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Introduction

The National Research Council lists the daily protein requirements of medium-frame and large-frame steers weighing 770 lb and gaining 2.2 lb daily as 1.7 and 1.8 lb, respectively; comparable values at 1,100 lb are 1.9 and 2.1 lb. These amounts of protein are expected to be provided for medium-frame steers weighing 880 lb and gaining weight at 2.2 lb daily by a diet containing 10.3% protein; the corresponding value for large-frame steers is 10.2% protein. Medium- and large-frame steers weighing 1,100 lb and gaining weight at 2.2 lb daily require 9.5% protein in the diet.

The zinc requirement of steers is not well defined; an estimated requirement of 30 ppm has been derived from experiments with calves and sheep. Corn grown at MARC contains 20 to 30 ppm zinc, a level that may be marginal for finishing beef cattle.

The known involvement of zinc in protein metabolism and the greater growth rate of large-frame than of medium-frame growing-finishing beef cattle suggests the possibility of an interaction of dietary zinc and protein levels and cattle frame size with respect to weight gain and feed utilization. The purpose of this experiment was to test this possibility.

Procedure

Three hundred twenty crossbred steers representing two frame sizes (large-frame, Gelbvieh x Simmental x Angus x Hereford and medium-frame, Pinzgauer x Red Poll x Angus x Hereford) were used to determine the effect of dietary protein (10 *vs* 13%) and zinc (24 *vs* 60 ppm) on wt gain, feed consumption, and efficiency of feed utilization. Diet composition is described in Table 1. The experiment was conducted in two replicates (January-June and July-December) of 160 steers each, composed of 80 large-frame and 80 medium-frame steers kept in partially slotted-floor pens in groups of five. Steers were weighed on day 0 and at 28-day intervals throughout a 140-day period in each replicate. Feed was added to each feed bunk daily and wt of refused feed was recorded each 28 days. Total feed intake of each pen of five steers was recorded, and daily wt gain and gain to feed ratio were calculated for each pen.

Results

Initial body wt, final wt, adjusted final wt, daily gain, daily feed intake, and gain to feed ratio are summarized by diet and frame size in Table 2.

Large-frame steers had higher adjusted final wt, daily gain, and gain to feed ratio than medium-frame steers. Steers in replicate 1 (January to June) had higher adjusted final wt, daily gain, and daily feed intake than steers in replicate 2 (July to December), possibly a reflection of lower environmental temperatures prevalent during the feeding period of steers in replicate 1. Dietary zinc level had no effect on final wt, daily gain, daily feed intake, or gain to feed ratio. Steers fed the high protein diet (13%) had a higher final wt and daily gain than steers fed low protein (10%). There were no interactions between or among any of the traits measured.

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Table 1—Ingredient composition of diets (as fed)[a]

	Low protein Low zinc	Low protein High zinc	High protein Low zinc	High protein High zinc
Corn silage	50.0	50.0	50.0	50.0
Corn, cracked	47.0	47.0	43.0	43.0
Soybean meal, 44% C.P.			4.0	4.0
Mineral-vitamin supplement w/o Zn[b]	3.0		3.0	
Mineral-vitamin supplement with Zn[c]		3.0		3.0

[a]Dry basis (calculated): Dry matter (DM) 59.50%; crude protein 10.9%; Calcium (Ca) .52%; Phosphorus (P) .34%.

[b]Soybean meal 74.7%; limestone 21.7%; dicalcium phosphate 2.0%; vitamin A premix percent (4.0 million units vitamin A/lb) 0.60%; trace mineral mixture 1%, containing the following elements to provide the indicated amounts in the final mixed diet: Iron (Fe)(as $FeSO_4 \cdot 7H_2O$), 10.0 ppm; Manganese (Mn)(as $MnSO_4 \cdot H_2O$), 80 ppm; Copper (Cu)(as $CuSO_4 \cdot 5H_2O$), 15 ppm; Cobalt (Co)(as $CoCO_3$), 1 ppm; I (as EDDI), 2 ppm; $CaCO_3$ as carrier to make up the 1% total.

[c]Same as for footnote b, except that ZnO is included. The ZnO provides a total of 36 ppm zinc (Zn) in mixed diet as fed (60.5 ppm Zn in DM).

The greater daily gain (2.6 *vs* 2.5 lb) of steers fed 13% protein than of those fed 10% protein suggests the possibility that a corn silage-corn finishing diet containing 10% protein should be supplemented with protein to maximize wt gain of large- and medium-frame steers. The small magnitude of response, however, is of minimum biological significance. The absence of a dietary protein level x frame-size interaction provides evidence that the greater wt gain and daily gain of large- compared with medium-frame steers is not affected by supplementary protein. The amounts of protein consumed by steers fed the 10% protein diet, based on computations of dry matter and protein analyses of the diets were calculated to be about 1.7 lb daily over the entire feeding period (range of 1.62 lb for large-frame steers fed high zinc-low protein to 1.75 lb for medium-frame steers fed low zinc-low protein). The steers in the present experiment had an overall daily gain of 2.53 lb (2.48 and 2.57 lb for 10 and 13% protein, respectively) which would suggest that the lower daily gain of steers fed the low protein diet was associated with a marginal protein intake. A possible factor limiting growth in steers fed the low protein diet was their inability to consume sufficient dry matter from a corn silage-based diet to satisfy daily protein requirement. The 13% protein diet clearly provided more protein than needed; steers fed the high protein diets failed to respond with improved gain to feed ratios.

The absence of a beneficial effect of supplementary zinc on any of the traits measured provides evidence that a level of 20 to 28 ppm zinc in a corn silage-corn diet for finishing steers is adequate and that large-frame steers, despite their faster wt gain and presumably greater protein accretion rate, do not respond to supplemental zinc with increased wt gain or feed intake. The failure of supplemental zinc to improve performance agrees with previous work in which 100 ppm added to an all-concentrate corn-based diet did not affect wt gain of feedlot cattle.

Table 2—Feedlot performance of large- and medium-frame size steers fed finishing diets containing two levels of protein and two levels of zinc

	Low zinc		High zinc		Low zinc		High zinc	
Frame size	med	lg	med	lg	med	lg	med	lg
No. of replicates	2	2	2	2	2	2	2	2
No. of steers	40	40	40	40	40	40	40	40
Initial body wt, lb	726	774	733	763	719	766	730	770
Final body wt, lb	1,069	1,142	1,071	1,118	1,074	1,155	1,078	1,144
Adj. final body wt, lb[a]	1,088	1,121	1,084	1,106	1,098	1,140	1,092	1,124
Adj. daily gain, lb[a]	2.42	2.64	2.38	2.53	2.49	2.77	2.44	2.66
Adj. daily feed intake, lb[a] (as fed)	28.1	27.8	27.6	27.3	28.6	28.0	28.8	25.9
Adj. gain to feed ratio[a]	.087	.095	.088	.094	.087	.100	.085	.105

[a]Adjusted to constant initial wt by covariance.