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## 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 (Small<sup>00</sup> to Small<sup>100</sup> 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 (Small<sup>00</sup> to Small<sup>100</sup> 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 ratings<sup>1</sup> 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 <sup>a</sup>	76.7 <sup>a</sup>	66.2 <sup>a</sup>
Medium-rare	71.8 <sup>a</sup>	73.9 <sup>a</sup>	66.7 <sup>a</sup>
Medium	60.4 <sup>b</sup>	59.9 <sup>b</sup>	59.4 <sup>b</sup>
Medium-well	61.1 <sup>b</sup>	56.0 <sup>b</sup>	57.0 <sup>b</sup>
Well-done	52.5 <sup>c</sup>	48.6 <sup>c</sup>	52.5 <sup>c</sup>
Standard error	2.1	2.2	1.8
<i>P</i> – value	< 0.01	< 0.01	< 0.01
White-light testing			
Rare	74.0 <sup>a</sup>	80.2 <sup>a</sup>	69.1 <sup>a</sup>
Medium-rare	73.9 <sup>a</sup>	77.5 <sup>a</sup>	70.4 <sup>a</sup>
Medium	60.1 <sup>b</sup>	61.7 <sup>b</sup>	62.4 <sup>b</sup>
Medium-well	59.0 <sup>b</sup>	56.8 <sup>c</sup>	59.9 <sup>b</sup>
Well-done	50.1 <sup>c</sup>	48.9 <sup>d</sup>	54.8 <sup>c</sup>
Standard error	2.4	2.2	2.0
<i>P</i> – value	< 0.01	< 0.01	< 0.01

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

<sup>1</sup>Sensory 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.

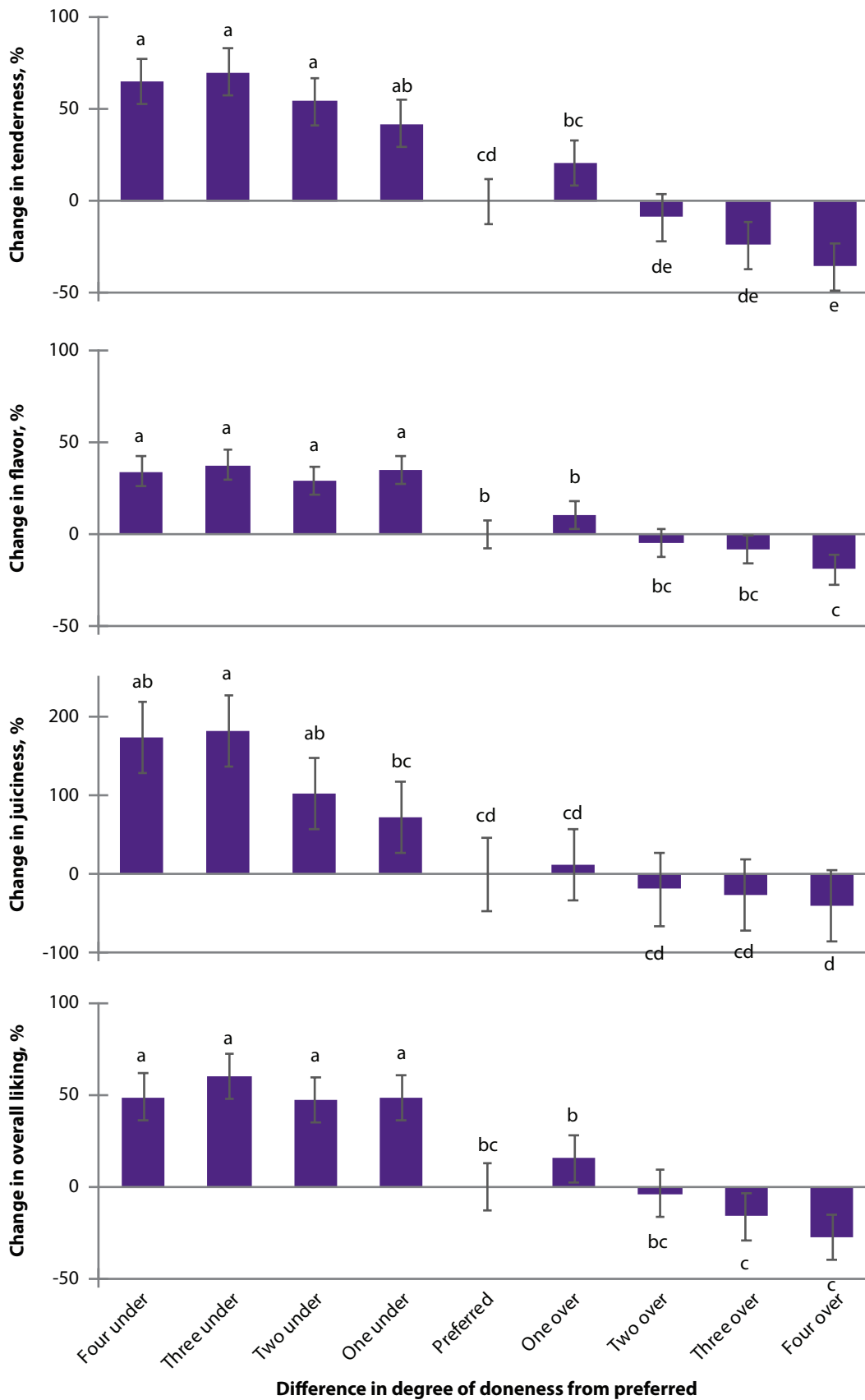
**Table 2. Least squares means for the interaction ( $P = 0.078$ ) of overall liking rating<sup>1</sup> of beef strip steaks cooked to five degrees of doneness by consumers ( $n = 283$ ; 95/rare; 95/medium; 93/well-done preference<sup>2</sup>) and evaluated under red and white lighting**

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

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

<sup>1</sup>Sensory scores: 100 = like extremely; 50 = neither like nor dislike; 0 = dislike extremely.

<sup>2</sup>Consumers 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.**  
<sup>abcde</sup>Means within the same sensory characteristic without a common superscript differ ( $P < 0.05$ ).