Effects of rumen-protected long-chain fatty acid supplementation during the finishing phase of beef steers on live performance, carcass characteristics, beef quality, and serum fatty acid profile[1]

Christina E. Bakker,[†] Amanda D. Blair,[†] Judson K. Grubbs,[†,2] Anna R. Taylor,[‡] Derek W. Brake,[||] Nathan M. Long,[$] and Keith R. Underwood[†]

[†]Department of Animal Science, South Dakota State University, Brookings, SD 57006; [‡]Cargill Animal Nutrition, Amarillo, TX 79109; [||]Division of Animal Sciences, University of Missouri, Columbia, MO 65211; and [$]Department of Animal and Veterinary Sciences, Clemson University, Clemson, SC 29634

ABSTRACT: The effect of a rumen-protected long-chain fatty acid (LCFA) supplement on live performance, meat quality, blood serum fatty acid profile, and predicted carcass composition was evaluated in this study. Angus steer calves ($n = 99$) were fed a low energy diet for 77 d prior to finishing. Prior to study initiation, the steers were separated into 12 pens with eight or nine steers per pen. Steers were transitioned from the low energy forage–based diet to a high concentrate diet containing high moisture ear corn, corn silage, dry rolled corn, soybean meal, and a liquid supplement containing monensin across 21 d. Megalac-R (RPFA) was fed to six pens at 2% of the diet dry matter. Control pens (CON; $n = 6$) received an additional 2% of diet dry matter as dry rolled corn and soybean meal. The final finishing diet net energy for gain (NE_g) was 1.20 and 1.19 mega calories·kg^{-1} of dry matter (DM) for RPFA and CON treatments, respectively. Steers were weighed every 28 d. Growth performance data including average daily gain (ADG), gain to feed ratio (G:F), and DM intake (DMI) were calculated as both monthly and overall data. After a 147-d finishing phase, steers were transported to a commercial abattoir for slaughter. After a 28-h chilling period, carcass data were obtained by trained personnel. Final live weights were greater ($P = 0.01$) for RPFA than CON cattle. Overall ADG and overall G:F was increased ($P = 0.02$; $P = 0.01$, respectively) for RPFA cattle. Ribeye area, backfat thickness, kidney pelvic heart fat, marbling score, and yield grade did not differ ($P > 0.05$) between treatments. Predicted percent carcass fat was increased for RPFA cattle ($P = 0.05$). Conversely, predicted percent carcass protein ($P = 0.07$) and bone ($P = 0.06$) tended to be greater for CON cattle. Long-chain fatty acid supplementation during the finishing phase did not increase marbling scores of the steers in this study but did increase final live weight, HCW, and predicted total body fat. These results suggest that RPFA supplementation has the potential to increase adipose tissue development. However, it is likely that animal age during supplementation and duration of supplementation impact the effect RPFAs have on carcass characteristics.

Key words: beef, fatty acid profile, finishing diet, meat quality, rumen-protected fatty acids

INTRODUCTION

Marbling, a primary factor used for quality grading in the U.S. beef industry has a strong relationship to beef carcass value (Boykin et al., 2017; USDA, 2018). Consumers are willing to pay a premium for beef with increased marbling (Platter et al., 2005). Marbling positively influences beef flavor and juiciness, two major attributes that contribute to palatability (Mcbee and Wiles, 1967; Behrends et al. 2005; Brewer et al., 2007; Felderhoff et al., 2007; Cashman et al., 2019).

