2020

Impact of Feeding NaturSafe® (An Immune Support Product) on Beef Quality

Morgan L. Henriott

Kellen B. Hart

Nicolas J. Herrera

Felipe A. Ribeiro

Nicolas A. Bland

See next page for additional authors

Authors

Morgan L. Henriott, Kellen B. Hart, Nicolas J. Herrera, Felipe A. Ribeiro, Nicolas A. Bland, Bucky L. Gwartney, and Chris Calkins

Impact of Feeding NaturSafe® (An Immune Support Product) on Beef Quality

Morgan L. Henriott
Kellen B. Hart
Nicolas J. Herrera
Felipe A. Ribeiro
Nicolas A. Bland
Bucky L. Gwartney
Chris R. Calkins

Summary with Implications

The objective of this study was to evaluate the effects of feeding NaturSafe® and the potential impact on meat quality characteristics in beef. Steers were fed one of five diets: a control with dietary antibiotics, a control without dietary antibiotics, or a diet without antibiotics containing 12 g/d/, 15 g/d/, or 18 g/d/ of NaturSafe® for a period of 112 d. Following harvest, strip loins were collected, aged for 13 or 29 d and placed under retail display conditions for 0 or 7 d. Feeding NaturSafe® at 12 g/d or 15 g/d resulted in tenderness (shear force) values less than or equal to the control diets. Differences in color were observed between the NaturSafe® levels and the control diets. However, feeding NaturSafe® had minimal discernible effects overall, on meat quality.

Introduction

NaturSafe® (Diamond V, USA) is a *Saccharomyces cerevisiae* fermentation product developed as a natural nutritional health product used in beef rations to enhance rumen and immune health. NaturSafe® has been specifically formulated to optimize beef cattle health, and performance, antibiotic stewardship, and food safety. Previous research has shown that NaturSafe® supports optimal rumen and liver health, overall animal health and immune function, consistency of feed intake, daily gain, feed conversion, and antibiotic effectiveness. However, little research has been conducted to evaluate the potential impact of NaturSafe® on beef quality. Therefore, the objective of this research was to characterize the effects of feeding NaturSafe® on beef quality characteristics.

Procedure

Sixty crossbreed steers (mean hot carcass weight = 928 lb.) were individually fed for 112 d through an antibiotic free production system. Cattle were randomly assigned to one of the five diet treatments (12 head per treatment): 12 g/d, 15 g/d, or 18 g/d of NaturSafe®, control diet without (-AB) antibiotics, or a control with antibiotics (+AB; 330 mg monensin + 110 mg tylosin·steer-1·d^{-1}). Following harvest, strip loins from the right side of the carcass were collected and wet-aged for 13 d or 29 d postmortem. Fat and lean cores were excised for microbiological evaluation prior to fabrication of steaks. From each strip loin three one-inch steaks were fabricated: one steak for tenderness measurements at 0 d of retail display, one steak for instrumental color, subjective color, and tenderness measurements after 7 d of retail display, and one steak for all other laboratory analysis. Laboratory analysis included: pH, sarcoplasmic calcium concentration, troponin-T degradation, fatty acid profile, proximate composition, sarcomere length, total collagen and insoluble collagen. One half inch steak was also fabricated and cut in half [half for lipid oxidation 0 d and half for lipid oxidation after 7 d of retail display]. After fabrication all steaks used for retail display were placed on foam trays, overwrapped with oxygen permeable film, and placed under simulated retail display conditions for 7 d at 37°F. The same fabrication scheme was used for both aging periods of 13 and 29 d. Microbiological analyses were conducted for aerobic plate counts (APC), psychotropic plate counts (PPC), and lactic acid bacteria (LAB) plate counts. Tenderness was measured using the Warner-Bratzler shear force (WBSF) method, sarcomere length was measured via laser diffraction, free Ca^{2+} concentration was analyzed via inductively coupled plasma spectroscopy following high-speed centrifugation, pH was measured via pH meter, and troponin-T degradation was analyzed via immunoblotting. Fatty acid profile was measured via gas chromatography, and collagen was measured via amount of total and insoluble collagen present in lean. Proximate composition including: moisture and ash (%) were measured via Thermogravimetric Analyzer, fat content was measured via ether extraction, and protein content measured via calculated differences. Lipid oxidation or Thiobarbituric acid reactive substance values (TBARS) were measured via the amount of mg of malonaldehyde per kg of muscle tissue subjected to retail display periods of 0 d or 7 d. Instrumental color was measured via colorimeter measuring L* (lightness), a* (redness), and b* (yellowness) and a portable spectrometer was used to measure percentage surface of oxymyoglobin, metmyoglobin, and deoxymyoglobin. Subjective discoloration was also evaluated daily during retail display by a panel of five trained panelists using a percentage scale where 0% meant no discoloration and 100% meant complete surface discoloration.

