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The Effects of Aging Time on Eating Quality of *Semimembranosus* Steaks

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Abstract

The objective of this study was to evaluate palatability, objective tenderness, and raw and cooked color of *semimembranosus* (SM) steaks aged 14 to 70 days. Beef top round subprimals (n = 10 / aging period) were collected and aged for 14, 28, 35, 42, 49, 56, 63, and 70 days. One steak from each aging period was used to evaluate Warner-Bratzler Shear Force (WBSF), and color measurements while one steak was used for consumer sensory evaluation. Steaks were cooked to an internal peak temperature of 160°F, following the American Meat Science Association Sensory Guidelines. Consumers (n = 96) were asked to evaluate each sample for overall liking, flavor, juiciness, and tenderness liking, and determine if the sample was acceptable for each attribute. One steak per treatment combination was used to evaluate cooked L^* (lightness), a^* (redness), and b^* (yellowness) values, then refrigerated for 24 hours before conducting WBSF. Consumer sensory results showed steaks aged 28, 56, and 70 day rated higher ($P < 0.05$) for tenderness and overall liking scores compared to 14 day steaks. There was also a higher ($P < 0.05$) percentage of 70 day steaks rated as acceptable for tenderness compared to 14 day steaks. There were no other sensory differences ($P > 0.05$) found for flavor liking and juiciness liking. The WBSF values for 14 and 35 day steaks were higher ($P < 0.05$) than all other treatments. No differences ($P > 0.05$) were found in all cooked color data. Conversely, 49, 56, and 63 day steaks had higher ($P < 0.05$) raw L^* values than 14 and 28-day steaks. Furthermore, 14, 28, 35, and 49 day steaks resulted in higher a^* values ($P < 0.05$) compared to the 70 day treatment. Therefore, extended aging can be used as an effective tool to improve tenderness without negatively impacting flavor or overall liking.

Introduction

Understanding how to add value to the cuts outside of the middle meats has been a priority over the past decade within the industry and scientific communities. The National Cattlemen's Beef Association (NCBA) Innovation Cuts were developed to educate consumers on lesser-known muscles to promote carcass utilization. One of these NCBA Innovation Cuts is the Tucson Cut, deriving from the *semimembranosus* (SM)*,* or top round subprimal (Institutional Meat Purchase Specifications #169, NAMP, 2014). However, whole muscle cuts derived from the round are typically

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known to be less tender and less desirable to consumers (Gruber et al., 2006). Gruber et al. (2006) also found the SM, specifically, to be one of the least tender cuts. Increasing tenderness in cuts outside the middle meats provides an opportunity for greater marketing emphasis at retail for lean, affordable beef (Miller et al., 2001).

Aging is a common practice in the meat industry to improve overall palatability. The 2010/2011 National Beef Tenderness Survey showed food service aging times ranged from 9 to 67 days, with the most common aging period in the industry being 28 days (Guelker et al., 2013). Aging has been shown to positively affect tenderness, while also causing changes to beef flavor compounds (Barker et al., 2023, Hernandez et al., 2023). Beef palatability is characterized by flavor, juiciness, and tenderness, with flavor being recognized as the most critical quality attribute of beef products (Lucherk et al., 2016, O'Quinn et al., 2018). While tenderness is easily the most variable and therefore the most researched palatability trait, flavor has moved to the forefront of research due to its importance for consumers.

Previous research has shown differing results with the effect of extended aging periods on flavor. Colle et al., (2015) found consumer sensory panel flavor scores in strip loin and top sirloin steaks aged 63 days did not change over time. Conversely, recent studies with trained panelists were able to identify negative beef flavor attributes (liver-like, oxidized, metallic, fishy, earthy/musty, and sour) as aging time increased for the same steaks (Barker et al., 2023, Hernandez et al., 2023). However, little research has been done to understand the effects of extended aging (>35 d) on consumer palatability of SM steaks. Continued research around less utilized muscles is imperative to understanding how to improve palatability of these muscles and therefore carcass utilization. The objective of this study was to evaluate consumer palatability, instrumental tenderness, and objective color of *semimembranosus* steaks aged from 14 to 70 days.

