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Effects of Graded Levels of Ruminally Protected Choline on Performance and Carcass Characteristics of Finishing Beef Steers[1]

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Finishing beef cattle deposit a high percentage of fat in their daily weight gain, but the extent to which metabolic cofactors like choline might limit this process is unknown. In the present study, we evaluated the effect of graded levels of a ruminally protected choline product on performance and carcass characteristics of finishing beef steers.

One hundred sixty medium- to large-framed beef steers (British x Continental) were used in the experiment. Steers were adapted to a 90% concentrate diet and had ad libitum access to this diet for approximately 8 d before the experiment began. On November 13, 1995, starting at approximately 7:30 a.m., all steers were implanted with Synovex S and vaccinated with Ultrabac 7. The 80 steers of heaviest body weight (**BW**) were assigned to the heavy block, with the remaining 80 steers assigned to the light block. Eight pens each were assigned randomly to the heavy and light blocks, and within each weight block, steers were assigned randomly to pens. Treatments were then assigned randomly to pens within weight blocks (two pens of 10 steers each per treatment within weight blocks). On November 14, 1995, beginning at 7:30 a.m., each steer was weighed and sorted to its assigned pen. The initial BW of each steer was considered to be the average of the BW measurements taken on November 13th and 14th. Four dietary treatments were applied in a randomized block design. The four treatments were 90% concentrate diets (Table 1) with graded levels of ruminally protected choline (**RPC**), consisting of: 1) **Control** - 90% concentrate diet with no RPC; 2) **Low RPC** - 90% concentrate diet with .25% (dry matter [**DM**] basis) RPC; 3) **Medium RPC** - 90% concentrate diet with .50% (DM basis) RPC; and 4) **High RPC** - 90% concentrate diet with .99% (DM basis) RPC. Percentages of RPC were designed to supply 0, 5, 10, and 20 g of choline per animal daily, assuming an intake of 20.95 lb/d of DM and 21.5% ruminal escape choline in RPC. Feed was offered in quantities sufficient to ensure ad libitum access throughout the trial. After 28, 56, and 84 d on feed, steers in all pens were weighed before the morning feeding. Feed bunks were cleaned at each weigh period to measure any unconsumed feed. On day 56, at the time of a regularly scheduled BW measurement, each steer was implanted with Revalor S. Heavy-block steers were weighed on days 111 and 112 and shipped to a commercial slaughter facility to obtain carcass data. Steers in the light block were fed 140 d before shipment to a commercial slaughter facility. Final BW for each steer was the average of the BW measurements taken on the two consecutive days before shipment. Carcass measurements collected at the slaughter facility included hot carcass weight, longissimus muscle area, marbling score, percentage of kidney, heart, and pelvic fat, fat thickness measured between the 12th and 13th ribs, and liver abscess score.

Data were analyzed with pen as the experimental unit. Effects of block, treatment, and block x treatment were considered, with the residual (pen within block x treatment) as the error term for testing treatment effects. Orthogonal contrasts (spacing based on the percentage of RPC in the diet) were used to test linear, quadratic, and cubic effects of RPC level.

Performance and carcass data for the overall experiment are shown in Table 2. Final BW responded cubically ($P < .10$) to RPC level, with the greatest BW for cattle fed the Low RPC treatment, followed by the Medium RPC treatment. Similar final BW were noted with the Control and High RPC treatments. Daily gain followed the same trend as final BW, responding cubically ($P < .10$) to RPC level, with an 11% increase in daily gain for the Low RPC treatment and a 4.3% increase for the Medium RPC treatment relative to Control. Daily gain was virtually the same for the Control and High RPC treatments. Overall DM intake was not affected ($P > .10$) by RPC level. Nonetheless, a trend for increased DM intake for all RPC-containing diets relative to the Control diet was evident throughout the experiment.