Sarcomere length, pH, fatty acid profile, proximate composition, total collagen, insoluble collagen, were analyzed as a completely randomized design. Free Ca^{2+} concentration, troponin-T degradation, and percentage of oxymyoglobin, metmyoglobin, and deoxymyoglobin were analyzed as a split-plot design with dietary treatment as the whole plot and aging period as the split-plot. The APC, PPC, LAB, WBSF, and TBARS data were analyzed as a split-split plot design with dietary treatment as the whole-plot, aging period as the split-plot and days of retail display as the split-split plot. The L*, a*, b* values and subjective discoloration data were analyzed as a split-split-plot design with day of retail display considered as a repeated measure. Animal was considered the experimental unit and

Table 1. Analytical measures of strip loins steaks from steers fed a control diet without antibiotics, control diet with antibiotics, or 12 g/d, 15 g/d, or 18 g/d NaturSafe®.

	Dietary Treatment					
	Control No DV, No antibiotics	Control-Antibiotics	12 g/d NaturSafe®	15 g/d NaturSafe®	18 g/d NaturSafe®	P-Value
WBSF (lbs of force)	6.99[a]	5.73[b]	5.56[b]	5.51[b]	7.01[a]	.0013
Sarcomere Length (µm)	1.68	1.64	1.69	1.66	1.65	.5408
pH	5.58	5.56	5.57	5.59	5.58	.9063
Calcium (µm)	92.74	83.76	83.96	90.75	96.71	.1779
Troponin-T Degradation (%)	14.26	16.62	18.20	20.14	17.57	.3330
Total Collagen (mg/g)	5.28	4.65	4.52	4.69	4.22	.5006
Insoluble Collagen (mg/g)	4.03	4.35	3.70	3.99	3.73	.8348
Soluble Collagen (mg/g)	1.48	1.69	1.71	.31	.47	.7075
Moisture (%)	70.59	70.43	70.91	70.97	71.02	.8263
Protein (%)	19.11	18.39	19.01	19.13	19.14	.2349
Fat (%)	8.57	9.36	8.23	7.98	8.03	.3801
Ash (%)	1.74	1.83	1.85	1.92	1.81	.4311
Discoloration 13 d[1]	.08[b]	0.00[b]	.25[b]	0.00[b]	.27[b]	.0010
Discoloration 29 d[1]	1.40[b]	1.08[b]	2.00[b]	8.03[a]	.76[b]	.0010
Lipid Oxidation (mg malon-aldehyde/kg)	1.98	1.79	1.81	1.67	1.62	.5438
Metmyoglobin (%)	23.02	22.55	23.76	24.49	24.66	.7326
Deoxymyoglobin (%)	1.84[c]	3.05[bc]	3.25[bc]	5.80[a]	4.60[ab]	.0077
Oxymyoglobin (%)	75.14	74.40	72.99	69.71	70.75	.1562
Aerobic Plate Count (log cfu/cm^2)	5.63	5.41	5.58	5.71	5.63	.7309
Psychotropic Plate Count (log cfu/cm^2)	3.94	3.33	3.70	4.17	4.17	.9558
Lactic Acid Bacteria (log cfu/cm^2)	8.51	8.38	8.33	8.13	8.21	.5004
SFA (%)[†]	44.59	44.87	44.18	44.43	44.32	.9344
UFA (%)[†]	55.29	55.08	55.74	55.43	55.63	.9146
MUFA (%)[†]	51.55	51.42	52.12	51.82	51.69	.9347
PUFA (%)[†]	3.74	3.60	3.62	3.62	3.94	.8216
Trans Fatty Acid (%)	2.24	2.28	2.19	1.99	2.17	.5433

[a-c] Means in the same column with different superscripts are different (P<0.05).

[1 a-d] Indicate differences among aging periods and treatments (P<0.05).

