EFFECTS OF ADDED FAT, DEGRADABLE INTAKE PROTEIN, AND RUMINALLY-PROTECTED CHOLINE IN DIETS OF FINISHING STEERS

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Summary

A total of 216 yearling steers was used in two finishing experiments to evaluate interactions between levels of dietary fat, protein and ruminally protected choline. In Trial 1, steers received diets that combined levels of 0% or 5% added fat (choice white grease), 10.8% or 12.5% crude protein, and 0 or 5 grams per head daily of ruminally protected choline. Steers were fed in pens of five head each for 89 days. Adding fat decreased intake (P<.01), average daily gain (P<.1), and carcass weight (P<.07) and increased carcass yield grade (P<.06) but did not alter feed efficiency (P>.9). Increasing the protein level from 10.8 to 12.5% had no significant effects on live animal performance, but the high protein level resulted in a greater (P<.05) percentage of carcasses grading USDA Choice. Choline supplementation tended to increase average daily gain (P=.13) as well as the percentage of carcasses grading USDA Choice (P=.23). Choline also increased dressing percentage (P<.07); this effect was most pronounced when fat was not included in the diet, indicating an interaction between fat and choline (P<.1). In Trial 2, steers were fed a common finishing diet, which was top-dressed with ruminally protected choline at 2 to 9 grams per head daily or no added choline. Choline supplementation yielded linear improvements in rate of gain (P<.01), dry matter intake (P<.05), and carcass weight (P<.01). All measures of carcass fatness increased as the amount of choline increased. Adding ruminally protected choline to diets of finishing steers significantly improved growth performance and carcass traits.

(Key Words: Finishing Cattle, Choline, Fat, Protein, Carcass.)

Introduction

Protein requirements of rumen microorganisms are influenced by the amount of available energy; as available carbohydrate increases, more ruminally degraded protein is needed to satisfy requirements of the ruminal microflora. Starch is extensively degraded to volatile fatty acids by rumen microflora. Conversely, minimal lipid digestion takes place in the rumen. Therefore, the potential exists for an interaction between source of energy (i.e., lipid vs starch) and ruminal protein requirements. Partial replacement of feed grains with animal fats may make it feasible to reduce the amount of protein that must be supplemented to feedlot cattle and thus, reduce supplementation costs.

Choline normally is provided in adequate quantities as a result of synthesis by ruminal protozoa. Therefore diets that create ruminal conditions that compromise protozoal growth may reduce choline supply postruminally. High-concentrate diets frequently produce ruminal pH to the range of 5.5 to 5.8, which is less than optimal for proliferation of protozoa. Including fat in the diet may further reduce protozoal populations. Consequently, diets that induce low protozoal populations may benefit from choline supplementation. In addition, previous research has suggested that choline chloride is degraded extensively in the rumen. Supplementing choline as a ruminally protected form may provide the choline needed to satisfy requirements for optimal growth rate in finishing cattle.

The objectives of these studies were to evaluate effects of various levels of added fat, degradable intake protein, and ruminally protected choline and to determine how these factors interact with respect to their influence on performance and carcass traits of finishing beef steers. A secondary objective was to determine the optimum level of ruminally protected choline for finishing beef steers.

Experimental Procedures

Trial 1. A trial was conducted using 159 crossbred beef steers to evaluate finishing performance of cattle fed diets combining various levels of protein (10.8 or 12.5%), choice white grease (0 or 5%), or ruminally protected choline (0 or 5 g/head daily; Balchem Corporation). Cattle were fed a common diet for several weeks to minimize variation in gut fill. Following the transition period, cattle were treated for internal and external parasites and implanted with Synovex® Plus™. Steers were stratified by weight and assigned randomly, within strata, to each of the eight treatment groups. Treatments were arranged as a 2 × 3 factorial, in four replicates. Cattle were housed in partially covered, 14’ x 28’ pens with concrete surfaces and fed once per day. The concentrate in the diets was increased incrementally from 40 to 92% by feeding each of five step-up diets for a period of 2 to 6 days. Experimental diets were fed for 89 days.

Steers were slaughtered when they achieved an estimated outside fat thickness (12th rib) of 0.4 inches. Daily gain and efficiency were determined by calculating final live weight as hot carcass weight divided by a common dressing percentage.

