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Abstract

Top sirloin butts are commonly blade-tenderized to significantly increase tenderness, but minimal data have shown the relationship between blade tenderization and color stability as well as the effect of extended postmortem aging periods past 30 days on color stability. Tenderness plays a significant role in consumer satisfaction with beef products, and blade tenderization and extended postmortem aging periods are effective ways to ensure that beef cuts are tender. Therefore, the objectives of this study were to: (1) determine color and flavor stability of beef gluteus medius during extended postmortem aging times with and without mechanical tenderization, and (2) determine the biochemical factors responsible for color stability of beef gluteus medius at five different aging periods.

Keywords

Cattlemen's Day, 2014; Kansas Agricultural Experiment Station contribution; no. 14-262-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1101; Beef Cattle Research, 2014 is known as Cattlemen's Day, 2014; Beef; Color; Shelf life; Flavor; Gluteus medius; Aging time

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Increasing Postmortem Aging Time Decreases Color and Flavor Stability of Top Sirloin Steaks

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Introduction

Consumers perceive fresh meat color as the most important characteristic in purchasing fresh meat cuts at retail. Bright-pink to bright-red meat color is the most desirable to consumers, and any deviation from this is less acceptable. The *gluteus medius* is found in a variety of valuable retail cuts such as strip steaks and sirloin steaks. It is known that the *gluteus medius* has a more limited color shelf life compared to *longissimus dorsi*. Decreases in color shelf life from the combination of the inherent properties of the *gluteus medius* and postmortem aging results in a higher percentage of retail cuts being marked down in price or removed from the retail case, leading to significant monetary losses across the beef industry.

Color stability has been widely studied using metmyoglobin reducing activity and oxygen consumption rate. Postmortem aging is known to decrease metmyoglobin reducing activity and increase the oxygen consumption rate, which results in diminished color stability in the retail case.

Postmortem aging is beneficial not only for tenderness, but also for beef flavor; however, increased product aging under anaerobic conditions (vacuum-packaging) is known to increase the production of lactic acid bacteria. Some undesirable off-flavors may be produced with the additional growth of lactic acid bacteria and lipid oxidation.

Top sirloin butts are commonly blade-tenderized to significantly increase tenderness, but minimal data have shown the relationship between blade tenderization and color stability as well as the effect of extended postmortem aging periods past 30 days on color stability. Tenderness plays a significant role in consumer satisfaction with beef products, and blade tenderization and extended postmortem aging periods are effective ways to ensure that beef cuts are tender. Therefore, the objectives of this study were to: (1) determine color and flavor stability of beef *gluteus medius* during extended postmortem aging times with and without mechanical tenderization, and (2) determine the biochemical factors responsible for color stability of beef *gluteus medius* at five different aging periods.

Experimental Procedures

Fifteen top sirloin butts were transported to the Kansas State University Meat Laboratory from three commercial beef harvest facilities and were randomly assigned to five different aging periods. The five postmortem aging treatments were 5, 19, 33, 47, and 61 days. Each beef top sirloin butt was then stored in the original vacuum package at 35 to 39°F throughout the aging period. On the final day of each postmortem aging treatment, top sirloin butts were removed from their vacuum packages and the *gluteus medius* was removed and trimmed of excess fat. The *gluteus medius* was then cut down the center, parallel with the muscle fibers, to yield two pieces of equal size, which were randomly assigned to a blade tenderization or a control treatment. The blade tenderized treatment was processed twice through a commercial blade tenderization machine. After tenderization treatment, the *gluteus medius* pieces were sliced perpendicular to the muscle fibers into eight 1-in. steaks. The first top sirloin steak, starting at the anterior end, was immediately vacuum-packaged with oxygen-impermeable film and stored at -112°F for approximately 7 days before assessment of lipid oxidation using the thiobarbituric acid reactive substances method. The second steak was used for metmyoglobin reducing activity and oxygen consumption rate determination, the third steak was used for simulated retail display, and the fourth steak was immediately vacuum-packaged with oxygen-impermeable film and frozen at -112°F until needed for sensory analysis. The fifth steak was immediately vacuum-packaged into oxygen-impermeable film and frozen at -112°F until needed for Warner-Bratzler Shear Force measurements, and the sixth steak was placed in a sterilized bag and immediately used to analyze lactic acid bacteria counts.