[†]SFA = saturated fatty acids, UFA= unsaturated fatty acids, MUFA = monounsaturated fatty acids, and PUFA = polyunsaturated fatty acids.

hot carcass weight and marbling score were used as covariates in the analysis. Data was analyzed using the PROC GLIMMIX procedure of SAS with the LS MEANS statement and TUKEY adjustment. Statistical significance was determined at $P < 0.05$.

Results

There were no dietary treatment effects for APC, PPC, and LAB (P=.7309, P=.9558, and P=.5004, respectively). However, aging time affected PPC, with 29 d having a higher amount of colony forming units (CFU) than 13 d (P<.0001). Allowing the beef to age would allow psychotropic bacteria to grow and multiply, contributing to the increase in CFU. Microbiological analyses were conducted to determine if feeding NaturSafe® reduced the prevalence of microbial growth on the lean. A reduction of microbes could lead to beef with longer shelf life and reduce meat spoilage. Bacterial counts are presented in Table 1.

Dietary treatment affected tenderness (P=.0013). The diets that contained 12 g/d and 15 g/d of NaturSafe®, along with the +AB control, exhibited lower shear force values indicating the steaks were more tender than the 18 g/d NaturSafe® and -AB control (Figure 1). Tenderness is extremely influential in consumers' decisions to repurchase meat.

Sarcomere length, pH, and collagen content were measured as potential indicators of meat tenderness. Typically, a longer sarcomere length, higher pH, and less collagen are associated with greater tenderness. Dietary treatment, however, had no effect

Table 2. Instrumental color values (L*, a*, b*) of strip loins steaks from steers fed either a control diet without antibiotics, control diet with antibiotics, 12 g/d, 15 g/d, or 18 g/d NaturSafe®.

		Dietary Treatment					
Instrumental Color Values	Aging	Control No DV, No antibiotics	Control-Antibiotics	12 g/d NaturSafe®	15 g/d NaturSafe®	18 g/d NaturSafe®	P-Value
L*	13 d	43.43[c]	46.28[a]	46.15[ab]	45.09[b]	44.75[b]	0.0111
	29 d	45.54[b]	46.57[a]	45.06[b]	45.57[ab]	46.26[ab]	
a*	N/A	19.41[b]	19.50[b]	18.52[b]	18.64[b]	20.54[a]	0.0003
b*	N/A	9.29[b]	9.84[a]	9.09[b]	9.36[b]	10.11[a]	0.0005

[a-c] Means in the same row with common superscript letters are not different (P<0.05).

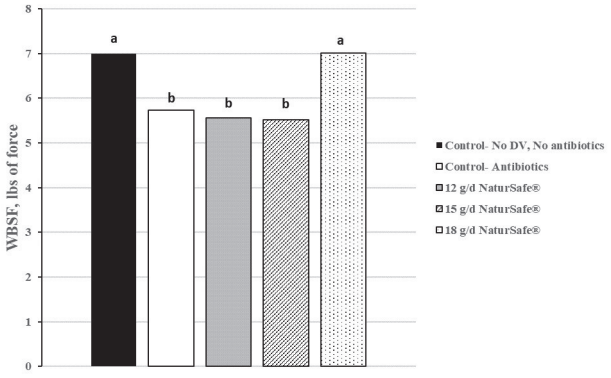

Figure 1. Warner Bratzler Shear Force of strip loins steaks fed either a control diet without antibiotics, control diet with antibiotics, 12 g/d, 15 g/d, or 18 g/d NaturSafe®.
[a,b] Different superscripts indicated differences (P<0.05).

on sarcomere length, pH, total collagen, insoluble collagen, and proximate composition (Table 1). Differences in collagen could have contributed to tenderness results or to overall eating quality for consumers if a significant difference would have been observed.

Days of aging had an effect on free Ca^{2+} concentration (P<.0001). Steaks that were aged for 29 d exhibited higher amounts of free calcium concentration than the 13 d steaks (P<.0001). However, no dietary treatment was observed for free Ca^{2+} concentration (P=.1779). Free Ca^{2+} concentration values can be found in Table 1. Calcium plays a major role in meat tenderization. Free Ca^{2+} concentration was measured since an increase in Ca^{2+} could activate enzymes causing an increase in proteolysis and leading to more tender meat. However, the lack of difference in free Ca^{2+} concentration does not explain observed differences in tenderness.

