



# Effects of buffered vinegar and sodium dodecyl sulfate plus levulinic acid on *Salmonella* Typhimurium survival and ground beef quality

A.M. Stelzleni, R.J. Kersey\*, A. Ponrajan, and M.A. Harrison  
Meat Science Technology Center, University of Georgia, Athens 30602

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## INTRODUCTION

- *Salmonella spp.* is a foodborne pathogen of concern in red meat products
  - In recent years there have been several recalls of ground beef products due to *Salmonella spp.* contamination
  - In 2010 the CDC stated a 3% increase in laboratory confirmed *Salmonella spp.* infections compared to 1996-1998
  - The CDC also estimated that nontyphoidal *Salmonella* was a leading contributor to illness and death attributed to domestic food sources for 2011
  - Ground beef is a food at risk of harboring *Salmonella* due to the mixing of surface material and improper handling at the end user
- OBJECTIVES:**
- Determine the effects of commercially available antimicrobials on *Salmonella* Typhimurium (ST) survival, shelf-life, and ground beef quality when added to beef trimmings

## MATERIALS AND METHODS

- **ST Challenge** (replicated 3 times)
- 15 kg of trim (80/20) were inoculated with ST (H2662, H3380, H3278, & H3402) by immersion containing  $10^5$  CFU/ml per treatment
- Trimmings were mixed 5 min with 1) no treatment (CNT), 2) liquid buffered vinegar 2% w/v (LVIN), 3) powdered buffered vinegar 2.5% w/w (PVIN), or 1.0% levulinic acid + 0.1% SDS at 10% w/v (SDLA)
- Trim was ground and 90, 113 g patties were produced per treatment
- 25 patties/treatment were randomly selected and wrapped in Styrofoam trays with PVC
- Patties were randomly assigned to 0, 1, 3, 5, or 7d storage ( $2 \pm 1^\circ\text{C}$  at 960 lux)
- On assigned day, 25 g of each patty was stomached with 225 ml buffered peptone water and serial dilutions were plated on tryptic soy agar containing 50  $\mu\text{g}/\text{ml}$  ampicillin
- Plates were incubated at  $37 \pm 2^\circ\text{C}$  for  $24 \pm 2$  h
- ST challenge was conducted in BL2 lab in UGA Department of Food Science
- **Shelf-life Challenge** (replicated 3 times)
- The shelf-life challenge was conducted at the UGA Meat Science Technology Center
- Samples for the shelf-life challenge were prepared following the same methods as the ST challenge except the trimmings were not inoculated
- On d 0, 1, 3, 5, & 7 patties were evaluated for objective color, subjective color, purge loss, lipid oxidation, and psychrotrophic organisms
- 10 additional patties were selected for trained sensory and Kramer shear analysis

## RESULTS

**Table 1.** ST inoculation and antimicrobial main effect<sup>1</sup> count levels (log CFU/g)

Item	Treatment				SEM
	CNT	LVIN	PVIN	SDLA	
Inoculation	5.98	5.95	5.95	5.96	0.04
Counts	5.62 <sup>a</sup>	5.45 <sup>b</sup>	5.36 <sup>c</sup>	5.26 <sup>d</sup>	0.03

<sup>abcde</sup>Within a row denotes difference at  $P < 0.05$

<sup>1</sup>D 7 patties had lower counts than d 0, 1, 3, or 5 (0.14-0.08 log CFU/g)  $P < 0.05$

**Table 2.** pH<sup>1</sup>, cooking, and sensory characteristics for ground beef patties

Item	Treatment				SEM
	CNT	LVIN	PVIN	SDLA	
pH	5.65 <sup>a</sup>	5.63 <sup>a</sup>	5.78 <sup>a</sup>	5.36 <sup>b</sup>	0.05
Thaw loss, %	3.63 <sup>b</sup>	4.06 <sup>b</sup>	2.46 <sup>b</sup>	9.20 <sup>a</sup>	1.00
Cook loss, %	24.49 <sup>ab</sup>	24.24 <sup>ab</sup>	20.41 <sup>b</sup>	29.33 <sup>a</sup>	2.49
Kramer, kgf/g	2.64	2.71	2.76	2.57	0.09
Cohesion <sup>2</sup>	2.64	2.71	2.76	2.57	0.09
Beef flavor <sup>3</sup>	4.96 <sup>a</sup>	4.33 <sup>b</sup>	4.28 <sup>b</sup>	4.92 <sup>a</sup>	0.19
Juiciness <sup>4</sup>	4.44 <sup>ab</sup>	4.15 <sup>b</sup>	5.01 <sup>a</sup>	4.29 <sup>ab</sup>	0.36
Off-flavor <sup>5</sup>	1.14 <sup>c</sup>	1.88 <sup>b</sup>	3.30 <sup>a</sup>	1.29 <sup>c</sup>	0.24