A key transcription factor regulating adipose development and differentiation is peroxisome proliferator gamma (PPARγ) (Saladin et al., 1999; Feve, 2005; Ebrahimi et al., 2018). Kern et al. (2014) reported that PPARγ is correlated to marbling development throughout different growth stages in beef steers. There are many activators of PPARγ including long-chain fatty acids (LCFA) (Smith, 2002; Sauma et al., 2006). The supplementation of rumen-protected LCFA's (Mangrum et al., 2016) and rumen-protected polyunsaturated fatty acids (Cooke et al., 2011) has increased marbling in carcasses from early weaned steers and feeder cattle when compared with nonsupplemented controls. However, there is limited research to determine how a rumen-protected LCFA fed during the finishing phase affect predicted carcass composition. Therefore, the objective of this study was to determine the effect of a rumen-protected LCFA fed during finishing on live performance, serum fatty acid profile, carcass traits, and predicted carcass composition. We hypothesized that supplementation of a rumen-protected LCFA during the finishing phase would increase marbling scores, alter blood serum fatty acid profiles towards the LCFA composition of the supplement, and increase predicted carcass fat of beef carcasses.

MATERIALS AND METHODS

Animal procedures were reviewed and approved by the South Dakota State University Institutional Animal Care and Use Committee (approval number 15-081E). Angus steers (n = 99; initial body weight 361 ± .61 kg) from a single source were received at the South Dakota State University Ruminant Nutrition Center and fed for 77 d to achieve a weight gain of 1.2 kg·d^{-1}. Steers received an anabolic implant containing 200 mg progesterone propionate and 20 mg estradiol benzoate (Synovex-S; Zoetis, Parsippany, NJ) upon receiving. On day 78, steers were adapted to a grain-based diet or a grain-based diet that contained (dry matter-basis; DM) 2% Megalac-R (Church and Dwight Co., Inc. Ewing, NJ) by replacing 1.75% dry-rolled corn and 0.25% soybean meal (Table 1) so that six pens received supplement long-chain fatty acids from Megalac-R (RPFA) and six pens of cattle did not (CON). Diets were formulated to provide approximately 1.3 mega calories net energy for gain

Table 1. Finishing diet for steers fed a control diet (CON) or control diet with 2% rumen-protected long-chain fatty acids

Ingredient	CON	RPFA	CON	RPFA	CON	RPFA
Diet Identification[1]	1		2		3	
Weeks on diet[1]	3		5		12	
High moisture ear corn	34.52	34.52	34.77	34.75	35.15	35.22
Corn silage	–	–	–	–	8.25	8.25
Oatlage	11.57	11.57	5.80	5.80	–	–
Dry rolled corn	35.11	33.60	46.59	44.34	43.84	41.60
Megalac-R[2]	–	2.00	–	2.03	–	1.99
Soybean meal	–	–	7.78	8.03	7.71	7.96
DDGS	13.32	12.66	–	–	–	–
Liquid supplement[3]	6.15	5.65	5.06	5.06	4.98	4.98
Nutrient composition						
NE$_g$[4], Mcal / kg	1.31	1.33	1.32	1.34	1.33	1.35
Crude protein	12.48	15.50	13.84	13.76	13.19	13.14
Fat	3.68	3.61	2.97	2.88	2.95	2.87
NDF	15.40	21.10	15.40	15.23	14.22	14.05

Percent inclusion: calculated on a dry matter basis.

[1]Diet was altered to accommodate feed ingredient availability. Steers were fed diet 1 for 3 wk, diet 2 for 5 wk, and diet 3 for 12 wk.

[2]Church and Dwight Co., Inc. Ewing, NJ.

[3]Westway Feed Products, Tomball, TX; contained 45.17% protein, 1.13% fat, 51.86% ash, and 588 g/T monensin.

[4]Net energy for gain, mega calories/kg.

$(NE_g) \cdot kg^{-1}$ of dry matter for RPFA and CON treatments, respectively. Due to feed availability, diet ingredients were changed slightly at the beginning of weeks 4 and 9 of the finishing phase (Table 1). At day 28 of the finishing phase received an anabolic implant that contained 120 mg trenbolone acetate and 24 mg estradiol (Revalor-S; Merck Animal Health, Madison, NJ). Growth performance data including average daily gain (ADG), gain to feed ratio (G:F), and DM intake (DMI) were calculated as both phase and overall data. Each phase encompassed the time frame between weight collections. Phase 1 was days 0 to 28, phase 2 was days 29 to 44, phase 3 was days 45 to 72, phase 4 was days 73 to 100, phase 5 was days 101 to 128, and phase 6 was days 129 to 147.