Table 1. Composition (% of DM) of finishing diets containing graded levels or ruminally protected choline (RPC)

	Treatment			
Ingredient	Control	Low RPC	Medium RPC	High RPC
Sudangrass hay	4.20	4.20	4.20	4.20
Alfalfa hay	6.10	6.10	6.10	6.10
Whole corn	10.16	10.15	10.16	10.16
Steam-flaked corn	63.58	63.36	63.09	62.58
Soybean meal	4.01	4.00	4.01	4.01
Molasses	4.92	4.92	4.92	4.91
Fat (yellow grease)	3.10	3.09	3.09	3.10
Limestone	.77	.77	.77	.77
Dicalcium phosphate	.50	.50	.50	.52
Salt	.36	.36	.36	.36
Urea	1.03	1.03	1.03	1.03
Ammonium sulfate	.25	.25	.25	.25
RPC	-	.25	.50	.99
Premix[a]	1.02	1.02	1.02	1.02

[a]Premix contained (DM basis): wheat midds (90.478%), Vitamin A - 30,000 IU/g (.665%), Vitamin E - 500 IU/g (.27%), Rumensin-80 (1.687%), Tylan-40 (.9%), and trace mineral package (6%). The trace mineral package contained cobalt carbonate (.362%), copper sulfate pentahydrate (3.268%), calcium iodate (.269%), ferrous sulfate monohydrate (19.445%), manganous oxide (6.944%), zinc sulfate monohydrate (28.169%), magnesium oxide (29.762%), wheat midds (8.831%), and mineral oil (2.95%).

Dry matter intake was greatest with the Low RPC diet (4.2% increase relative to Control), followed by the Medium and High RPC diets, and least for the Control diet. Feed:gain ratio was least for the Low RPC treatment (overall improvement of 6.8% relative to Control), superior for the Medium RPC treatment vs Control, and essentially equal for the High RPC and Control treatments (cubic response, $P < .10$).

Carcass measurements (Table 2) were not greatly affected by RPC level. Dressing percent responded cubically to RPC level ($P < .10$), but the differences among treatments were small and of questionable biological significance. Marbling score responded quadratically ($P < .05$) to RPC level, decreasing with the Low and Medium RPC treatments relative to Control, and increasing somewhat for the High RPC treatment. Yield grade responded in a linear fashion ($P < .10$) to RPC level, indicating fatter carcasses for cattle fed the RPC diets. Although not significant ($P > .10$), fat thickness measured between the 12th and 13th ribs also tended to increase with increasing RPC level. Other carcass measurements were not affected ($P > .10$) by RPC level. Numbers of abscessed livers (data not shown) were low in all treatments. As a result of these low numbers, no statistical tests were performed on liver abscess data.

The results of this experiment are interpreted to suggest that diets containing RPC increased daily gain and improved feed efficiency of finishing beef steers fed a high-concentrate diet, but responses depended on RPC level. The optimum response to RPC was noted with a diet that contained .25% (DM basis) RPC. Effects of RPC on carcass characteristics were generally limited, but a trend for increased carcass fatness was noted (linear increase in yield grade with increasing RPC level). Further research is needed to substantiate the findings of this experiment and to determine the potential mode(s) of action of RPC in cattle fed high-concentrate diets.

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Table 2. Effects of graded levels of ruminally protected choline on performance and carcass characteristics of beef steers

Item	Treatment				SE[a]	Contrast[b]
	Control	Low RPC	Medium RPC	High RPC		
Initial BW, lb	775.1	772.9	773.0	773.9	.74	Q (.10)
Final BW, lb	1,162.7	1,201.0	1,175.6	1,159.7	11.3	C (.10)
Daily gain, lb	3.05	3.39	3.18	3.07	.09	C (.10)
Daily DM intake, lb/steer	18.24	19.01	18.75	18.72	.28	NS
Feed:gain	6.03	5.62	5.93	6.11	.13	C (.10)
Hot carcass wt, lb	712.4	730.8	723.9	708.2	8.3	NS
Dressing percent	61.3	60.9	61.6	61.1	.24	C (.10)
Ribeye area, sq. in.	13.4	13.8	13.6	12.7	.33	NS
KPH, %	2.0	2.1	2.1	2.0	.05	NS
Fat thicknes, in.	.38	.37	.41	.43	.04	NS
Marbling score[c]	4.11	3.81	3.80	3.89	.08	Q (.05)
Yield grade	2.25	2.20	2.36	2.60	.12	L (.10)

[a]Pooled standard error of treatment means, n = four pens per treatment.

[b]Observed significance level (in parentheses) for linear (L), quadratic (Q), and cubic (C) contrasts. NS = non-significant (P > .10).

[c]3.0 = Slight[0]; 4.0 = Small[0]: 5.0 = Modest[0].

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