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Abstract

The objective of this study was to determine the palatability traits of beef cuts of differing bone status and quality grade. Paired (n = 12) beef short loins, export ribs, and boneless ribeye rolls were collected from a commercial abattoir. Short loins were fabricated into boneless strip loins with corresponding bone-in tenderloins or bone-in strip loins with boneless tenderloins at Kansas State University. Product was aged in vacuum packages for 28 days and fabricated into 1-in thick steaks. A total of 18 trained sensory panels were conducted. Steaks were cooked on clamshell style grills to a peak temperature of 160°F. Panelists ranked the samples on 100-point continuous line scales with descriptive anchors at 0, 50, and 100. Bone-in tenderloins and bone-in ribeyes were rated more flavorful ($P < 0.05$) than boneless cuts from the same muscle. There were no beef flavor intensity differences observed for bone-in and boneless strip steaks. Bone state had no effect ($P > 0.05$) on initial juiciness, myofibrillar tenderness, or overall tenderness. Bone-in strip loin samples were rated juicier ($P < 0.05$) than tenderloins and boneless ribeye samples. Tenderloin samples were rated higher ($P < 0.05$) for myofibrillar and overall tenderness than strips and ribeyes, which were similar ($P > 0.05$). U.S. Department of Agriculture (USDA) Choice samples were rated higher ($P < 0.05$) for all palatability traits than USDA Select samples. Nuances observed within palatability traits show that bone-in and boneless cuts of the same muscle rated similar regardless of bone state. This provides evidence that a comparable overall eating experience can be derived from a bone-in or boneless steak from the same muscle and grade.

Introduction

The evolution of consumer demands and processing practices over the past several decades, specifically in the beef industry, have caused a shift to marketing primarily boneless subprimals (Bass, 2018). Consequently, there is increased interest and novelty surrounding bone-in cuts in high-end steakhouses and retail markets. Consumers continue to prefer the aesthetic and visual stimulation of bone-in cuts (Bass, 2018). Moreover, bone-in cuts are believed to have a more flavorful eating experience for consumers (Lopez, 2013; Chicago Steak Company, 2016; Goldwyn, n.d.). There has been minimal research evaluating the impact of bone on beef palatability and whether the impact depends on quality grade. Therefore, the objective of this study was to deter-

mine the palatability attributes of beef cuts (strip loin, tenderloin, and ribeye) of varying bone states and quality grades.

Experimental Procedures

Left and right sides of 12 beef carcasses representing U.S. Department of Agriculture (USDA) Choice (upper 2/3) and USDA Select quality grades were selected by trained Kansas State University personnel at a commercial packing plant in the Midwest. K-State research personnel collected quality and yield grade data prior to fabrication. Paired (n = 12 pairs; 24 total/cut/grade) beef short loins, bone-in ribeye rolls, and boneless ribeye rolls were vacuum packaged and transported to the Kansas State University Meat Laboratory. After arriving at K-State, short loins from each animal were fabricated into either a boneless strip loin with a corresponding bone-in tenderloin, or a bone-in strip loin with a paired boneless tenderloin at three days postmortem. Following the initial fabrication, product was vacuum-packaged and aged for 28 days at 32–39°F. Frozen subprimals were then fabricated into 1-in thick steaks using a band saw. Steaks designated for trained sensory analysis were thawed at 36 to 39°F for 24 hours prior to cooking. Steaks were cooked to a peak temperature of 160°F (medium) on clamshell style griddles and temperatures were monitored using a probe thermometer. Samples were cut into 1-in thick × 0.4-in × 0.4-in cuboids, and 2 pieces were served to the trained panelists. For ribeye samples, only the longissimus muscle was served. Panelists were trained according to the American Meat Science Association sensory guidelines (American Meat Science Association, 2016). A total of 18 panels were conducted at the Kansas State University Meat Science Sensory Lab. For each session, eight panelists were seated at individual booths under low-intensity red incandescent lights and given eight samples in a randomized order. Panelists ranked the samples on a 100-point continuous line scale with descriptive anchors at 0, 50, and 100 for initial juiciness, sustained juiciness, myofibrillar tenderness, connective tissue amount, overall tenderness, beef flavor intensity, and off-flavor intensity. Trained sensory panelists recorded their responses using a digital survey (Qualtrics XM, Provo, UT) on an electronic tablet (Lenovo TB-8505F). Warner-Bratzler Shear Force (WBSF) analysis was also performed. A total of six cores (0.5-in diameter) were cut from each cooked steak parallel to the muscle fiber. The cores were sheared perpendicular to the muscle fiber using an Instron testing machine. Measurements of the six cores per steak were averaged and results were recorded as average peak force (lb). Data were analyzed as a split-plot design with a whole plot factor of quality grade and sub-plot factors of muscle and bone.

Results and Discussion

Trained sensory panel analysis results for bone state and muscle are listed in Table 1. Overall, bone status had a minimal impact on palatability traits. Nonetheless, bone-in tenderloins and bone-in ribeyes were rated more flavorful ($P < 0.05$) than boneless cuts from the same muscle. There were no ($P > 0.05$) beef flavor intensity differences observed for bone-in and boneless strip steaks. Bone state had no effect ($P > 0.05$) on initial juiciness, myofibrillar tenderness, or overall tenderness for any cut. Bone-in strip loin samples were rated juicier ($P < 0.05$) than tenderloins and boneless ribeye samples. Furthermore, tenderloin samples were rated higher ($P < 0.05$) for myofibrillar and overall tenderness than strip loin and ribeye steaks, which were rated similar ($P > 0.05$) by trained panelists. Trained sensory panel results for quality grade are found in Table 2. USDA Choice samples were rated higher ($P < 0.05$) for all palatability traits than

Select samples. There was a significant interaction between quality grade × bone state × muscle with results listed in Table 3. Both Choice and Select tenderloins of both bone states had the least ($P < 0.05$) amount of detectable connective tissue. Moreover, there was no difference ($P > 0.05$) in the WBSF values for strips and ribeyes, with tenderloin samples having the lowest ($P < 0.05$) average peak force as shown in Table 4. The USDA Choice samples were rated higher ($P < 0.05$) for all palatability traits and had lower WBSF values than Select samples.