After a 147-d finishing phase, steers were transported to a commercial abattoir for slaughter. Hot carcass weight (HCW) was collected prior to chilling the carcasses. After a 28-h chilling period, carcasses were ribbed between the 12th and 13th ribs. Ribeye area (REA), backfat thickness (FT), and kidney, pelvic, heart fat (KPH), and marbling scores were measured by trained personnel. USDA yield grades were calculated using HCW, REA, FT, and KPH.

Proximate Analysis and Carcass Composition Calculation

A subset of carcasses (n = 24, 2 per pen) were selected for carcass composition analysis using 9-10-11 rib dissections and analyzed using equations as described by Hankins and Howe (1946). Subset selection was conducted by choosing the carcasses of the two steers with initial body weights, recorded at the beginning of the finishing phase, closest to the average initial weight of the pen. Soft tissue was separated from bone and both were weighed and recorded. The soft tissue was homogenized using a bowl chopper (Model CM-14, Mainca, St. Louis, MO). A 1-kg sample was packaged and stored at −20°C for determination of moisture, protein, fat, and ash through proximate analysis.

The homogenized proximate analysis samples were prepared by freezing in liquid nitrogen and then powdered using a Waring commercial blender (Model 51BL32, Waring Products Division, New Hartford, CT) to produce a homogenous sample. Proximate analysis of the soft tissue was conducted to determine water, fat, crude protein, and ash content of the samples. To determine water content, approximately 5.5 g of sample were weighed, placed in preweighed foil pans, covered in preweighed filter paper, and placed in an oven (Thelco Laboratory Oven, Precision Scientific, Winchester, VA) for 24 h at 101°C. After drying and reweighing, dried samples were extracted with petroleum ether in a side arm soxhlet (method 960.39; AOAC, 2000) for 60 h. Excess ether was allowed to evaporate from samples under the fume hood prior to drying at 101°C for 4 h and subsequent reweighing. Fat content was calculated as the difference between dried and extracted sample weight. Crude protein was determined by wrapping approximately 200 mg of sample in nitrogen-free foil sheets and inserting samples into a nitrogen analyzer (Rapid N III, Elementar, Hanau, Germany). To determine ash content, 3 g of sample was placed in a preweighed crucible, dried for 24 h at 101°C to determine water content, and ashed for 16 h at 500°C in a muffle furnace (Isotemp Programmable Muffle Furnace, Fischer Scientific, Waltham, MA) and reweighed following cooling in a desiccator.

Hankins and Howe (1946) equations for steers were used to predict composition of the carcass soft tissue from the chemical composition of the 9-10-11 rib section soft tissue using the following equations:

$$\text{Carcass water} = 16.83 + 0.75\,(9 - 10 - 11 \text{ rib water content}),$$

$$\text{Carcass fat} = 3.49 + 0.74\,(9 - 10 - 11 \text{ rib fat content}),$$

$$\text{Carcass protein} = 61.9 + 0.65\,(9 - 10 - 11 \text{ rid protein content}).$$

Total carcass values were calculated from the previously calculated values for soft tissue composition by equations for the proportion of carcass bone and soft tissue outlined by Hankins and Howe (1946) and described by Kern et al. (2014).

Serum Fatty Acid Profile

Blood samples were collected on day 140 of finishing by jugular venipuncture in vacutainer tubes at 1200 h, 4 h postfeeding, to determine serum fatty acid composition. Samples were allowed to clot and centrifuged at 4°C at $2{,}000 \times g$ for 20 min. Serum was collected and transferred into 2-mL Eppendorf tubes and frozen until analyzed as described by Park and Goins (1994). Briefly, duplicate 1-mL samples of serum were lyophilized (LabConco, Kansas City, MO) and transmethylated. Samples were analyzed using a Shimadzu 2014 gas chromatograph (Shimadzu, Koyoto, Japan) equipped with a Shimadzu AOC-20S automatic sampler. Separations were completed using a 60-m capillary

column (Agilent Technologies, Santa Clara, CA). Identification of fatty acids was achieved by comparing retention times of known standards. An internal standard, methyl tricosanoic (C23:0) acid, was incorporated into every sample during methylation in order to quantify the sample as a percentage of weight of total fatty acids.

