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Length of Aging has Greater Effect than Lactic Acid Treatment on Color Stability of Beef Chuck Muscles

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Abstract

Lactic acid spray washes are widely used as an antimicrobial intervention in the beef industry. Sprays are typically applied to the exterior of carcasses and subprimal cuts to reduce or eliminate potential pathogenic bacteria. While the efficacy of these washes has been proven, other questions remain about their effect on color attributes of meat when applied to subprimal cuts. The objective of this study was to determine the effect of a lactic acid subprimal wash on the color stability of beef chuck rolls.

Keywords

beef chuck muscles, lactic acid, color stability

Authors

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K-STATE Research and Extension

CATTLEMEN'S DAY 2017

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G.D. McCoy, T.A. Houser, T.G. O'Quinn, E.A.E. Boyle, K.J. Phelps, and J.M. Gonzalez

Introduction

Lactic acid spray washes are widely used as an antimicrobial intervention in the beef industry. Sprays are typically applied to the exterior of carcasses and subprimal cuts to reduce or eliminate potential pathogenic bacteria. While the efficacy of these washes has been proven, other questions remain about their effect on color attributes of meat when applied to subprimal cuts. The objective of this study was to determine the effect of a lactic acid subprimal wash on the color stability of beef chuck rolls.

Key words: beef chuck muscles, lactic acid, color stability

Experimental Procedures

Twenty-four beef chuck rolls (Institutional Meat Purchase Specifications 116A) were transported to the Kansas State University Meat Laboratory from a commercial abattoir, denuded, and randomly assigned to a control water treatment or 3.6% lactic acid (1.9 pH) antimicrobial spray treatment. After treatment, each chuck roll was cut into four pieces with each piece being randomly assigned to an aging period of 3, 14, 21, or 28 days with every aging period represented within a chuck roll, and stored in the dark at 35-39°F. All chuck pieces were vacuum packaged in high barrier film and instrumental lightness (L*), redness (a*), and yellowness (b*) color readings were taken throughout the aging period. On the final day of each aging period, the chuck roll pieces were removed from the vacuum packages and cut into 1 in steaks, placed on foam trays with moisture absorbent pads, overwrapped with polyvinyl chloride film, and displayed under fluorescent lighting in a 7-day simulated retail display. A trained color panel evaluated redness and discoloration of the *complexus* and *serratus ventralis* of each steak daily. Panelists assigned scores for redness of both muscles using a 6-point scale: 0 = light pinkish-red, 20 = cherry red, 30 = dull red, 40 = slightly dark red, 50 = dark red, and 60 = very dark red. Panelists also assigned scores for discoloration directly representative of the percentage of surface discoloration. Instrumental L*, a*, and b* were recorded on each day of simulated retail display.

Results and Discussion

External L*, a*, and b* values for chuck rolls treated with water and lactic acid are shown in Table 1. The external color of beef chuck rolls from the water treatment became lighter ($P<0.05$) from days 0 to 14 indicated by an increase in L* values. The lightness of the lactic acid treatment did not change throughout the aging period. An aging by treatment interaction ($P<0.05$) was observed for external a* values. The water treatment had a redder ($P<0.05$) external color than the lactic acid treatment throughout the aging period as indicated by higher a* values. The water treatment showed a decrease in a* values from day 0 to days 21 and 28, getting less red. An aging by treatment interaction ($P<0.05$) was observed for external b* values. The water treatment maintained lower ($P<0.05$) b* values throughout the aging period, meaning the water treatment was less yellow than the lactic acid treatment regardless of aging time.

Redness scores for the *complexus* and *serratus ventralis* from chuck rolls from both treatments are shown in Table 2. Panelists reported lower ($P<0.05$) redness scores for the *complexus* muscles from the lactic acid treatment on day 0, indicating a duller red compared to the slightly dark red *complexus* muscles from the water treatment. Redness scores for the *serratus ventralis* muscle from the water treatment increased ($P<0.05$) from days 0 to 21 and remained constant for the remainder of the aging period. Redness scores for the lactic acid treatment increased ($P<0.05$) from days 21 to 28. It is important to note that these increases in redness scores indicate the *serratus ventralis* got darker, transitioning from a dull red to a slightly dark red.

