Abstract ID #: 61

THE EFFECTS OF NOVEL ANTIMICROBIALS ON QUALITY AND SHELF-LIFE CHARACTERISTICS OF BLADE TENDERIZED BEEF STRIP LOINS

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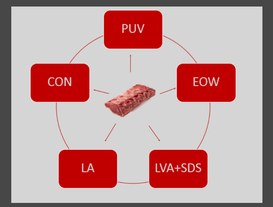
Introduction

- Beef tenderness is an important palatability attribute for consumer satisfaction.
- To enhance tenderness blade tenderization (BT) is commonly employed; however, foodborne outbreaks have been associated with BT products.
- Application of antimicrobial interventions prior to BT is a commonly employed to reduce the inherent risk of BT.
- As new antimicrobial technologies arise, they must also be tested to ensure the quality and shelf life is not compromised.

Objectives

The objective of this study was to investigate the effects of pulse ultra-violet light (PUV), 5% levulinic acid + 0.5% sodium dodecyl sulfate (LVA+SDS), and electrolyzed oxidizing water (EOW; 50 ppm Cl), on beef strip loin (SL) subprimals prior to BT to see their effects on shelf life and sensory characteristics compared to SL treated with 4.5% lactic acid (LA), and no antimicrobial intervention (CON).



Materials and Methods

- Whole USDA Choice beef SL (n = 75) of known date were randomly assigned to antimicrobial interventions across three replications.

Treatment application

- Pulse UV samples were treated for 15 s at 5.754 J/cm^2 6±2 cm from the quartz window.
- All other treatments were applied to subprimals using a six-nozzle sanitizing cabinet (0.42 L/nozzle·min^{-1} at 275.79 kPa).
- SL made a single pass, lean side up, through a mechanical tenderizer (Ross TC700MC).
- After BT, SL were vacuum packaged, boxed, and stored (0±1ºC) for 7 d.

Quality measurements

Warner-Bratzler shear force and sensory analysis

- Following storage, subprimals were squared and 2 steaks (2.54 cm) were cut from the anterior face with one designated for Warner-Bratzler shear force and the other for trained sensory analysis.
- Pulse UV samples were not included in sensory analysis due to the PUV equipment being previously utilized in pathogen studies.

Retail display color

- After steak removal, roasts (5 cm) were cut for shelf life analysis, packaged in Styrofoam trays with PVC overwrap and randomly assigned to 0, 1, 2, 3, 5, or 7 d of display in open top coffin display cases (0±1.5ºC, two defrost cycle every 24 h) and 24 h lighting (1600 - 2100 lux; 30000K).
- On each day objective color was measured on d 7 roasts for L*, a*, b*, hue, chroma, and ΔE.

Aerobic plate count and thiobarbituric acid reactive substance analysis

- Aerobic plate count (APC) and thiobarbituric acid reactive substance analysis (TBARS) were also quantified on d 0, 1, 2, 3, 5, and 7 roasts.

Statistical analysis

- Data were analyzed using Proc Mixed (V9.4, SAS Inst.) as a randomized split-plot where sub-primal was the whole plot and steak or roast was the subplot.
- The PDIFF option of least squares means was utilized to test for differences ($\alpha \leq 0.05$).

Results

- APC increased ($P < 0.05$) with extended display, and, even though APC were similar ($P > 0.05$) among CON (5.64 log CFU/cm^2), PUV (5.20 log CFU/cm^2), and EOW (5.78 log CFU/cm^2), both LVA+SDS- and LA-treated roast had lower ($P < 0.05$) APC than all other treatments (3.49 and 4.33 log CFU/cm^2, respectively).
- Antimicrobial treatment prior to BT did not ($P > 0.05$) affect objective color measures. However, as display progressed L*, a*, b*, and chroma decreased ($P < 0.05$), while hue and ΔE values increased ($P < 0.05$).
- Antimicrobial treatments did not ($P>0.05$) affect lipid oxidation, WBSF, or sensory characteristics.

Conclusion

- The results from this study suggest that LVA+SDS could be used as an antimicrobial prior to SL BT without compromising quality or sensory characteristics.

Acknowledgment

Funding was provided by an Agriculture and Food Research Initiative Grant no. 2011-68003-30012 from the USDA National Institute of Food and Agriculture, Food Safety: Food Processing Technologies to Destroy Food-borne Pathogens Program – (A4131).