Warner–Bratzler Shear Force

Strip loins (IMPS 180) were collected from the carcasses chosen as a subset for carcass the prediction of carcass composition. The strip loin was faced and then one 2.54-cm steak was cut, vacuum packaged, and aged for 14 d prior to freezing. Steaks were thawed for 24 h at 4°C and then cooked to a target internal temperature of 71°C using an electric clam shell grill (George Foreman, Model GR2144P, Middleton, WI). Peak internal temperatures were recorded for each steak using a digital thermometer (Atkins Aqua Tuff NSF Series, Cooper-Atkins Corporation, Middlefield, CT). Steaks were then stored overnight at 4°C. Steaks were removed from refrigeration and equilibrated to 20°C before six cores (1.27-cm diameter) were removed parallel to the muscle fiber direction. Cores were sheared perpendicular to the direction of the muscle fibers using a Warner–Bratzler shear machine (G-R Electric Manufacturing Company, Manhattan, KS) fitted with a Mecmesin 500N basic force gauge (Mecmesin Ltd. West Sussex, United Kingdom) and peak force (kg) was recorded for each core. Shear force value was determined by averaging the peak force values for all six cores for each steak.

Intramuscular Fat Content

The portion of each strip loin that was removed when the strip loins were faced was designated for ether extraction. Steaks were allowed to thaw slightly and trimmed of visible connective tissue and other muscles leaving only the longissimus muscle. Steaks were then minced, snap frozen in liquid nitrogen, and powdered using a Waring commercial blender (Model 51BL32, Waring Products Division, New Hartford, CT), and placed back in a −20°C freezer until lipid extraction. Lipid extraction was conducted as previously described for carcass composition.

Statistical Analysis

Live animal performance, rib composition data, fatty acid profiles of serum, WBSF, and ether extract were analyzed using PROC Mixed of SAS with fixed effect of treatment. Pen was used as the experimental unit. Live performance data were analyzed separately by phase in addition to overall performance. Significance was determined at $P \leq 0.05$ and a trend was declared at $0.05 < P < 0.10$.

RESULTS AND DISCUSSION

Animal performance data are presented in Table 2. Overall average daily gain was increased

Table 2. Live performance data of steers fed a control diet (CON) or diet with 2% rumen-protected long-chain fatty acids (RPFA)

Variable	CON	RPFA	SEM	P
Phase 1[1]				
Weight, kg	412	414	1.40	0.52
ADG[2], kg/d	1.78	1.81	0.05	0.65
DMI[3], kg/d	7.44	7.45	0.01	0.49
G:F[4]	0.238	0.243	0.01	0.59
Phase 2[1]				
Weight, kg	435	436	2.09	0.91
ADG[2], kg/d	1.53	1.46	0.14	0.74
DMI[3], kg/d	9.30	9.26	0.14	0.83
G:F[4]	0.163	0.158	0.01	0.78
Phase 3[1]				
Weight, kg	487	493	2.36	0.11
ADG[2], kg/d	1.83	2.02	0.06	0.05
DMI[3], kg/d	9.83	9.79	0.11	0.80
G:F[4]	0.187	0.208	0.01	0.02
Phase 4[1]				
Weight, kg	531	540	3.11	0.07
ADG[2], kg/d	1.59	1.70	0.06	0.23
DMI[3], kg/d	9.94	10.00	0.10	0.68
G:F[4]	0.160	0.170	0.01	0.29
Phase 5[1]				
Weight, kg	577	587	1.97	<0.01
ADG[2], kg/d	1.64	1.68	0.06	0.62
DMI[3], kg/d	10.27	10.46	0.12	0.26
G:F[4]	0.160	0.162	0.01	0.86
Phase 6[1]				
Weight, kg	606	616	2.37	0.01
ADG[2], kg/d	1.52	1.50	0.05	0.81
DMI[3], kg/d	10.60	10.78	0.16	0.44
G:F[4]	0.143	0.143	0.01	1.00
Overall[1]				
ADG[2], kg/d	1.62	1.68	0.02	0.02
DMI[3], kg/d	9.51	9.57	0.07	0.54
G:F[4]	0.170	0.176	0.001	0.01

Least square means. Percent inclusion: calculated on a dry matter basis.