Percent discoloration scores for the *complexus* and *serratus ventralis* from chuck rolls from both treatments are shown in Table 3. An aging by treatment interaction ($P=0.02$) was observed for discoloration of the *complexus* and *serratus ventralis* muscles. Panelist reported higher discoloration scores for the *complexus* muscles from the lactic acid treatment at day 28 compared to day 0. Panelist discoloration scores for the *serratus ventralis* increased from days 0 to 14 and then remained constant for both the water and lactic acid treatments. These increases in discoloration scores indicate a greater percentage of surface discoloration after the day 0 aging period.

Instrumental L*, a*, and b* values for the *complexus* and *serratus ventralis* muscles from chuck rolls from both treatments are shown in Table 4. Instrumental L* values for the *complexus* muscle increased ($P<0.05$) from day 0 to day 14 and remained constant throughout the remainder of the aging period for both the water and lactic acid treatments. This indicates that the *complexus* muscle for both treatments became lighter over the 28-day aging period. Instrumental L* values for the *serratus ventralis* muscle from the water treatment increased ($P<0.05$) from day 21 to day 28. Instrumental L* values for the *serratus ventralis* from the lactic acid treatment increased ($P<0.05$) from day 0 to day 14. This indicates that both treatments became lighter throughout the aging period, with the lactic acid treatment becoming lighter at a greater rate. Instrumental a* values for the *complexus* muscle decreased ($P<0.05$) from day 0 to day 14 for both the water and lactic acid treatments. This decrease in a* value means that both water and lactic acid treatments became less red over time. Similarly, instrumental a* values for the *serratus ventralis* decreased ($P<0.05$) from day 0 to day 14 (Figure 4) for both water and lactic acid treatments. This decrease in a* value indicates that the *serratus ventralis* for both the water and lactic acid treatments became less red over time. Instrumental b* val-

ues for the *complexus* muscle decreased (P<0.05) from days 0 to 14 for both treatments. This indicates that the *complexus* became less yellow over time. Instrumental b* values for the *serratus ventralis* also decreased (P<0.05) from days 0 to 14 for both treatments. This decrease indicates that the *serratus ventralis* also became less yellow over time.

Beef chuck rolls treated with water had a redder external color than chuck rolls treated with lactic acid throughout the aging period. During simulated retail display, aging time appeared to be the greatest factor in color stability. This is shown by the color panel reporting darker red colored *complexus* and *serratus ventralis* muscles with a higher percentage of discoloration after the day 0 aging period. This is further supported by the decrease in instrumental a* values for both treatments after the day 0 aging period, indicating a less red product.

Implications

The application of lactic acid washes negatively impacts the color of the treated chuck roll surface, resulting in a less red external color. However, the treatment does not impact the redness or discoloration of steaks cut from treated chuck rolls. Length of aging, not exterior antimicrobial treatment, has the greatest effect on color stability of beef chuck muscles under retail display conditions.

Table 1. Mean external lightness (L*), redness (a*), and yellowness (b*) values for beef chuck rolls treated with water or lactic acid and aged in a vacuum package at 35-39°F for up to 28 days

	Aging time				
Color attribute	Day 3	Day 14	Day 21	Day 28	SEM[1]
L*[2]					
Water	33.1^{by}	35.3^{ay}	35.1^{ay}	35.6^{ay}	0.692
Lactic acid	34.3^{ay}	35.9^{ay}	34.8^{ay}	35.5^{ay}	0.692
a*[3]					
Water	19.5^{ay}	18.7^{aby}	18.2^{by}	18.2^{by}	0.48
Lactic acid	16.8^{az}	15.9^{bz}	16.6^{az}	16.9^{az}	0.48
b*[4]					
Water	10.6^{bz}	11.4^{az}	10.8^{abz}	9.9^{bz}	0.477
Lactic acid	14.4^{by}	15.7^{ay}	15.2^{aby}	15.5^{ay}	0.477

[1]Standard error of the mean.
[2]L* lightness (0 = black, 100 = white).
[3]a* redness/greenness (positive values = red, negative values = green).
[4]b* yellowness/blueness (positive values = yellow, negative values = blue).
[ab]Means within a row with different superscripts differ (P<0.05).
[yz]Means within a column with different superscripts differ (P<0.05).