Trial 2. A dose-titration experiment was conducted to determine the optimum inclusion level for ruminally protected choline. Cattle were adapted to high grain diets, processed, and allocated to treatments in a manner identical to that used for Trial 1. Treatments were composed of increasing levels of ruminally-protected choline. The high-fat, high protein diet from Trial 1 was top-dressed with 2, 3, 4, 6, 7, 8, or 9 grams per head daily of choline as a fat-encapsulated product. Cattle in four pens were fed the control diet (no added choline), and a single pen of cattle was allotted to each level of added choline.

Results and Discussion

Table 2 summarizes the effects of choice white grease and dietary protein on performance and carcass characteristics of steers (Trial 1). No significant interactions occurred between dietary protein and fat. Increasing dietary protein did not influence gain or feed efficiency, but the percentage of carcasses grading USDA Choice was dramatically improved ($P<.05$) for cattle fed the higher protein level. Adding choice white grease to the diet depressed feed intake ($P<.01$) and average daily gain ($P<.1$), but efficiency was not altered.

Interactions between choline and fat are shown in Table 3. Dietary levels of fat or choline did not influence final live weight but did affect dressing percentage. Adding 5 g/day of choline significantly increased dressing percentage (60.1 vs 60.9%). The effect of choline on dressing percentage was more pronounced when fat was not included in the diet ($P<.1$). Feeding choice white grease depressed rate of gain (P<.1), but the addition of choline tended to alleviate this effect (P=.15). Dry matter intake was reduced with the addition of choline when fat was not included, but intake was not impacted greatly by choline when choice white grease was added. Adding choline to the diet tended to improve feed efficiency when fat was not added to the diet (P=.13). Yield grade also was impacted by the interaction between choline and fat (P<.1). Other measures of carcass fatness followed similar trends but were not significant.

Results of Trial 2 are summarized in Table 4. Each gram of added choline resulted in an increase in feed intake of 0.33 lb/head daily and a concomitant increase in gain of .09lb/head daily. Carcass weights were increased by nearly 5 lb/gram of added choline. All measures of body fatness tend to support the suggestion that increasing the level of ruminally protected choline in the diet may reduce days required to achieve a desired compositional endpoint.

Table 1. Compositions (Dry Basis) of Experimental Diets[a]

	10.8% Protein		12.5% Protein	
Item	0% Fat	5% Fat	0% Fat	5% Fat
Rolled corn, %	85.30	79.36	84.69	78.74
Ground alfalfa hay, %	8.0	8.0	8.0	8.0
Choice white grease , %	-	5.0	-	5.0
Car-Mil Glo®, %	3.0	3.0	3.0	3.0
Dehulled soybean meal, %	1.0	1.0	1.0	1.0
Corn gluten meal, %	-	.9	-	.9
Urea, %	.09	.09	.70	.70
Limestone, %	1.55	1.55	1.55	1.55
Potassium chloride, %	.40	.43	.40	.44
Salt, %	.30	.30	.30	.30
Magnesium oxide, %	.11	.12	.11	.12
Ammonium sulfate, %	.10	.10	.10	.10
Vitamin/mineral premixes, %	.15	.15	.15	.15
Ruminally-protected choline, g/head/day	0 or 5	0 or 5	0 or 5	0 or 5
Crude protein, %	10.8	10.8	12.5	12.5
NPN, %	.40	.40	2.17	2.17
Crude Fat, %	4.09	8.84	4.06	8.81
NEm, Mcal/lb	.84	.91	.84	.90
NEg, Mcal/lb	.55	.60	.54	.59
Calcium, %	.75	.75	.75	.75
Phosphorus, %	.32	.31	.30	.30
Potassium, %	.75	.75	.75	.75
Magnesium, %	.25	.25	.25	.25
Sulfur, %	.17	.17	.17	.17
Rumensin®, g/ton	30	30	30	30
Tylan®, g/ton	10	10	10	10

[a]Diets contained the following concentrations of added vitamins and trace minerals (dry basis): 1,200 IU/lb vitamin A; 10 IU/lb vitamin E; .05 ppm cobalt; 10 ppm copper; .6 ppm iodine; 60 ppm manganese; .25 ppm selenium; 60 ppm zinc.