Experimental Procedures

Beef top round subprimals (n = 10 cuts / aging time) were collected at a commercial beef processing plant and brought to Kansas State University. Subprimal cuts were aged for 14, 28, 35, 42, 49, 56, 63, and 70 days at 35 to 38°F. Following aging, cuts were fabricated into 1-in. thick steaks, frozen, and stored at -4°F. One steak from each subprimal was allocated for tenderness and color evaluations, while another was designated for consumer sensory evaluation. Steaks were removed from storage, then thawed between 35 and 38°F. After thawing, packages were opened and steaks were allowed a 30-minute bloom period before measuring L^* (lightness), a^* (redness), b^* (yellowness), using a HunterLab MiniScan Spectrophotometer (A/10 illuminate). These readings were used to calculate hue angle, chroma, and percentage of oxymyoglobin (OMb), deoxymyoglobin (DMb), and metmyoglobin (MMb) on the surface of the steak according to the American Meat Science Association Color Guidelines (AMSA; King et al., 2023). A flat top griddle was used to cook steaks at 375°F to an internal peak temperature of 160°F, measured with a temperature probe inserted at the geometric center of the steak. Steaks were divided into equal thirds for consumer sensory analysis. Consumers (n = 96) were given samples, which they evaluated for overall liking, flavor liking, juiciness liking, and tenderness liking, and asked to determine if samples were acceptable for each attribute. Samples were rated on a 10-point scale, with 0 indicating extremely dry, tough, or extremely dislike, and 10 indicating extremely juicy, tender, or extremely like. Immediately following cooking of the steaks to be tested for color and shear force, the steaks were sliced at a 45° angle exposing a 1-in. internal surface used for cooked color readings. Cooked L^*, a^*, and b^* readings were taken after a 3-minute bloom period using a HunterLab MiniScan Spectrophotometer. Cook loss was calculated from the weight of the steaks prior to and after cooking. Steaks were refrigerated at 35-38°F for 24 hours before conducting Warner-Bratzler Shear Force tests (WBSF). The WBSF steaks were cooked using the same protocol as described above, and followed the AMSA Sensory Guidelines (AMSA, 2015). All data were analyzed using SAS PROC GLIMMIX (v. 9.4, SAS Institute, Inc., Cary, NC) as a completely randomized design, with aging period as a fixed effect, and the level of significance set at 0.05.

Results and Discussion

Results of consumer sensory evaluation indicated there were no differences ($P > 0.05$) among aging periods for flavor and juiciness liking (Table 1), or for the percentage of samples consumers rated as acceptable for flavor and overall acceptability (Table 2). Consumer sensory results showed 28, 56, and 70 day steaks rated higher ($P < 0.05$) for tenderness and overall liking scores compared to 14 day steaks. There was also a higher ($P < 0.05$) percentage of 70 day steaks rated as acceptable for tenderness compared to 14 day steaks. These results align with previous studies that also found increased tenderness in cuts aged for extended periods (Colle et al., 2015, Dixon et al., 2012; Gruber et al., 2006). The consumer sensory results show consumer panelists were unable to detect negative flavor changes associated with extended aging periods, but still found them to be more tender, resulting in a better eating experience.

Supporting the consumer data, WBSF results showed 14 and 35 day steaks had higher ($P < 0.05$) shear values than all other aging periods, indicating they were tougher than the other aging periods (Table 3). Raw L^* values for 14 and 28 day steaks were lower ($P < 0.05$) than 56 day steaks showing steaks were darker at a shorter aging period. Furthermore, 14, 28, 35, and 49 day steaks resulted in higher a^* values ($P < 0.05$) compared to the 70 day treatment. This indicates the less aged steaks were more red than 70 day steaks. Furthermore, 70 day steaks had a higher ($P < 0.05$) raw MMb percentage than 28 day steaks, as well as a higher ($P < 0.05$) raw OMb percentage than 49 and 56 day steaks. Additionally, 28 day steaks had a higher ($P < 0.05$) raw DMb percentage than 70 day steaks. Having a higher percentage of OMb shows the treatment should remain at a bright, cherry-red color for a longer period, potentially impacting shelf life. Surprisingly, no differences ($P > 0.05$) were observed in cooked color (L^*, a^*, b^* values, OMb, DMb, MMb percentages, chroma and hue angle) readings.

Implications

This research indicates extended aging improves tenderness and overall liking while not decreasing flavor for consumers, which supports using extended aging periods for historically tough muscles.

References

American Meat Science Association. 2015. Research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of meat. 2nd ed. American Meat Science Association. Champaign, IL.

Barker, S.N., J.C. Brooks, J.T. Bachler, D.R. Woerner, and J.F. Legako. 2023. Flavor development of individually vacuum-packaged beef steaks during extended wet aging. Meat and Muscle Biology 7.

Colle, M., R. Richard, K. Killinger, J. Bohlscheid, A. Gray, W. Loucks, R. Day, A. Cochran, J. Nasados, and M. Doumit. 2015. Influence of extended aging on beef quality characteristics and sensory perception of steaks from the gluteus medius and longissimus lumborum. Meat Science 110:32-39.

Dixon, C.L., D. Woerner, R. Tokach, P. Chapman, T. Engle, J. Tatum, and K. Belk. 2012. Quantifying the aging response and nutrient composition for muscles of the beef round. Journal of Animal Science 90:996-1007.

Gruber, S., J. Tatum, J. Scanga, P. Chapman, G. Smith, and K. Belk. 2006. Effects of postmortem aging and USDA quality grade on Warner-Bratzler shear force values of seventeen individual beef muscles. Journal of Animal Science 84:3387-3396.

Guelker, M., A. Haneklaus, J. Brooks, C. Carr, R. Delmore Jr, D. Griffin, D. Hale, K. Harris, G. Mafi, and D. Johnson. 2013. National Beef Tenderness Survey–2010: Warner-Bratzler shear force values and sensory panel ratings for beef steaks from United States retail and food service establishments. Journal of Animal Science 91:1005-1014.

