Consumer data were analyzed using a split-plot model with consumer preference as the whole plot factor and degree of doneness as the subplot factor.

Results and Discussion

As for the change in ratings when compared to the consumer’s preferred degree of doneness, when steaks were undercooked they were rated higher ($P < 0.05$) and when steaks were overcooked they were rated lower ($P < 0.05$), regardless of the consumer’s degree of doneness preference (Figure 1). For all ratings, when steaks were cooked below the consumer’s preference, there were no differences ($P > 0.05$) among the ratings, all of which were rated higher ($P < 0.05$) than their preferred degree of doneness. Means decreased ($P < 0.05$) as the amount of overcooking increased, with steaks cooked four degrees of doneness over their preferred degree of doneness being rated the tougher and lower for flavor liking ($P < 0.05$) than steaks cooked to their preferred degree of doneness.

There were no consumer preference \times degree of doneness interactions or consumer preference effects for tenderness, juiciness, and flavor ($P > 0.05$) when steaks were evaluated under both lighting types (Table 1). Within the white-light testing, the consumer preference \times degree of doneness interaction for overall liking was marginally significant ($P = 0.078$; Table 2). Inherently for traits that were more objective in their anchors (tenderness and juiciness), consumers’ opinions were not biased; however, when consumers assessed overall liking or whether or not the sample was acceptable on scales that were more opinion based, consumers’ degree of doneness bias was reflected. Consumers who preferred rare and medium rated rare and medium-rare the greatest ($P < 0.05$) and well-done the lowest ($P < 0.05$) for overall liking. This was similar to the progression seen within the red-light testing, as cooking temperature increased, overall liking decreased ($P < 0.05$). However, for consumers who preferred well-done, there were no differences ($P > 0.05$) among degrees of doneness for overall liking within the white-light test. But, when tested under the red-lights, consumers who preferred well-

done rated rare and medium-rare with the greatest ($P < 0.05$) overall liking, with well-done having the least ($P < 0.05$) overall liking being similar ($P > 0.05$) only to medium.

Implications

When steaks are overcooked, palatability ratings decrease; however, undercooking has a positive effect on palatability perception, regardless of the consumer's degree of doneness preference.

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Table 1. Consumer (n = 283) palatability ratings¹ of beef strip loin steaks cooked to five degrees of doneness and evaluated under red and white lighting

Treatment	Tenderness	Juiciness	Flavor
Red-light testing			
Rare	71.8 ^a	76.7 ^a	66.2 ^a
Medium-rare	71.8 ^a	73.9 ^a	66.7 ^a
Medium	60.4 ^b	59.9 ^b	59.4 ^b
Medium-well	61.1 ^b	56.0 ^b	57.0 ^b
Well-done	52.5 ^c	48.6 ^c	52.5 ^c
Standard error	2.1	2.2	1.8
<i>P</i> – value	< 0.01	< 0.01	< 0.01
White-light testing			
Rare	74.0 ^a	80.2 ^a	69.1 ^a
Medium-rare	73.9 ^a	77.5 ^a	70.4 ^a
Medium	60.1 ^b	61.7 ^b	62.4 ^b
Medium-well	59.0 ^b	56.8 ^c	59.9 ^b
Well-done	50.1 ^c	48.9 ^d	54.8 ^c
Standard error	2.4	2.2	2.0
<i>P</i> – value	< 0.01	< 0.01	< 0.01

^{abcd}Means within the same section (red-light or white-light) of the same column without a common superscript differ ($P < 0.05$).

¹Sensory scores: 100 = extremely tender, juicy, and like extremely; 50 = neither tough nor tender, neither dry nor juicy, and neither dislike nor like; 0 = extremely tough, dry, and dislike extremely.

Table 2. Least squares means for the interaction ($P = 0.078$) of overall liking rating¹ of beef strip steaks cooked to five degrees of doneness by consumers ($n = 283$; 95/rare; 95/medium; 93/well-done preference²) and evaluated under red and white lighting

Treatment	Consumer preference ²		
	Rare	Medium	Well-done
Red-light testing			
Rare	71.7 ^a	65.9 ^a	66.7 ^a
Medium-rare	73.5 ^a	65.8 ^a	66.4 ^a
Medium	63.8 ^b	57.6 ^b	58.9 ^{bc}
Medium-well	57.5 ^{bc}	55.5 ^{bc}	63.6 ^{ab}
Well-done	52.3 ^c	49.3 ^c	54.4 ^c
Standard error	2.9	2.9	2.9
P – value	< 0.01	< 0.01	< 0.01
White-light testing			
Rare	75.7 ^a	70.4 ^a	65.4
Medium-rare	75.6 ^a	73.2 ^a	67.7
Medium	63.9 ^b	60.4 ^b	62.3
Medium-well	60.2 ^{bc}	57.6 ^b	61.3
Well-done	53.2 ^c	48.4 ^c	57.4
Standard error	2.9	2.9	2.9
P – value	< 0.01	< 0.01	0.07

^{abcd}Means within the same section (red-light or white-light) of the same column without a common superscript differ ($P < 0.05$).

