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SUPPLEMENTATION OF FED STEERS WITH A BIOVANCE TECHNOLOGIES, INC. ANIONIC COMPOUND TO IMPROVE BEEF TENDERNESS

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Introduction

Calcium has been known to improve postmortem tenderness by the means of calcium-activated proteases (calpains) that deteriorate myofribrillar structure (Koohmaraie, 1992). Recent research has been investigating methods to achieve a higher concentration of Ca^{+2} in postmortem muscles. One method of increasing calcium is by injection of $CaCl_2$ solution into beef cuts to enhance meat tenderness (Wheeler et al., 1993).

Altering serum Ca^{+2} concentrations prior to harvest has been hypothesized to result in increased intracellular muscle Ca^{+2} content, leading to improved tenderness in postmortem muscle. Nutritional supplementation of products that effect absorption and circulation of Ca are currently being investigated. Although scientific consensus has not been reached on the topic (Scanga et al., 2001), several studies (eg., Karges et al., 2001; Montgomery et al., 2002) have shown that oral supplementation of feedlot cattle with supranutritional levels of Vitamin D_3 during the late stages of finishing, just prior to harvest, may improve beef tenderness. Feeding dairy cows a negative "Dietary Cation-Anion Balance" (DCAB) diet during the pre-partum period to induce mild metabolic acidosis increases plasma Ca^{+2} concentrations around parturition (Block, 1984) to reduce the incidence of milk fever.

Objective

The objective of the two studies was to test and demonstrate the concept of improving beef tenderness by treating fed cattle with a negative DCAB diet achieved through the supplementation of a Biovance Technologies, Inc. anionic compound.

Methodology

Cattle Selection

Trial 1—British and Continental cross steers (N=120) on feed at the Colorado State University Agricultural, Research, Development, and Education Center were divided into

two treatment groups. Steers were blocked by weight in ten head pens, and pens were randomly assigned to a treatment group. Treatments consisted of supplementation (n=62 head), and negative controls (n=58 head), with genetics as a block effect. The supplement was incorporated into a total mixed ration (TMR) for the following inclusion rate: (a) days 1 and 2 = 0.11 kg/hg/d; (b) days 3 and 4 = 0.23 kg/hg/d; (c) days 5 and 6 = 0.34 kg/h/d; and (d) days 7 through 14 = 0.46 kg/h/d to obtain a negative DCAB. Feedlot performance data were collected over the 14 day trial.

Trial 2—Three large pens of *Bos taurus* and *Bos indicus* cross steers (N=410), located at a commercial feedlot, were identified 113 days prior to harvest. Steers were of similar source and biological type within each pen. Allocation of steers to treatment groups occurred by dividing each pen into two by means of alternating animals as they were processed, for a total of 6 pens (3 treatment pens; n=206 head, 3 negative control pens; n=204 head). At the time of processing, individual ear tags were inserted and breed scores (Species: *Bos taurus* or *Bos indicus*) were recorded by Colorado State University (CSU) personnel. Supplementation with the anionic compound occurred via a TMR fed three times daily for the following inclusion rate: (a) day 1 = 0.037 kg/hd/d; (b) day 2 = 0.11 kg/hd/d; (c) days 3 and 4 = 0.23 kg/hd/d; (d) days 5 and 6 = 0.34 kg/hd/d; and (e) days 7 through 14 = 0.46 kg/hd/d. *Carcass Selection*

All cattle for both trials were harvested at a commercial facility, and individual identities were maintained via tag transfer and recording of plant carcass numbers. Following a 36-hour chilling period, personnel of CSU determined actual and adjusted preliminary yield grade, marbling score, and percentages of kidney, pelvic and heart fat, as well as recorded hot carcass weight, and USDA Yield and Quality Grade. Ribeye areas for carcasses, from trial 1, were measured using a Computer Vision System (CVS) manufactured by Research Management Systems USA, with trial 2 ribeye areas being measured by CSU personnel.

Trial 1—Carcass data were collected on all 120 steers. Sixty carcasses were randomly selected for Warner-Bratzler shear force (WBSF) data prior to USDA grading, balancing for genetic effect. Strip loins (*Longissimus* muscle) from the left side of 59 out of 60 carcasses (30 treatment, 29 control) were collected during in-plant fabrication. Strip loin samples were shipped to the CSU Meats laboratory for vacuum-packaging and aging. Steaks were aged for 3, 7, 14, 21, and 28 days postmortem, after which all steaks were subjected to WBSF evaluation. All steak samples were chilled (never frozen), cut 2.54 cm in thickness from the anterior end of the strip loin, and evaluated for shear force characteristics.