Hernandez, M.S., D.R. Woerner, J.C. Brooks, T.L. Wheeler, and J.F. Legako. 2023. Influence of aging temperature and duration on flavor and tenderness development of vacuum-packaged beef longissimus. Meat and Muscle Biology 7.

King, D. A., M.C. Hunt, S. Barbut, J.R. Claus, D.P. Cornforth, P. Joseph, Y.H.B. Kim, G. Lindahl, R.A. Mancini, M.N. Nair, K.J. Merok, A. Milkowski, A. Mohan, F. Pohlman, R. Ramanathan, C.R. Raines, M. Seyfert, O. Sørheim, S.P. Suman, and M. Weber. 2023. American Meat Science Association guidelines for meat color measurement. Meat and Muscle Biology 6. doi:10.22175/mmb.12473.

Miller, M.F., M. Carr, C. Ramsey, K. Crockett, and L. Hoover. 2001. Consumer thresholds for establishing the value of beef tenderness. Journal of Animal Science 79:3062-3068.

Table 1. Consumer panel palatability ratings for *semimembranosus* steaks across aging treatments

Aging period	Overall liking	Flavor liking	Juiciness liking	Tenderness liking
14	4.7[c]	4.7	4.6	3.7[c]
28	6.0[ab]	5.7	5.9	5.2[ab]
35	5.3[bc]	4.8	4.9	4.5[bc]
42	5.2[bc]	4.9	5.2	4.8[bc]
49	5.7[abc]	5.3	5.2	5.0[abc]
56	6.4[a]	5.9	6.5	6.2[a]
63	5.7[abc]	5.4	5.7	5.5[ab]
70	6.1[ab]	5.8	5.6	5.7[ab]
SEM[1]	0.39	0.37	0.44	0.50
P-value	0.04	0.07	0.06	0.02

[abc]Means within the same column without a common superscript differ ($P < 0.05$).

[1]Standard error of the mean (largest) of the least square means.

Table 2. Percentage of consumers who rated each palatability trait as acceptable for *semimembranosus* steaks

Aging period	Overall acceptability	Flavor acceptability	Juiciness acceptability	Tenderness acceptability
14	61.3	69.9	60.6[b]	50.7[d]
28	85.4	83.9	84.4[a]	67.2[bcd]
35	79.9	74.2	62.8b	66.7[bcd]
42	71.5	67.6	72.5[ab]	60.8[cd]
49	82.5	80.5	74.9[ab]	69.5[abcd]
56	91.4	79.6	86.8[a]	81.1[ab]
63	77.4	76.6	82.9[a]	72.9[abc]
70	76.3	76.5	76.5[ab]	83.8[a]
SEM[1]	4.8	3.7	4.2	3.0
P-value	0.2	0.51	0.02	0.01

[abc]Means within the same column without a common superscript differ ($P < 0.05$).
[1]Standard error of the mean (largest) of the least square means.

Table 3. Warner-Bratzler Shear Force (WBSF), raw *L, *a**, *b**, percentage of myoglobin content, chroma, and hue angle for *semimembranosus* steaks**

Aging period	WBSF	*L**[1]	*a**[2]	*b**[3]	Metmyoglobin (%)[4]	Oxymyoglobin (%)[4]	Deoxymyoglobin (%)[4]	Chroma[4]	Hue angle[4]
14	4.77[a]	41.23[c]	19.16[a]	17.94[a]	6.58[ab]	42.81[bc]	50.61[a]	26.30[a]	0.76
28	3.61[c]	40.14[c]	18.02[ab]	17.88[a]	4.43[c]	46.74[abc]	48.84[ab]	25.40[a]	0.78
35	4.47[ab]	42.04[bc]	17.89[ab]	16.36[bc]	6.13[bc]	44.65[abc]	49.23[ab]	24.29[ab]	0.75
42	3.89[bc]	41.97[bc]	17.76[abc]	16.18[bc]	6.95[ab]	43.21[bc]	49.84[ab]	24.07[abc]	0.74
49	3.68[bc]	43.67[ab]	18.71[a]	16.84[ab]	6.59[ab]	40.64[c]	52.78[a]	25.21[a]	0.74
56	3.33[c]	45.03[a]	17.57[abc]	16.20[bc]	7.73[ab]	42.60[c]	49.67[ab]	23.91[abc]	0.75
63	3.34[c]	43.57[ab]	15.74[bc]	15.76[bc]	7.23[ab]	49.03[ab]	43.75[bc]	22.35[bc]	0.80
70	3.80[bc]	42.21[bc]	15.27[c]	15.21[c]	8.21[a]	50.68[a]	41.11[c]	21.60[c]	0.79
SEM[5]	0.29	0.81	0.90	0.50	0.72	2.28	2.23	0.91	0.02
P-value	0.01	<0.01	0.04	<0.01	0.02	0.03	<0.01	0.01	0.29

[abc]Means within the same column without a common superscript differ ($P < 0.05$).
[1]*L**: 0 = black, 100 = white.
[2]*a**: -60 = green, 60 = red.
[3]*b**: -60 = blue, 60 = yellow.
[4]Calculated following the AMSA Color Guidelines.
[5]Standard error of the mean (largest) of the least square means.