[1]Phase 1: d 0–28, Phase 2: d 29–44, Phase 3: d 45–72, Phase 4: d 73–100, Phase 5: d 101–128, Phase 6: d 129–147, Overall: d 0–147.

[2]Average Daily Gain.

[3]Dry Matter Intake.

[4]Gain: Feed Ratio.

($P = 0.02$) by RPFA compared with CON as well as during phase 3 ($P = 0.05$). Overall gain to feed ratio was also increased ($P = 0.01$) by RPFA vs. CON and during phase 3 ($P = 0.02$). Live weight tended to be increased by RPFA compared with CON during phase 4 ($P = 0.07$) and was increased for phases 5 and 6 ($P < 0.01$ and $P = 0.01$, respectively).

Increased final live weight translated to an increased HCW ($P = 0.04$; Table 3). Ribeye area, FT, KPH, marbling score, and yield grade did not differ ($P > 0.05$) between treatments. Carcass characteristics of the subsample group were similar to the characteristics of the experimental groups meaning the subset carcasses can be considered a representative sample for meat quality characteristics (Table 4). In addition to similar carcass traits, ether extract

Table 3. Carcass data of steers fed a control diet (CON) or diet with 2% rumen protected long chain fatty acids (RPFA)

Variable	CON	RPFA	SEM	*P*
HCW, kg	362.92	368.38	1.07	0.04
REA[1], cm²	81.57	82.78	1.03	0.18
Backfat[1], cm	1.19	1.14	0.05	0.32
KPH, %	1.85	1.85	0.23	0.97
Marbling score[2]	406	404	10.75	0.87
Yield grade	3.14	3.09	0.09	0.57

Percent inclusion: calculated on a dry matter basis. Least square means.

[1]Ribeye area and backfat measured between the 12th and 13th ribs.

[2]Marbling Score: 300 = Slight⁰, 400 = Small⁰, 500 = Modest⁰.

Table 4. Carcass and meat quality data of subset of steers ($n = 24$) fed a control diet (CON) or diet with 2% rumen protected long chain fatty acids (RPFA) used for predicted carcass composition and meat fatty acid analysis

Variable	CON	RPFA	SEM	*P*
HCW, kg	360.89	371.30	4.89	0.04
REA[1], cm²	82.19	83.48	2.58	0.61
Backfat[1], cm	1.17	1.22	0.08	0.60
KPH, %	1.83	1.85	0.06	0.79
Marbling score[2]	382	404	23.36	0.36
Yield grade	3.04	3.09	0.16	0.80
WBSF[3], kg	3.50	3.48	0.10	0.91
Ether extract[4], %	4.39	5.05	0.52	0.39

Percent inclusion: calculated on a dry matter basis. Least square means.

[1]Ribeye area and backfat measured between the 12th and 13th ribs.

[2]Marbling Score: 300 = Slight⁰, 400 = Small⁰, 500 = Modest⁰.

[3]WBSF: Warner–Bratzler shear force of longissimus muscle; aged 14 d.