Results

Aerobic plate count treatment by day interaction

Table 1. Least squares means and standard errors for aerobic plate count treatment by day interaction for roasts from beef strip loins subjected to antimicrobial intervention and blade tenderization

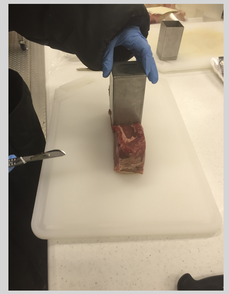
	Treatment[a]					
Day	CON	PUV	EOW	LVA+SDS	LA	SEM[b]
0	3.69ax	3.05ax	3.64ax	2.57ay	2.52ay	0.31
1	4.51bx	3.46ay	4.47bx	2.21az	3.20by	0.31
2	4.91bcx	4.48bxz	5.24cx	2.89ay	3.79cz	0.31
3	5.29cx	4.91bxz	5.46cx	2.83ay	4.11cz	0.31
5	7.02dx	6.71cx	7.17dx	4.12by	5.01dz	0.31
7	8.47ex	8.59dx	8.72ex	6.31cy	7.37ez	0.31

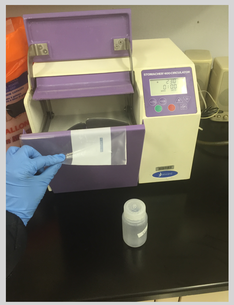
a,b,c,d, and e, indicates means within treatments (within columns) that do not share a common letter are statistically different ($P \leq 0.05$); x, y and z, indicates means within sampling point (within rows) that do not share a common letter are statistically different ($P \leq 0.05$).

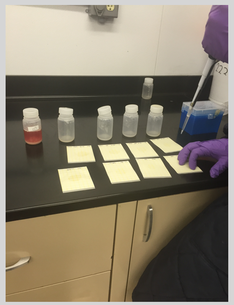
[a]Antimicrobial intervention: CON = control; blade tenderization only; PUV = Pulse ultraviolet light; EOW = electrolyzed oxidizing water (50 mg/L); LVA+SDS = 5% v/v Levulinic acid plus 0.5% w/v sodium dodecyl sulfate; LA = 4.5% v/v lactic acid.

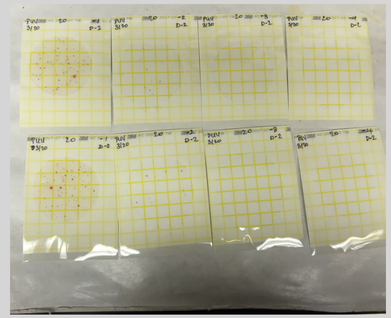
[b]SEM = standard error of means.

[c]Values are reported as CFU/cm^2.









Results

Objective color and myoglobin content main effects by treatment

Table 2. Least squares means and standard errors for objective color and myoglobin content main effects by treatment for roasts from beef strip loins subjected to antimicrobial intervention and blade tenderization

	Treatment[a]					
Variables[b]	CON	PUV	EOW	LVA+SDS	LA	SEM[c]
L*	39.52	39.57	37.64	36.96	37.79	0.86
a*	26.41	25.82	25.68	26.36	27.44	0.68
b*	21.21	20.96	20.66	21.08	21.98	0.41
Hue	39.01	39.49	39.17	38.96	38.85	0.66
Chroma	33.91	33.30	32.99	33.79	35.18	0.74
ΔE	6.29	7.50	7.54	7.82	6.19	0.84
DMb	0.99	0.92	1.32	1.45	1.28	0.17
OMb	0.21	0.23	0.22	0.21	0.20	0.01
MMb	1.29	1.26	1.27	1.28	1.32	0.02

[a]Antimicrobial intervention: CON = control; blade tenderization only; PUV = Pulse ultraviolet light; EOW = electrolyzed oxidizing water (50 mg/L); LVA+SDS = 5% v/v Levulinic acid plus 0.5% w/v sodium dodecyl sulfate; LA = 4.5% v/v lactic acid.
[b]*L** = 0 = black to 100 = white; *a** = measurement of green to red on color spectrum, high values indicate more red; *b** = measurement of yellow to blue on color spectrum, higher values indicate more yellow; Hue = lower values indicate redder color; Chroma = higher value indicates more red saturation; DMb = deoxymyoglobin; OMb = oxymyoglobin; MMb = metmyoglobin.
[c]SEM= standard error of means.

Objective color and myoglobin content main effects by day

Table 3. Least squares means and standard errors for objective color and myoglobin content main effects by day for roasts from beef strip loins subjected to antimicrobial intervention and blade tenderization