<sup>abcde</sup>Within a row denotes difference at  $P < 0.05$

<sup>1</sup>Antimicrobial main effects through 7 d simulated retail display

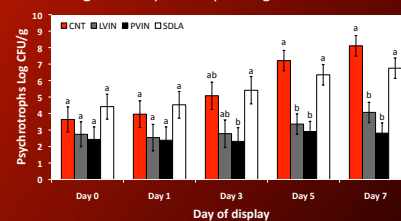
<sup>2</sup>1=extremely fragile, 8=extreme cohesion

<sup>3</sup>1=extremely bland, 8=extremely intense

<sup>4</sup>1=extremely dry, 8=extremely juicy

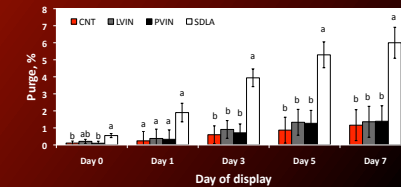
<sup>5</sup>1=not detected, 6=extremely strong

**Figure 1.** Psychrotrophic organism counts<sup>1</sup>



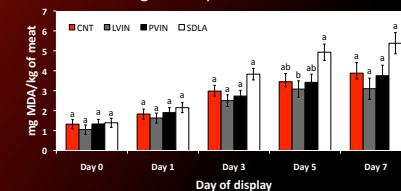
<sup>1</sup>Letters ab denote difference within day of display  $P < 0.05$

**Figure 2.** Percent purge during display<sup>1</sup>



<sup>1</sup>Letters ab denote difference within day of display  $P < 0.05$

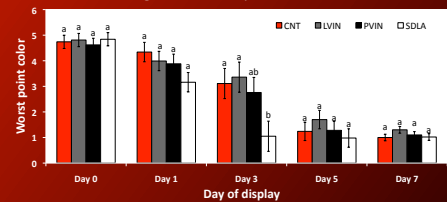
**Figure 3.** Lipid oxidation<sup>1</sup>



<sup>1</sup>Letters ab denote difference within day of display  $P < 0.05$

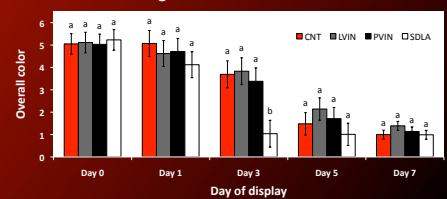
**Shelf-life Color**

**Figure 4.** Worst point color<sup>1</sup>



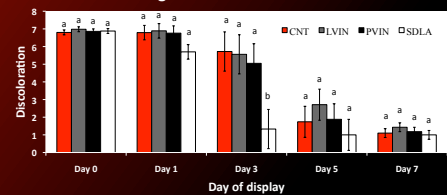
<sup>1</sup>1=brown/gray, 6=light red/pink; Cumulative area at least 2 cm; ab denotes difference within day of display  $P < 0.05$

**Figure 5.** Overall color<sup>1</sup>



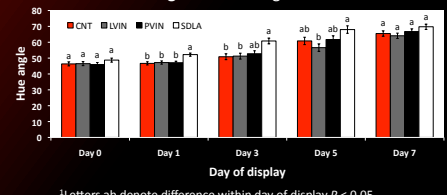
<sup>1</sup>1=brown/gray, 6=light red/pink; ab denotes difference within day of display  $P < 0.05$

**Figure 6.** Discoloration<sup>1</sup>



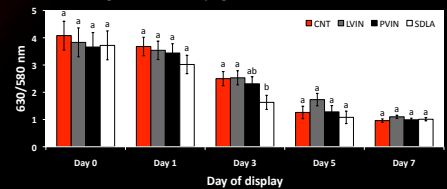
<sup>1</sup>1=96-100% discolored, 7=0-4% discolored; ab denotes difference within day of display  $P < 0.05$

**Figure 7.** Hue angle<sup>1</sup>



<sup>1</sup>Letters ab denote difference within day of display  $P < 0.05$

**Figure 8.** Metmyoglobin 360/580 nm<sup>1</sup>



<sup>1</sup>Letters ab denote difference within day of display  $P < 0.05$

## CONCLUSIONS & IMPLICATIONS

- All treatments reduced ST, however, no reductions were greater than 0.5 log CFU/g
- Buffered vinegar retarded psychrotrophic organism growth, but PVIN had greater off-flavor
- SDLA had more moisture loss, and shortest shelf-life
- LVIN may extend shelf-life with out affecting moisture

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