[4]Ether Extract of longissimus muscle.

and WBSF values of steaks for the subset carcass group were not different between RPFA and CON carcasses ($P > 0.05$). The increase in HCW was likely the result of an increase in weight distributed throughout the carcass resulting in no differences in measurable carcass characteristics. Conversely, Mangrum et al. (2016) fed a rumen-protected fatty acid to early weaned steers (weaned at 150 ± 5 d) and did not observe a difference in final live weights or hot carcass weight. However, Mangrum (2016) did see an increase in marbling scores in the RPFA treatment group compared with steers not provided a fatty acid supplement when fed over the course of a 110-d backgrounding phase and then transitioned to a 176-d finishing period. A comparison of Megalac to two other rumen-protected lipid supplements rich in PUFAs resulted in an increase in intramuscular fatty acid content for the Megalac diet, high in palmitic acid, compared with a diet containing a protected lipid supplement high in 18:2n-6 and 18:3n-3 (Scollan et al., 2003). Additionally, the fatty acid profile of the lipid supplement showed increases in the proportion of 18:2n-6 and 18:3n-3 in muscle compared with the Megalac treatment (Scollan et al., 2003). It is possible that the increase in intramuscular fat reported by Scollan (2003) was not observed in the present study for two reasons. First, the cattle used by Scollan (2003) were Charolais, which is a terminal breed not known for their marbling potential as opposed to the Angus influenced cattle in the present study (Herring, 2006). Second, the dietary fat content provided by Scollan (2003) was twice the level of dietary fat provided in the current study. Both of these reasons suggest level of supplement and genetic potential for marbling of cattle may affect the efficacy of a rumen-protected supplement. Adipogenesis occurs differently among the four main fat depots. Bruns et al. (2004) observed that subcutaneous fat and KPH increased in a quadratic fashion while intramuscular fat increased linearly when evaluated in carcasses ranging from 208 to 380 kg. Moreover, intramuscular adipocytes are thought to undergo hyperplasia from the late fetal stage until about 250 d of age, whereas subcutaneous adipose tissue hyperplasia continues through weaning (Hood and Allen, 1973). The observation of differences in marbling scores by Mangrum et al. (2016) and the lack thereof in this study can potentially be explained by the timing of supplementation. The steers in Mangrum et al. (2016) began treatment at approximately 150 d of age. Therefore, they were well within the "marbling window" proposed by Du et al. (2013) that spans from early

weaning to approximately 250 d of age. This is supported by the work of Tipton et al. (2017) that found that supplementation of Megalac-R at either 150 or 210 d of age for either 45 or 90 d resulted in increased marbling at the end of supplementation in beef steers.

Although there was no difference in marbling scores between treatments in the present study, predicted carcass composition was altered with a rumen-protected LCFA supplement. Predicted percent carcass fat was increased for RPFA cattle ($P = 0.05$; Table 5). Conversely, predicted percent carcass protein ($P = 0.07$) and bone ($P = 0.06$) tended to be greater for CON cattle. The increase in carcass fat could likely be attributed to general adipocyte growth, spurred by either the RPFA supplement or the slightly increased NE_g of the RPFA diet, instead of a focused increase in intramuscular adipocytes. The decrease in predicted carcass protein and bone was likely the inverse reaction to increased carcass fat. The results of our study in combination with previous data (Du et al., 2013; Mangrum et al., 2016) seem to suggest that physiological age is a critical factor in the effectiveness of RPFA supplementation on marbling scores.

The increase in phase 6 live weight and HCW is likely the result of increased growth throughout the carcass as evidenced by a lack of differences in any carcass characteristic. The increase in predicted carcass fat indicates that adipogenesis was increased in RPFA cattle. However, the lack of differences in backfat and marbling scores suggests the increased adipogenesis was distributed across the body instead of primarily within intramuscular fat or subcutaneous fat depots. Although PPARγ is widely known as a transcription factor that upregulates adipogenesis and can be activated by long-chain fatty acids, it is also thought to stimulate lipogenesis (Saladin et al., 1999; Kersten, 2001; Sauma et al., 2006). The majority of adipocyte hyperplasia (cell proliferation) occurs until approximately 8 mo of age in beef cattle (Hood and Allen, 1973).