Results and Discussion

As expected, both extended postmortem aging and blade tenderization significantly increased tenderness in beef top sirloin steaks. Postmortem aging was not as effective as blade tenderization in improving tenderness until day 61 of the study (data not shown).

With increased postmortem aging time, steaks cut from aged top sirloin butts were much less color-stable, as shown by increased display color and discoloration scores. Using a limit of 25% surface browning (metmyoglobin), top sirloin butts aged 5, 19, 33, 47, and 61 days yielded steaks with a color shelf of 4 days, 2 days, 1 day, 1 day, and 1 day, respectively (data not shown). In addition, top sirloins that were blade-tenderized were darker in appearance and had higher discoloration scores than controls for comparable postmortem aging days. Quality traits for the interaction of aging and tenderization are shown in Table 1.

Fresh meat undergoes constant change between the three pigments of myoglobin (purple), oxymyoglobin (red), and metmyoglobin (brown) and relies on enzyme systems and substrate availability to make that happen. As postmortem age increased, enzyme activity and substrate availability decreased, resulting in lower metmyoglobin reducing activity. This lower metmyoglobin reducing ability directly related to the decreased color stability observed in this study.

Lactic acid bacteria significantly increased with increased aging times (data not shown); however, this did not affect pH significantly or change the flavor profile dramatically. Oxidative rancidity significantly increased for samples with increased aging periods. As a result, samples that were aged longer had more warmed-over flavor. Longer aging periods also resulted in product with less bitter flavor and less bloody/serumy flavor, indicating that flavor changes did occur as aging time increased (data not shown). Sensory traits for the interaction of aging and blade tenderization are shown in Table 2.

Implications

Extended postmortem aging and blade tenderization are effective tools in increasing tenderness of top sirloin steaks, but they may decrease retail color shelf life and flavor characteristics.

Acknowledgements

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Table 1. Least squares means of aging × tenderization interaction for quality traits of beef top sirloin steaks subjected to different postmortem aging and tenderization treatments

	Control					Blade-tenderized					
	Aging period (days)					Aging period (days)					
	5	19	33	47	61	5	19	33	47	61	SEM
Lipid oxidation[1]	0.07	0.10	0.14	0.19	0.17	0.06	0.14	0.15	0.19	0.20	0.018
Metmyoglobin reducing activity[2]	85.1	72.2	64.9	69.1	62.3	85.2	74.5	61.3	73.2	61.3	3.78
Oxygen consumption rate[3]	49.3	42.2	57.5	44.8	77.5	47.5	55.2	57.1	52.9	89.6	6.25
L*[4]	44.1[f]	46.4[de]	47.7[d]	53.5[ab]	53.1[bc]	43.6[f]	45.2[ef]	47.2[d]	51.8[c]	54.8[a]	0.563
a*[5]	24.3[cd]	24.4[cd]	22.8[e]	29.8[a]	25.9[b]	23.8[de]	23.9[de]	25.8[bc]	28.7[a]	26.8[b]	0.566
b*[6]	19.9	21.8	22.9	35.3	28.7	19.8	21.4	24.8	34.5	31.2	0.764
Initial color panel[7]	4.4	3.3	3.5	3.8	3.7	4.5	3.6	3.7	4.0	3.6	0.16
Display color panel[8]	3.73[f]	4.14[e]	4.51[d]	5.65[b]	5.54[b]	4.03[e]	4.80[c]	4.95[c]	6.32[a]	6.42[a]	0.099
Discoloration panel[9]	2.52[f]	3.61[d]	4.07[c]	4.45[b]	4.41[b]	2.97[e]	4.15[c]	4.82[a]	4.85[a]	4.75[a]	0.100
Warner-Bratzler shear force, lb	9.9[a]	7.8[b]	7.4[b]	7.3[b]	5.6[c]	6.9[b]	5.8[c]	5.3[c]	5.6[c]	5.0[c]	0.37
Lactic acid bacteria (log CFU/g)	1.07	1.79	2.69	3.14	3.76	1.27	1.91	2.70	3.05	3.95	0.243
pH	5.5	5.5	5.4	5.5	5.5	5.5	5.5	5.4	5.5	5.5	0.016

