# Effect of Zinc Level and Source on Finishing Cattle Performance and Carcass Traits

L.J. McBeth, C.R. Krehbiel, J.J. Martin, C.A. Strasia, D.R. Gill, C.E. Markham, R.E. Peterson, J.M. Reeves, S.S. Swanek, and C.K. Swenson

## Story in Brief

Crossbred steers (n=336) were fed for 130 d at the Panhandle State University Research Center in Goodwell, OK to determine the effects of Zn level and source on feedlot performance and carcass merit. Thirty ppm of added Availa®Zn resulted in similar or greater performance compared with 30 ppm of added ZINPRO® Zn methionine, and numerically greater improvements in performance were observed when 60 ppm of added Availa Zn was added to the basal diet compared with 60 ppm of added $ZnSO_4$. When 120 ppm of total dietary Zn was fed, 50:50 $ZnSO_4$:AvailaZn resulted in 1.6% greater daily gain, 2.7% lower DMI, 4.2% improved efficiency, and 28.2% more choice carcasses than when 120 ppm from $ZnSO_4$ was fed. Adding 30 ppm of Zn methionine to the control diet (60 ppm Zn from $ZnSO_4$) resulted in similar carcass advantages, however feedlot performance was numerically lower compared with feeding 90 ppm total dietary Zn from $ZnSO_4$. Our results suggest increases in daily gain and DMI with increasing supplemental Zn. In addition, numeric advantages in feedlot performance and carcass traits were observed when a combination of Availa Zn and $ZnSO_4$ were fed.

Key Words: Zinc, Carcass quality, Feedlot performance, Cattle

## Introduction

Zinc and Cu have been shown to play a major role in disease resistance and immune responsiveness in stressed feeder cattle. For example, Chirase et al. (1994) found that an organic source of Zn reduced the recovery time for cattle challenged with an infectious bovine rhinotracheitis virus. In addition to their positive effects for stressed cattle, Zn and Cu have been shown to influence finishing performance. A summary of 22 feedlot trials evaluating Zn methionine has shown significant advantages in performance over controls (Zinpro Corp., 1994). In addition, % USDA Choice was increased by 8% for cattle fed Zn methionine. In a study comparing $ZnSO_4$ and two levels of Availa®Zn (Zinpro Corporation, Eden Prarie, MN), steers fed Availa Zn had 3.6% greater ADG than steers fed $ZnSO_4$ whereas feed efficiency was improved 2.5% (Zinpro Corp., 1999a). When Zn source (30 ppm $ZnSO_4$, 50:50 $ZnSO_4$ and Availa Zn, or Availa Zn) and protein level (11 or 14%) were evaluated, ADG and feed efficiency were numerically greater for steers fed Availa Zn compared with steers fed $ZnSO_4$. In addition, quality grade and marbling were higher for steers receiving Zn from both the 50:50 $ZnSO_4$:Availa Zn and Availa Zn diets compared with steers fed $ZnSO_4$ (Zinpro Corp., 1999b). The study suggested that when protein levels are higher and implants are used, Zn requirements are elevated. In addition, providing Zn as an organic source improved feed efficiency and quality grade, marbling score, and tended to increase longissimus muscle area.

This study was designed to evaluate the effects of Zn source ($ZnSO_4$, Zn methionine, or Availa Zn) and Zn level (60, 90, or 120 ppm) in finishing cattle diets.

## Materials and Methods

Approximately 550 crossbred yearling steers that were previously grazed on native tallgrass prairie near Eureka, KS were delivered to CRI Feedlot near Goodwell, OK, on July 25, 2001. On the morning of July 26, 336 steers (avg initial BW = 349 ± 22 kg) were sorted and processed. At processing, steers were ear tagged, horn tipped as needed, implanted with Ralgro®, vaccinated with IBR-$PI_3$-BVD-BRSV, vaccinated with a seven-way clostridial preparation, and treated for control of external and internal parasites. After processing, steers were trucked to the Panhandle State University (PSU) Research Center, Goodwell, OK. On arrival, steers were weighed individually, blocked by weight into five weight blocks, and assigned randomly to 30 pens (24 pens of 12 steers each and six pens of eight steers each). Steers received a second implant (Revalor®S) on d 56 of the finishing period.