Trial 2—One hundred and four carcasses were randomly selected for carcass and WBSF data following USDA grading, balancing the number of Choice vs. Select, and *Bos taurus* vs. *Bos indicus* cattle for each treatment group. The strip loin from the left side of each carcass was collected during in-plant fabrication. Two strip loins were not obtained resulting in 50 strip loins from negative control carcasses in comparison to 52 strip loins from supplemented carcasses. Strip loin samples were shipped to the CSU Meats laboratory for portioning, vacuum-packaging and aging. Steaks were cut from the anterior end of each strip loin and were aged for 7 and 14 days, respectively, frozen, and subsequently subject to WBSF evaluation. Frozen steaks were faced to a thickness of 2.54 cm.

Warner-Bratzler Shear Force

In trials 1 and 2, strip loin steaks were cooked on an electric conveyor grill (model TBG-60, Magikitch'n, Quakertown, PA). After cooking, each steak was allowed to equilibrate to room temperature (22^{o}C). Core samples (1.27 cm in diameter; 5 to 9 cores/steak) were removed from each steak parallel to the muscle fiber orientation and sheared perpendicular to the fiber, using an Instron testing machine fitted with a Warner-Bratzler Shear head. Measurements of peak shear force were recorded and averaged to obtain a single shear force value for each steak.

Trial 1—Strip loin steaks were cooked to a target internal temperature of 70^{o}C. Each steak was cooked at a constant time of 6 minutes and 35 seconds at a setting of 162.8^{o}C for the top and bottom heating platens. Peak internal temperature measurements were recorded for each steak using a hand held thermometer (model HH21 thermometer; Omega Engineering, Inc., Stanford, CT).

Trial 2—WBSF values were determined for steaks using the procedures of AMSA (1995). Strip loin steaks were tempered for 48 hours at approximately 2^{o}C, and cooked to a target internal temperature of 72^{o}C. The steaks were cooked at a constant time of 6 minutes and 35 seconds at a setting of 176^{o}C for the top and bottom heating platens. Peak internal temperature measurements were recorded for each steak using a hand held Type K thermocouple (model 39658-K, Atkins Technical, Gainsville, FL.

Data Analysis

In the two trials, Mixed Model procedures of SAS (SAS Inc., Cary, N.C.) were used to analyze feedlot performance, urine pH, and carcass and WBSF data.

Trial 1—Least squares means for feedlot performance, urine pH, and carcass data were computed. In the model, treatment was a fixed effect, and initial BW was included as a covariate to equalize initial variability in starting weight. Data from WBSF was tested with a repeated measures analysis that included postmortem aging time, treatment, and breed, the treatment by age interaction, and the treatment by breed interaction. Postmortem aging time was treated as a repeated measurement.

Trial 2—Least squares means for carcass data were computed. Data from WBSF was tested with a repeated measures analysis that included postmortem aging time, treatment, breed, USDA Quality Grade, the treatment by age interaction, the treatment by breed interaction, and the treatment by USDA Quality Grade interaction. Postmortem aging time was treated as a repeated measurement.

Results & Discussion

Warner-Bratzler Shear Force

Trial 1—As expected, length of postmortem aging time influenced (P<0.001) WBSF values (Table 1). Shear force values decreased from d 7 through 28. An initial analysis of shear force values included aging periods of 3, 7, 14, 21, and 28 in the model, and resulted in no differences between the supplemented steers and controls. However, results from the analysis including d 3 in the model were very sensitive to the influences of tenderness at d 3 of aging; very little difference was observed in mean WBSF values

from carcass of supplemented steers versus carcasses of control steers at d 3, but a noticeable difference in WBSF occurred between carcasses of treated versus un-treated steers at other postmortem aging times. Therefore, further analyses were conducted in which WBSF values for steaks aged only 3 d were omitted; this evaluation revealed an overall treatment effect (P=0.03) in which supplemented steers generated steaks having lower shear force values than did control steers (Table 2).

Trial 2—WBSF values were significantly different (P<0.05) across USDA Quality Grades, but no treatment or breed effect were seen (P>0.05). Least squares means were numerically higher for supplemented steers (3.84 kg) versus the controls (3.62 kg), opposite of what was observed in trial 1. Due to the discrepancy between trials 1 and 2 in regards to treatment effect, investigation of ration samples occurred. Ration analysis from trial 2 indicated that a negative DCAB was not achieved and therefore did not result in improved postmortem tenderness.

Feedlot Performance

Trial 1—Effects of supplementation of an anionic compound on feedlot performance and urine pH are shown in Table 3. Average daily feed intake were similar across treatments. Urine pH for the supplemented steers was lower (P<0.05) than urine pH for negative control steers.

Carcass Characteristics

Trial 1—Least squares means for carcass characteristics (Table 4) indicated that preliminary yield grade of supplemented cattle and, consequently, adjusted preliminary yield grades, were higher (P<0.05) than those of controls. All other carcass characteristics were similar (P>0.05) across treatments.