However, evidence supports that some hyperplasia can occur after this time when existing cells reach lipid capacity and the majority of adipocyte tissue growth is the result of hypertrophy (Robelin, 1981; Cianzio et al., 1985; Du et al., 2013). Therefore, the RPFA supplement could have increased adipocyte hypertrophy and lipogenesis throughout the carcass as evidenced by the increase in predicted carcass fat in this study. However, adipocyte size was not evaluated and therefore we cannot conclude that this difference was due to increased adipocyte size.

Serum fatty acid concentrations are reported in Table 6. Steers fed the RPFA treatment had greater amounts of palmitic (16:0; $P < 0.01$), stearic (18:0; $P = 0.02$), vaccenic (18:1n7; $P < 0.01$), linoleic (18:2; $P = 0.02$) and total fatty acids ($P = 0.01$) in response to increased dietary fatty acid content.

Inclusion of a RPFA into finishing diets altered blood serum fatty acid profile shown by increased serum fatty acids included in the LCFA supplement. The results of this study are similar to Mangrum et al (2016) with increases in palmitic, stearic, linoleic, and total fatty acids. These results were expected as RPFA is protected from rumen biohydrogenation which results in greater absorption of the unsaturated fatty acids contained in RPFA into the bloodstream (Zinn et al., 2000). Differences in serum fatty acid profile did not translate into increases in intramuscular fat content. These results differ from Oliveria et al., (2012) where Nellore bulls were fed Megalac-E for 96 d, and an increase in linoleic acid and total omega-6 fatty acids was observed compared with a control diet without oil supplementation. The discrepancy between the two studies can be explained by the different fatty acid profile of the two supplements (Megalac-R vs. Megalac-E) and the increased DM inclusion of

Table 5. Predicted carcass composition of subset of steers ($n = 24$) fed a control diet (CON) or diet with 2% rumen protected long chain fatty acids (RPFA)

Variable	CON	RPFA	SEM	P
Bone, %	14.59	13.78	0.39	0.06
Fat, %	23.88	25.52	0.72	0.05
Moisture, %	47.35	46.75	0.51	0.26
Protein, %	13.79	13.56	0.14	0.07

Percent inclusion: calculated on a dry matter basis. Calculated according to Hankins and Howe (1946). Least square means.

Table 6. Serum fatty acid profile (μg/ml of serum) of steers fed a control diet (CON) or diet with 2% rumen protected long chain fatty acids (RPFA)

Fatty Acid	CON	RPFA	SEM	P
14:0	13.67	15.74	2.26	0.38
16:0	139.88	176.60	8.46	<0.01
18:0	237.11	281.69	15.91	0.02
18:1n9	22.42	27.95	5.69	0.35
18:1n7	92.69	120.01	7.00	<0.01
18:2	605.93	801.17	51.11	0.02
20:4n6	25.32	30.20	2.92	0.13
20:4n3	42.41	45.88	3.21	0.31
Total fatty acids	1249.68	1532.93	94.29	0.01

Percent inclusion: calculated on a dry matter basis. Least square means.

Megalac-E compared to Megalac-R (4.5% vs. 2%). This suggests that with more time, the differences in serum fatty acid profile could translate to differences in the fatty acid profile of the meat, but this research has not yet been conducted on finishing cattle supplemented with the Megalac-E product.

CONCLUSIONS

Previous research has shown the impact of LFCA supplementation on carcass characteristics and meat quality; however, results appear to be dependent on a myriad of factors. This study determined that HCW and final weight were increased for steers fed the RPFA treatment compared with the control. Furthermore, the fatty acid profile of blood serum reflects increases in the concentrations of fatty acids present within the Megalac-R product. This indicates that while marbling scores did not differ between experimental treatments, the fatty acids from the RPFA supplement were absorbed into the blood stream. Therefore, further research is warranted to determine whether feeding rumen-protected long-chain fatty acids at a different stage of development such as the time frame from weaning to finishing or a longer feeding period than what occurred in the current study would result in increased marbling scores and improved USDA quality grades. Also, it would be important to determine whether this feeding strategy is best utilized for cattle with traditionally lower marbling scores.

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