Dietary treatments included: 1) 60 ppm $ZnSO_4$ (control); 2) control plus 30 ppm $ZnSO_4$; 3) control plus 30 ppm ZINPRO® Zn methionine; 4) control plus 30 ppm Availa®Zn; 5) control plus 60 ppm $ZnSO_4$; and 6) control plus 60 ppm Availa Zn. Diets were formulated to meet or exceed NRC (1996) nutrient requirements (Table 1). Monensin (33 mg/kg of diet) and tylosin (11 mg/kg of diet) were fed. Steers were gradually adapted to the final diet by offering approximately 65, 75, and 85% concentrate diets for 7, 7, and 7 d, respectively. The basal diet was purchased from Texas County Feed Yard, Guymon, OK. Steers were fed twice daily at 0700 and 1300. A premix containing ground corn and the appropriate treatment was top-dressed at a rate of .23 kg/hd/d at the evening feeding. Feed refused was weighed every 28 d. In addition, diet samples were collected, and DM content of the diets and dietary ingredients were determined. Diet and ingredient samples were composited by 28-d periods, allowed to air dry, and ground in a Wiley mill to pass a 1-mm screen. Diet and ingredient samples were returned to the Oklahoma State University campus and analyzed for N, ash (AOAC, 1990), and ADF (Goering and Van Soest, 1970). Steers were weighed individually before feeding every 28 d throughout the trial. Initial weight was analyzed as taken, and interim weights were analyzed with a 4% pencil shrink. Final live weight was calculated by dividing hot carcass weight by a common dressing percentage (65). Daily feed intake was summed and feed efficiencies (DMI:ADG) were calculated every 28 d. Steers were harvested at National Beef, Liberal, KS on December 4, 2001. Hot carcass weight was determined following harvest, and carcasses were evaluated after a 24-h chill for subcutaneous fat depth at the 12th rib, longissimus muscle area, percentage kidney, pelvic, and heart fat, yield grade, marbling score, and quality grade (USDA, 1997).

Twenty-eight d cattle performance data were analyzed using PROC MIXED for repeated measures (SAS, 1999). Class variables included in the model as fixed effects were treatment and time period and their interaction. Weight class was also considered a class variable and was included in the model. Cumulative feedlot performance from d 0 to harvest and carcass data were analyzed as a randomized complete block design using the GLM procedure of SAS (1999). Treatment and weight replicate were included in the model as class variables. Pens were considered the experimental unit for all cattle performance data. There were 5 replicates for each treatment. Pre-planned comparisons included: 1) linear and quadratic Zn level; 2) inorganic vs organic Zn; and 3) 30 ppm Zn methionine vs 30 ppm Availa Zn. Carcass quality and yield grades as assigned by USDA were examined on an individual animal basis using Chi-Square analysis techniques (SAS, 1999).

| Table 1. Dry matter and nutrient composition of the finishing diet | |
|---|---|
| Ingredients | % of diet DM |
| Flaked corn | 81.0 |
| Corn silage | 4.5 |
| Alfalfa hay | 4.5 |
| Yellow grease | 3.0 |
| Cotton seed Meal | 40.9 |
| Soybean meal | 28.6 |
| Limestone (38%) | 14.0 |
| Urea | 10.0 |
| Salt | 4.3 |
| Tallow | 1.4 |
| Rumensin 80 | .29 |
| Tylan 40 | .14 |
| Zinc Sulfate | .17 |
| Vitamin A | .10 |
| Manganous Oxide | .06 |
| Copper sulfate | .01 |
| | |
| Nutrients | |
| Dry matter, % as fed | 77.1 |
| NEm, Mcal/100lb | 100.1 |
| NEg, Mcal/100lb | 65.5 |
| Crude protein, % of DM | 12.99 |
| Crude fiber, % of DM | 4.77 |
| Calcium, % of DM | .49 |
| Phosphorus, % of DM | .31 |
| Potassium, % of DM | .56 |
| Copper, ppm | 8.10 |
| Zinc, ppm | 59.8 |

## Results and Discussion

A tendency (P=.06) for a treatment x period interaction was observed for daily gain (data not shown). This resulted in 8.7% lower daily gain from d 84 through 112 and 42.7% greater daily gain from d 113 through finish for steers consuming 120 ppm Zn compared with steers on the other treatments. From d 113 through finish, steers consuming control plus 60 ppm Availa Zn had 20.8% greater daily gain than steers consuming control plus 60 ppm $ZnSO_4$. Dry matter intake was influenced by period (P<.001) and treatment (P<.001) (Table 2). From d 29 through 55, steers consuming control plus 30 ppm Zn methionine or control plus 60 ppm $ZnSO_4$ had greater (P<.05) DMI than control steers, whereas on d 56 through 83, steers consuming control plus 30 ppm Availa Zn, 30 ppm Zn methionine, or 60 ppm $ZnSO_4$ had greater (P<.05) DMI than control steers. In general, DMI was greater for steers consuming 90 or 120 ppm Zn compared with controls. Feed efficiency (DMI:ADG) generally increased (P<.001) as days on feed increased (data not shown).