Table 2. Effects of Added Fat and Protein Level on Performance and Carcass Traits (Trial 1)

	0% Added Fat		5% Added Fat		
Item	10.8% CP	12.5% CP	10.8% CP	12.5% CP	SEM
Number of head	40	39	40	40	
Initial weight, lb	895	899	894	899	5
Final live weight, lb	1190	1212	1185	1188	11
Gain, lb/day[ac]	3.48	3.46	3.22	3.27	.13
Dry matter intake, lb/day[b]	22.2[de]	22.7[d]	20.9[f]	21.1[ef]	.48
Feed:Gain	6.33	6.58	6.49	6.41	.25
Liver abscesses, %	4.7	2.7	11.8	8.3	4.5
Hot Carcass Weight, lb	728	729	713	719	7
Dressing percentage	61.2	60.1	60.2	60.5	.5
Kidney, pelvic and heart fat	2.2	2.3	2.2	2.2	.1
12th rib fat thickness, in	.40	.45	.46	.47	.03
Ribeye area, in^2	13.5	13.3	13.3	13.0	.3
USDA Yield Grade	1.7	1.9	2.1	2.0	.1
USDA Choice, %g	50	69	39	59	8

[a]Effect of added fat (P<.1).
[b]Effect of added fat (P<.01).
[c]0% fat greater than 5% fat (P<.1).
[def]Means in the same row with common superscripts are not different at P<.1.
[g]Effect of protein (P<.05).

Table 3. AEffects of Added Fat and Protected Choline on Performance and Carcass Traits (Trial 1)

	0% Added Fat		% Added Fat		
Item Choline>	0 g/day	5 g/day	0 g/day	5 g/day	SEM
Number of head	40	39	4040		
Initial weight, lb	901	893	896	896	4
Final live weight, lb	1211	1191	1182	1191	10
Gain, lb/day[a]	3.36[gh]	3.58[g]	3.18[h]	3.32[gh]	.13
Dry matter intake, lb/day[de]	23.1[g]	21.9[h]	20.6[i]	21.4[hi]	.5
Feed:Gain[f]	.146[g]	.164[h]	.155[gh]	.155[gh]	.25
Liver abscesses, %	4.9	2.5	5.3	14.8	4.5
Hot carcass weight, lb	725	732	713	720	6
Dressing percentage[bc]	59.9[g]	61.5[h]	60.3[g]	60.4[g]	.5
12th rib fat thickness, in[e]	.46[h]	.39[g]	.43[gh]	.50[h]	.03
Kidney, pelvic and heart fat	2.2	2.3	2.2	2.2	.1
Ribeye area, in^2	13.3	13.6	12.8	12.4	.3
USDA Yield Grade[ac]	1.9[gh]	1.7[h]	1.9[gh]	2.1[g]	.1
USDA Choice, %	52	67	48	51	8

[a]Effect of added fat (P<.1).
[b]Effect of added choline (P<.1)
[c]Fat by choline interaction (P<.1).
[d]Effect of added fat (P<.01).
[e]Fat by choline interaction (P<.05).
[f]Effect of added choline (P=.1)
[ghi] Means in the same row with common superscripts are not different at P<.1.

Table 4. Effects of Ruminally Protected Choline on Finishing Performance and Carcass Characteristics of Steers (Trial 2)

Item	Intercept ± SE[a]	Slope ± SE[a]	Significance (P)
Number of head	60		
Initial weight, lb	882 ± 10	.3 ± 2.1	.89
Final live weight, lb	1173 ± 12	6.7 ± 2.6	.03
Gain, lb/day	3.30 ± .09	.09 ± .03	.01
Dry Matter Intake, lb/day	20.20 ± .63	.33 ± .13	.03
Gain:Feed	.163 ± .006	.002 ± .001	.25
Liver abscesses, %	.17 ± 3.4	.98 ± .70	.20
Hot Carcass Weight, lb	710.2 ± 6.4	4.8 ± 1.3	.01
Dressing percentage	60.52 ± .25	.07 ± .05	.22
12th rib fat thickness, in	.39 ± .03	.02 ± .01	.01
Kidney, pelvic and heart fat	2.12 ± .08	.05 ± .02	.02
Ribeye area, in^2	13.25 ± .34	-.002 ± .07	.98
USDA Yield Grade	1.76 ± .11	.06 ± .02	.02
USDA Choice, %	49.1 ± 8.4	1.0 ± 1.7	.57

[a]Intercept represents the expected value when steers are fed no supplemental choline. The slope represents the expected change for each 1 g increase in the amount of supplemental choline fed.