	Day of display								
Varibles[a]	0	1	2	3	4	5	6	7	SEM[b]
L*	40.11a	39.14b	39.22b	38.45c	37.93d	37.60d	36.95e	36.95e	0.42
a*	31.77a	30.08b	28.65c	27.59d	25.99e	24.71f	22.14g	19.78h	0.38
b*	24.65a	23.36b	22.67c	21.69d	20.61e	20.05f	18.65g	17.44h	0.23
Hue	37.79a	37.81a	38.37b	38.19ab	38.47ab	39.18c	40.43d	42.54e	0.37
Chroma	40.22a	38.09b	36.56c	35.10d	33.19e	31.84f	28.99g	26.67h	0.41
ΔE	0.00a	2.89b	36.56c	5.80d	7.72e	9.21f	12.01g	14.40h	0.46
DMb	1.21	1.24	1.14	1.19	1.18	1.21	1.21	1.21	0.08
OMb	0.17a	0.17b	0.18c	0.20d	0.21e	0.23f	0.26g	0.30h	0.01
MMb	1.48a	1.41b	1.37c	1.34d	1.28e	1.23f	1.14g	1.03h	0.02

a, b, c, d, e, f, g, and h - Least squares means within rows with different letters are different ($P < 0.05$).
[a]*L** = 0 = black to 100 = white; *a** = measurement of green to red on color spectrum, high values indicate more red; *b** = measurement of yellow to blue on color spectrum, higher values indicate more yellow; Hue = lower values indicate redder color; Chroma = higher value indicates more red saturation; DMb = deoxymyoglobin; OMb = oxymyoglobin; MMb = metmyoglobin.
[b]SEM= standard error of means.

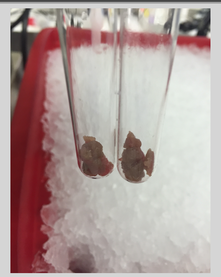
Results

Thiobarbituric acid reactive substance analysis treatment

Table 4. Least squares means and standard errors for thiobarbituric acid reactive substance analysis (TBARS) treatment by day interaction for roasts from beef strip loins subjected to antimicrobial intervention and blade tenderization

	Treatment[a]					
Day	CON	PUV	EOW	LVA+SDS	LA	SEM[b]
0	0.13a	0.13a	0.14a	0.17a	0.14a	0.12
1	0.16a	0.19a	0.18a	0.20a	0.17a	0.12
2	0.18a	0.18a	0.19a	0.28b	0.24a	0.12
3	0.19a	0.26a	0.39b	0.40b	0.29a	0.12
5	0.52b	0.58b	0.47b	0.63c	0.47b	0.12
7	0.55bx	0.69bx	0.69cx	1.27dy	0.80cx	0.12

a,b,c,d, and e, indicates means within treatments (within columns) that do not share a common letter are statistically different ($P \leq 0.05$); x, and y indicates means within sampling point (within rows) that do not share a common letter are statistically different ($P \leq 0.05$).
[a]Antimicrobial intervention: CON = control; blade tenderization only; PUV = Pulse ultraviolet light; EOW = electrolyzed oxidizing water (50 mg/L); LVA+SDS = 5% v/v Levulinic acid plus 0.5% w/v sodium dodecyl sulfate; LA = 4.5% v/v lactic acid.
[b]SEM = standard error of means.
[c]Values are reported in mg MDA/kg meat.



Sensory and cooking characteristics for roasts

Table 5. Least squares means and standard error main effects for sensory and cooking characteristics for roasts from beef top sirloin subjected to antimicrobial intervention and blade tenderization

	Treatment[a]					
Variables	CON	PUV	EOW	LVA+SDS	LA	SEM[b]
Initial Tenderness[c]	4.55	-	5.22	4.89	5.13	0.31
Sustained Tenderness[c]	4.92	-	5.60	5.47	5.45	0.34
Beef Flavor Intensity[d]	3.95	-	4.37	4.33	4.29	0.28
Juiceness[e]	3.7	-	4.01	4.37	4.14	0.31
Off-flavor[f]	1.33	-	1.38	1.34	1.45	0.16
WBSF[g]	3.08	2.63	2.59	3.20	2.79	0.24

[a]Antimicrobial intervention: CON = control; blade tenderization only; PUV = Pulse ultraviolet light; EOW = electrolyzed oxidizing water (50 mg/L); LVA+SDS = 5% v/v Levulinic acid plus 0.5% w/v sodium dodecyl sulfate; LA = 4.5% v/v lactic acid.
[b]SEM = standard error of means.
[c]8 = extremely tender, 7 = very tender, 6 =moderately tender, 5 = slightly tender, 4 = slightly tough, 3 = moderately tough, 2 = very tough, and 1 = extremely tough.
[d]8 = extremely intense, 7 = very intense, 6 = moderately intense, 5 = slightly intense, 4 = slightly bland, 3 = moderately bland, 2 = very bland and 1 = extremely bland.
[e]8 = extremely juicy, 7 = very juicy, 6 = moderately juicy, 5 = slightly juicy, 4 = slightly dry, 3 = moderately dry, 2 = very dry, and 1 = extremely dry.
[f]6 = extreme off-flavor, 5 = very strong off-flavor, 4 = moderate off-flavor, 3 = slight off-flavor, 2 = threshold off-flavor, and 1 = non-detected.
[g]Warner-Bratzler Shear Force.