Table 2. Mean redness scores for the *complexus* and *serratus ventralis* muscles from beef chuck rolls treated with water or lactic acid and aged in a vacuum package at 35-39°F for up to 28 days

	Aging time				
Redness[1]	Day 3	Day 14	Day 21	Day 28	SEM[2]
complexus					
Water	60.3^{ax}	62.6^{ax}	61.4^{ax}	63.0^{ax}	2.31
Lactic acid	55.2^{ay}	59.8^{ax}	56.9^{ax}	59.9^{ax}	2.31
serratus ventralis					
Water	55.3^{bx}	66.7^{ax}	67.4^{ax}	62.8^{ax}	2.31
Lactic acid	54.6^{bx}	60.2^{abx}	60.5^{aby}	64.5^{ax}	2.31

[1]Redness color scale: 0 = light pinkish-red, 20 = cherry red, 40 = dull red, 60 = slightly dark red, 80 = dark red, and 100 very dark red.
[2]Standard error of the mean.
^{ab}Means within a row with different superscripts differ (P<0.05).
^{yz}Means within a column, within a muscle with different superscripts differ (P<0.05).

Table 3. Mean percent discoloration scores for the *complexus* and *serratus ventralis* muscles from beef chuck rolls treated with water or lactic acid and aged in a vacuum package at 35-39°F for up to 28 days

	Aging time				
Discoloration[1]	Day 3	Day 14	Day 21	Day 28	SEM[2]
complexus					
Water	37.8^{az}	39.5^{az}	37.2^{az}	43.1^{az}	3.41
Lactic acid	36.9^{bz}	45.5^{abz}	43.6^{abz}	46.1^{az}	3.41
serratus ventralis					
Water	32.7^{bz}	39.1^{az}	38.2^{az}	43.7^{az}	3.41
Lactic acid	33.9^{bz}	45.1^{az}	43.9^{az}	45.9^{az}	3.41

[1]Percent discoloration.
[2]Standard error of the mean.
^{ab}Means within a row with different superscripts differ (P<0.05).
^{z}Means within a column, within a muscle with different superscripts differ (P<0.05).

Table 4. Mean lightness (L*), redness (a*), and yellowness (b*) values for the *complexus* and *serratus ventralis* muscles from beef chuck rolls treated with water or lactic acid and aged in a vacuum package at 35-39°F for up to 28 days

	Aging time				
Color Attribute	Day 3	Day 14	Day 21	Day 28	SEM[1]
complexus					
L*[2]					
Water	34.7^{by}	39.0^{ay}	39.1^{ay}	39.8^{az}	0.821
Lactic acid	36.0^{by}	40.2^{ay}	39.9^{ay}	41.9^{ay}	0.821
a*[3]					
Water	28.4^{ay}	24.2^{by}	22.3^{by}	23.4^{by}	0.734
Lactic acid	27.9^{ay}	22.8^{by}	21.0^{by}	23.2^{by}	0.734
b*[4]					
Water	28.4^{ay}	23.8^{by}	21.3^{cy}	24.1^{by}	0.685
Lactic acid	26.9^{ay}	23.5^{by}	21.0^{cy}	24.9^{by}	0.685
serratus ventralis					
L*[2]					
Water	36.5^{by}	38.3^{bz}	37.1^{bz}	43.2^{ay}	0.821
Lactic acid	36.7^{by}	40.9^{ay}	40.9^{ay}	42.3^{ay}	0.821
a*[3]					
Water	29.3^{ay}	22.3^{by}	21.5^{by}	23.5^{by}	0.734
Lactic acid	28.9^{ay}	22.7^{by}	20.9^{by}	23.1^{by}	0.734
b*[4]					
Water	29.1^{ay}	20.2^{cz}	18.9^{cy}	23.3^{by}	0.685
Lactic acid	28.9^{ay}	22.2^{cy}	20.0^{cy}	24.0^{by}	0.685

[1]Standard error of the mean.
[2]L* lightness (0 = black, 100 = white).
[3]a* redness/greenness (positive values = red, negative values = green).
[4]b* yellowness/blueness (positive values = yellow, negative values = blue).
[ab]Means within a row with different superscripts differ (P<0.05).
[yz]Means within a column, within a muscle with different superscripts differ (P<0.05).