Trial 2—Carcass traits for Choice and Select cattle are displayed in Table 5. There were no significant differences (P>0.05) between treatment groups when comparing carcass traits.

Conclusions

From the results of the two trials, when a negative Dietary Cation-Anion Balance is achieved, supplementation with a Biovance Technologies, Inc. anionic compound improves postmortem beef tenderness without adverse effects on live animal or carcass performance. Currently, a third trial is being conducted to confirm the results of these studies.

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Tables

Table 1. Effects of aging on Warner-Bratzler Shear Force Values for aging periods 3, 7, 14, 21, and 28 days postmortem for treatments and overall sample population in trial 1

	3 day	7 day	14 day	21 day	28 day
Supplemented WBSF, kg	7.52 ± 0.26^{a}	4.34 ± 0.26^{b}	3.93 ± 0.26^{bc}	3.30 ± 0.26^{cd}	3.10 ± 0.26^{d}
Control WBSF, kg	7.55 ± 0.27^{a}	4.59 ± 0.26^{b}	4.23 ± 0.26^{bc}	3.60 ± 0.26^{cd}	3.40 ± 0.26^{d}
Overall WBSF, kg	7.53 ± 0.19^{a}	4.46 ± 0.19^{b}	4.08 ± 0.19^{b}	3.45 ± 0.19^{c}	3.25 ± 0.18^{c}

[a, b, c, d] Means, within row, lacking a common superscript letters, differ ($P<0.05$)

Table 2. Effects of supplementing a Biovance Technologies, Inc. anionic compound on Warner-Bratzler Shear Force Values

	Supplemented	Negative Control	SEM	*P*
Trial 1 WBSF, kg	3.64^{b}	3.99^{a}	0.1570	0.0293
Trial 2 WBSF, kg	3.84	3.62	0.1410	0.1126

[a, b] Means, within row, lacking a common superscript letters, differ ($P<0.05$)

Table 3. Effects of Biovance Technologies, Inc. anionic compound on final BW, dry matter intake, and urine pH for Trial 1

	Supplemented	Negative Control	SEM	*P*
Final BW, kg	523.9	526.0	4.03	0.74
ADF Intake[a], kg DM/d	9.61	9.21	0.38	0.47
Urine pH	5.4[c]	6.3[b]	0.17	0.005

Initial BW was used as a covariate.
Urine pH was sampled from one head per pen.
[a] Average Daily Feed Intake
[b,c] Means, within row, lacking a common superscript letters, differ ($P<0.05$)

Table 4. Least squares means of carcass characteristics for both treatment groups in Trial 1

	Supplemented	Negative Control	SEM	*P*
HCW[a], kg	322.1	325.2	4.0	0.609
Dressing %	60.8	60.9	0.005	0.880
PYG[b]	3.2[e]	3.0[f]	0.078	0.031
Adjusted PYG[b]	3.4[e]	3.2[f]	0.064	0.028
KPH[c], %	2.5	2.3	0.059	0.171
Ribeye Area, cm^2	82.0	80.5	0.903	0.299
Final Yield Grade	3.0	2.9	0.114	0.323
Marbling Score[d]	412	382	9.0	0.053

Initial BW was used as a covariate.
[a] Hot Carcass Weight
[b] Preliminary Yield Grade
[c] Kidney, Pelvic, and Heart Fat
[d] Traces = 200, Slight = 300, Small = 400, Modest = 500, and Moderate = 600
[e, f] Means, within row, lacking a common superscript letters, differ ($P<0.05$)

Table 5. Least squares means of Choice and Select carcass characteristics for both treatment groups in Trial 2

	USDA Choice				USDA Select			
	Supplemented	Negative Control	SEM	*P*	Supplemented	Negative Control	SEM	*P*
HCW[a], kg	352	358	10.9775	0.5854	353	351	9.8980	0.8
PYG[b]	3.2	3.2	0.1239	0.9736	3.0	3.0	0.0917	0.7
Adjusted PYG[b]	3.3	3.4	0.1061	0.8802	3.2	3.2	0.0862	0.6
KPH[c], %	2.2	2.2	0.0823	0.7069	2.0	2.1	0.0784	0.6
Ribeye Area, cm^2	82.4	82.1	2.9884	0.9270	86.6	86.9	2.9860	0.9
Final Yield Grade	3.2	3.2	0.1931	0.7032	2.8	2.7	0.1933	0.7
Marbling Score[d]	441	435	10.4966	0.5233	338	347	4.7197	0.0

[a]Hot Carcass Weight
[b] Preliminary Yield Grade
[c] Kidney, Pelvic, and Heart Fat
[d] Traces = 200, Slight = 300, Small = 400, Modest = 500, and Moderate = 600
Means, within row, lacking a common superscript letters, differ ($P<0.05$)