[1] Thiobarbituric acid reactive substances, ppm malonaldehyde.
[2] Percentage metmyoglobin reduced.
[3] Percentage oxymyoglobin reduced.
[4] L* lightness (0 = black, 100 = white).
[5] a* redness/greenness (positive values = red, negative values = green).
[6] b* yellowness/blueness (positive values = yellow, negative values=blue).
[7] 1 = bleached red, 2 = very light cherry-red, 3 = moderately cherry-red, 4 = cherry-red, 5 = slightly dark red, 6 = moderately dark red , 7 = dark red, 8 = very dark red.
[8] 1 = very bright red, 2 = bright red, 3 = dull red, 4 = slightly dark red, 5 = moderately dark red, 6 = dark red to dark reddish tan, 7 = tannish red, 8 = tan to brown.
[9] 1 = 0% surface discoloration, 2 = 1 to 10% surface discoloration, 3 = 11 to 25% surface discoloration, 4 = 26 to 50% surface discoloration, 5 = 51 to 75% surface discoloration, 6 = 76 to 99% surface discoloration, 7 = 100% surface discoloration.
[a–f] Means within a row with different superscripts differ ($P < 0.05$).

Table 2. Least squares means of aging × tenderization interaction for sensory traits of beef top sirloin steaks subjected to different postmortem aging and tenderization treatments

	Control					Tenderized					
	Aging period (days)					Aging period (days)					
	5	19	33	47	61	5	19	33	47	61	SEM
Overall tenderness[1]	9.1^{c}	9.2^{c}	9.0^{c}	9.2^{c}	10.0^{b}	9.4^{b}	10.3^{ab}	10.1^{b}	10.2^{b}	10.5^{a}	0.26
Myofibrillar tenderness[1]	9.4^{b}	9.6^{b}	9.3^{b}	9.6^{b}	10.4^{a}	9.7^{a}	10.6^{a}	10.5^{a}	10.6^{a}	10.8^{a}	0.32
Beef identity[2]	9.2	9.5	8.9	9.1	9.3	9.2	9.3	9.3	9.2	8.9	0.24
Brown/roasted[2]	7.8	8.1	8.1	8.0	8.3	8.0	8.1	8.1	8.0	7.9	0.71
Bloody/serumy[2]	3.6^{ab}	3.3^{bcd}	3.4^{abcd}	3.0^{d}	3.5^{abc}	3.5^{ab}	3.8^{a}	3.2^{bcd}	3.4^{abcd}	3.1^{cd}	0.47
Liver-like[2]	1.3	1.2	1.5	1.4	1.7	1.3	1.6	1.5	1.5	1.6	0.27
Metallic[2]	2.0^{abc}	1.8^{bc}	1.9^{abc}	1.9^{abc}	1.9^{abc}	1.7^{c}	2.2^{a}	2.0^{ab}	2.0^{abc}	2.1^{a}	0.20
Fat-like[2]	1.7	1.7	1.8	1.5	1.7	1.7	1.9	1.7	1.7	1.5	0.15
Green[2]	0.66	0.61	0.55	0.52	0.55	0.60	0.50	0.56	0.54	0.62	0.22
Rancid[2]	0.77	0.48	0.63	0.79	0.64	0.71	0.84	0.94	0.76	0.87	0.21
Spoiled[2]	0.30	0.23	0.47	0.23	0.50	0.33	0.45	0.40	0.46	0.61	0.14
Warmed over[2]	1.8	1.9	2.0	2.0	2.0	1.7	1.8	2.1	2.1	2.0	0.49
Overall sweet[2]	1.4^{bc}	1.6^{a}	1.4^{abc}	1.4^{cd}	1.5^{ab}	1.5^{abc}	1.4^{bc}	1.5^{abc}	1.4^{bcd}	1.2^{d}	0.23
Sour[2]	2.5	2.6	2.5	2.6	2.6	2.5	2.7	2.7	2.7	2.8	0.15
Bitter[2]	3.3^{abcd}	3.1^{cd}	3.0^{d}	3.4^{ab}	3.1^{bcd}	3.1^{cd}	3.4^{ab}	3.3^{abc}	3.5^{a}	3.4^{a}	0.29
Salty	1.9	1.9	1.8	1.8	1.8	1.9	2.0	1.8	1.9	1.7	0.23
Umami[2]	2.0	2.2	1.9	2.1	2.2	1.9	2.2	2.0	2.2	1.9	0.22

[1] 15 = very tender, 1 = very tough.
[2] 15 = extremely strong, 0 = none.
[a–d] Means within a row with different superscripts differ ($P < 0.05$).