Implications

The results observed within palatability traits show that regardless of bone state, bone-in and boneless cuts of the same muscle are rated similar by panelists. This indicates that a similar overall eating experience could be derived from a boneless or bone-in steak from the same cut and quality grade.

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Table 1. Least squares means for trained sensory panel ratings[1] for strip, tenderloin, and ribeye steaks of varying bone states

	Strip		Tenderloin		Ribeye			
Trait	Bone-in	Boneless	Bone-in	Boneless	Bone-in	Boneless	SEM[2]	*P*-value
Initial juiciness	60.6[a]	59.0[ab]	56.2[b]	55.7[b]	58.0[ab]	56.4[b]	1.4	0.06
Sustained juiciness	55.0	53.8	51.3	50.9	52.4	51.2	1.6	0.24
Myofibrillar tenderness	63.2[b]	63.7[b]	85.9[a]	85.1[a]	63.1[b]	61.9[b]	1.6	<0.0001
Overall tenderness	59.7[b]	61.2[b]	85.2[a]	83.9[a]	60.5[b]	59.0[b]	1.8	<0.0001
Beef flavor intensity	37.3[ab]	37.5[a]	37.1[ab]	34.6[c]	37.8[a]	35.8[bc]	0.9	0.002
Off-flavor intensity	0.0	0.1	0.0	0.0	0.2	0.0	1.0	0.55

[1]Sensory scores: 0 = extremely dry/tough/non/extremely bland/no off-flavor; 50 = neither dry nor juicy/neither tough nor tender; 100 = extremely juicy/tender/abundant/extremely intense.
[2]SEM (largest) of the least square means in the same section of the same row.
[a-c]Least squares means in the same section of the same row without a common superscript differ ($P < 0.05$).

Table 2. Least squares means for trained sensory panel ratings[2] for Choice and Select USDA quality grades[2]

Trait	Choice	Select	SEM[3]	*P*-value
Initial juiciness	60.5[a]	54.8[b]	0.8	<0.0001
Sustained juiciness	55.6[a]	49.2[b]	0.9	<0.0001
Myofibrillar tenderness	73.3[a]	67.7[b]	1.1	0.0006
Overall tenderness	71.4[a]	65.1[b]	1.6	0.0006
Beef flavor intensity	38.1[a]	35.2[b]	0.6	<0.0001
Off-flavor intensity	0.04	0.05	0.05	0.85

[1]Sensory scores: 0 = extremely dry/tough/non/extremely bland/no off-flavor; 50 = neither dry nor juicy/neither tough nor tender; 100 = extremely juicy/tender/abundant/extremely intense
[2]Quality grade: Choice = USDA High Choice (upper 2/3) with marbling scores ranging from moderate 0 to 100; Select = USDA Select with marbling scores ranging from slight 0 to 100.
[3]SEM (largest) of the least square means in the same section of the same row.
[ab]Least squares means in the same section of the same row without a common superscript differ ($P < 0.05$).

Table 3. Interactive effects for trained sensory panel ratings[1] for strip, tenderloin, and ribeye steaks of varying bone states[2] and USDA quality grade[3]

	Choice						Select							
	Strip		Tenderloin		Ribeye		Strip		Tenderloin		Ribeye			
Trait	BI	BL	BI	BL	BI	BL	BI	BL	BI	BL	BI	BL	SEM[4]	*P*-value
Connective tissue amount	6.0^{bc}	4.7^{c}	1.1^{d}	1.3^{d}	5.8^{bc}	5.6^{c}	10.9^{a}	6.7^{bc}	1.3^{d}	1.3^{d}	7.4^{bc}	8.6^{ab}	1.5	0.04

[1]Sensory scores: 0 = extremely dry/tough/non/extremely bland/no off-flavor; 50 = neither dry nor juicy/neither tough nor tender; 100 = extremely juicy/tender/abundant/extremely intense.
[2]Bone-in = BI; Boneless = BL.
[3]Quality grade: Choice = USDA High Choice (upper 2/3) with marbling scores ranging from moderate 0 to 100; Select = USDA Select with marbling scores ranging from slight 0 to 100.
[4]SEM (largest) of the least square means of the same row.
[a-d]Least squares means in the same section of the same row without a common superscript differ ($P < 0.05$).

Table 4. Least squares means for Warner-Bratzler shear force of strip, tenderloin, and ribeye steaks of varying bone states[1] and USDA quality grade[2]

	Strip		Tenderloin		Ribeye							
Trait	BI	BL	BI	BL	BI	BL	SEM[3]	*P*-value	Choice	Select	SEM[3]	*P*-value
Shear force (lb)	8.2^{a}	7.9^{a}	6.0^{b}	6.0^{b}	8.4^{a}	8.4^{a}	0.2	<0.001	6.8^{b}	8.2^{a}	0.2	0.005

[1]Bone-in = BI; Boneless = BL.
[2]Quality grade: Choice = USDA High Choice (upper 2/3) with marbling scores ranging from moderate 0 to 100; Select = USDA Select with marbling scores ranging from slight 0 to 100.
[3]SEM (largest) of the least square means in the same section of the same row.
[a,b]Least squares means in the same section of the same row without a common superscript differ ($P < 0.05$).