¹Sensory scores: 100 = like extremely; 50 = neither like nor dislike; 0 = dislike extremely.

²Consumers were screened for their preferred degree of doneness prior to panels but evaluated all five degrees of doneness.

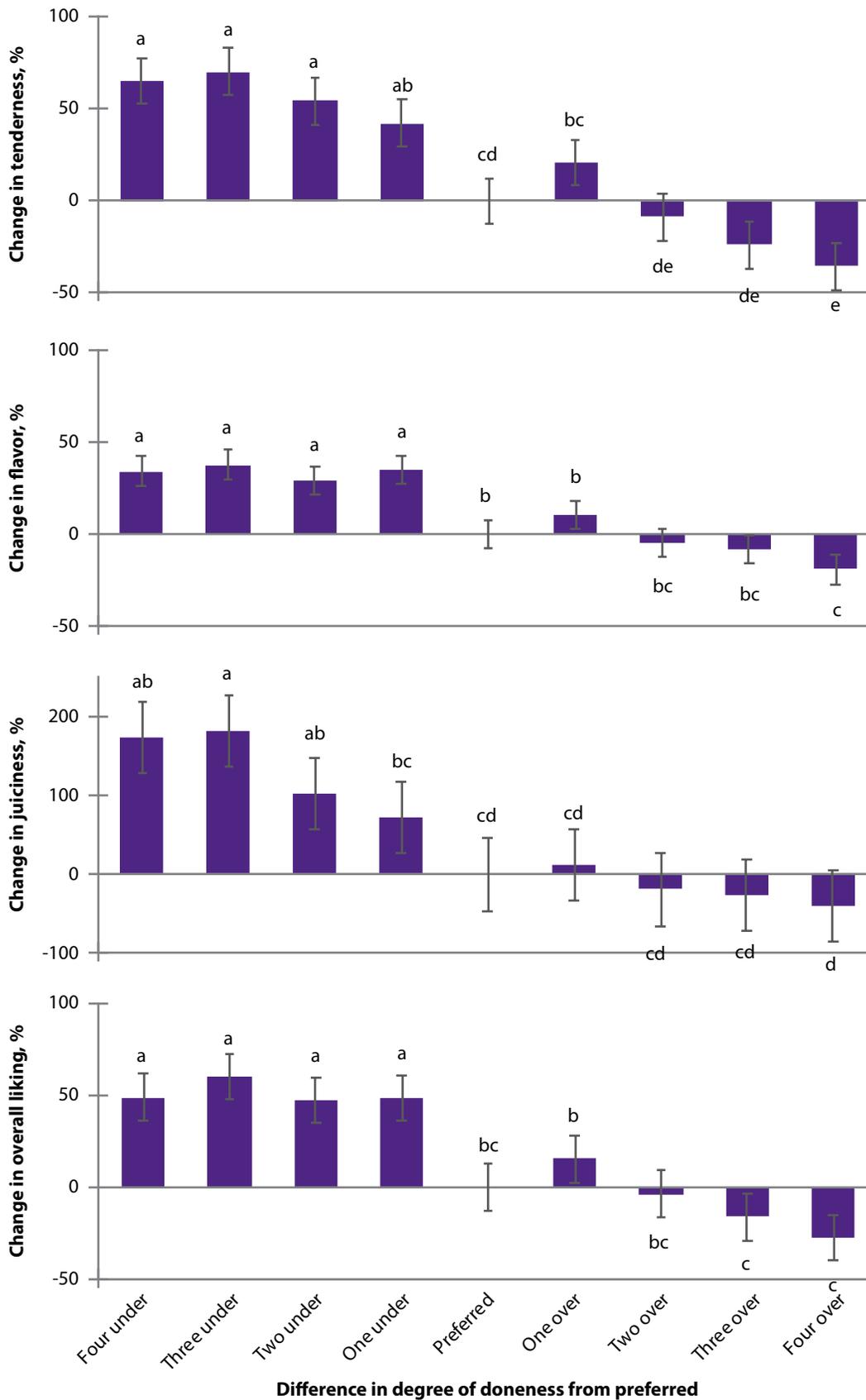


Figure 1. Percentage change in consumer sensory ratings between red- and white-lighted testing to assess the impact of undercooking and overcooking beef strip loin steaks.
^{abcde}Means within the same sensory characteristic without a common superscript differ ($P < 0.05$).

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BEEF CATTLE RESEARCH

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