Troponin-T degradation was utilized as an indicator of proteolysis. During proteolysis, enzymes start breaking down different structures in the sarcomere and myofibril that leads to an increase in meat tenderness. Therefore, degradation of proteins, such as troponin-T often is used as an indicator of tenderness. However, there was no dietary treatment effect on troponin-T degradation (P=.3330). As anticipated, steaks aged for 29 d had higher amounts of troponin-T degradation than those aged 13 d (P<.0001).

Dietary treatment had an effect on fatty acid profile when compared on a mg/100 g tissue basis (Table 1, P=.0302). The +AB control group had significantly more alpha-linolenic acid [C18:3w3] than the 15 g/d and 18 g/d NaturSafe steaks on a mg/100 g tissue basis There were no other differences among the fatty acid profiles on both a percentage and mg/100 g tissue basis.

Lipid oxidation was determined as an indicator of oxidation or rancidity of the meat. Diet had no effect on lipid oxidation (P=.5438). The TBARS values displayed a days of aging by retail display interaction (P=.0164). Steaks aged for 29 d and subjected to 7 d of retail display had the highest TBARS values, as expected. Steaks that were aged for both 13 d and 29 d and not subjected to retail display had the lowest lipid oxidation. However, it should be noted that mean values for days of aging by retail display ranged from 1.13 to 2.60 mg malonaldehyde/kg. The values obtained would not relate to extreme off-flavors or detrimental effects on quality.

Color is the number one factor consumers consider when making their purchasing decisions. Consumers desire a bright red cherry color meat. The L* values represent darkness to lightness, a* measures greenness to redness, and b* is an indicator of blueness to yellowness. The L* values increased or became lighter over retail display and had a days of aging by retail display effect (P<.0001). Steaks that were aged for 13 d had significantly higher L* values at 6 d of retail display compared to the 29 d steaks. The L* values also had dietary treatment by days of aging effect (P=.0111). There were no differences in lightness for the control (+AB), 12 g/d, and 15 g/d of NaturSafe® among aging periods. The a* and b* values exhibited a dietary treatment effect and a days of aging by retail display effect (Table 2). Steaks from cattle fed 18 g/d, NaturSafe®, had significantly higher a* values than all other treatments (P=.0003). The a* values decreased as days of retail display increased for both aging periods, however, the 13 d aged steaks had significantly higher a* values at every day of retail display than the 29 d aged steaks (P<.0001). The b* values followed the same trend as a*, decreasing as days of retail displayed increased. The 18 g/d of NaturSafe® and control (+AB) had significantly higher b* values than all other treatments (P=.0005). A significant difference between the aging periods can be found beginning at 2 d and continuing throughout the rest of retail display with 29

d having a lower b* value than 13 d aged steaks ($P<.0001$).

Percentage of metmyoglobin and oxymyoglobin were both influenced by days of aging with oxymyoglobin being higher in the 13 d aged steaks and metmyoglobin being lower, compared to the 29 d steaks ($P<.0001$). Deoxymyoglobin was influenced by both days of aging and dietary treatment. Steaks aged for 29 d had significantly more percent deoxymyoglobin than the 13 d steaks ($P=.0024$). The 15 g/d of NaturSafe® had more deoxymyoglobin than both controls and the 12 g/d of NaturSafe® ($P=.0077$). A greater percent of oxymyoglobin is most desirable because it indicates that oxygen is bound to the heme iron molecule, creating a bright red color. Dietary treatment by days of aging and days of aging by retail display both influenced discoloration. Steaks from the 15 g/d NaturSafe®, aged for 29 d had the largest amount of discoloration compared to all other treatments ($P=.0010$). However, it should be noted that discoloration values for all steaks were quite low. Discoloration for the 29 d steaks was significantly higher at days 6 and 7 of retail display compared to the 13 d steaks ($P<.0001$).

These data suggest that feeding NaturSafe® 12 g/d or 15 g/d to cattle caused very few differences in beef characteristics compared to the control diet with antibiotics. Feeding NaturSafe® to cattle at 18 g/d caused a few more differences compared to the other two levels of NaturSafe®. Overall, feeding NaturSafe® had minimal discernible effects on meat quality.

Morgan L. Henriott, graduate student

Kellen B. Hart, graduate student

Nicolas J. Herrera, graduate student

Felipe A. Ribeiro, graduate student

Nicolas A. Bland, graduate student

Bucky L. Gwartney, Diamond V, Inc., Cedar Rapids, IA

Chris R. Calkins, professor, Animal Science, Lincoln, NE