Cumulative feedlot performance is shown in Table 3. No differences (P>.10) were observed for overall daily gain or DMI. However, numerically, steers consumed 7.0 and 6.9% more feed and daily gain was 4.6 and 6.3% greater when 90 and 120 ppm Zn was fed, respectively, compared with 60 ppm Zn. The numerical increase in DMI is in contrast to previous work with increasing Zn concentrations (Malcolm-Callis et al., 2000). Similarly, in a summary of 22 feedlot experiments comparing ZINPRO Zn methionine to $ZnSO_4$, DMI intake was similar (Zinpro Corp., 1994). However, Galyean et al. (1995) showed greater DMI in steers fed supplemental Zn compared with steers fed the basal diet. Across the feeding period in the present experiment, steers fed 90 ppm $ZnSO_4$ had 3.9% greater daily gain than when 90 ppm of organic sources were fed, whereas Availa Zn resulted in 1.6% greater daily gain than $ZnSO_4$ when 120 ppm Zn was fed. Results from previous experiments have shown an improvement in daily gain when 360 mg ZINPRO Zn methionine (Zinpro Corp., 1994) or 30 to 200 ppm of Availa Zn (Zinpro Corp., 1999ab) has been added to the diet compared with inorganic Zn. Reasons for the numerically lower daily gain when 30 ppm of Zn methionine or Availa Zn were added to the control diet in our experiment are unclear. Across the entire feeding period, steers fed Availa Zn were 6.5% more (P=.07) efficient than steers fed Zn methionine.

No significant differences were observed in carcass traits (Table 4). Numerically, steers fed control plus 30 ppm Zn methionine and control plus 60 ppm Availa Zn had 8.7% more marbling and 3.2% less 12th-rib fat than steers on the other treatments. For steers fed control plus 30 ppm Zn methionine, this resulted in numerically more choice carcasses with a similar yield grade (Table 5). Increases in measures of fat deposition are consistently greater in steers supplemented with organic sources of Zn compared with inorganic Zn sources. For example, in the 22 trial summary (Zinpro Corp., 1994), supplementing 360 mg of Zn methionine to the basal diet resulted in 8% more choice carcasses. In addition, Greene et al. (1988) found that steers fed Zn methionine had a higher quality grade, marbling, and KPH than steers fed ZnO; Spears and Kegley (1994) reported similar results. Although little data is available, Availa Zn has also been shown to increase marbling in feedlot cattle (Zinpro Corp., 1999b), similar to Zn methionine.

**Table 2. Effects of treatment and period on dry matter intake (kg/d) in steers fed different levels and sources of Zn for 130 d**

| | | 60 ppm $ZnSO_4$ | | | 60 ppm $ZnSO_4$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Period | 60 ppm $ZnSO_4$ | 30 ppm $ZnSO_4$ | 30 ppm AvailaZn | 30.ppm ZnMet | 60 ppm $ZnSO_4$ | 60 ppm AvailaZn | SEM[a] | Trt | Per | Trt*Per |
| d 0 - 29 | 9.23 | 9.66 | 9.34 | 9.76 | 9.89 | 9.35 | .33 | <.001 | <.001 | .99 |
| d 29 - 55 | 10.00[a] | 10.64[ab] | 10.70[ab] | 11.23[b] | 10.96[b] | 10.74[ab] | | | | |
| d 56 - 83 | 9.77[a] | 10.44[ab] | 10.74[b] | 10.71[b] | 10.69[b] | 10.48[ab] | | | | |
| d 84 - 112 | 9.92 | 10.47 | 10.58 | 10.42 | 10.67 | 10.46 | | | | |
| d 113 - 130 | 9.28 | 9.95 | 9.97 | 9.79 | 10.03 | 9.79 | | | | |

[a]Standard error of the least squares means

[a,b]Means within a row with common superscripts do not differ

**Table 3. Effects of zinc level and source on cumulative feedlot performance in steers fed for 130 d**

| | | 60 ppm $ZnSO_4$ | | | 60 ppm $ZnSO_4$ | | | Contrasts | |
|---|---|---|---|---|---|---|---|---|---|
| Item | 60 ppm $ZnSO_4$ | 30 ppm $ZnSO_4$ | 30 ppm AvailaZn | 30 ppm Zn Met | 60 ppm $ZnSO_4$ | 60 ppm Availa Zn | SEM[a] | Inorganic vs Organic | ZnMet vs Availa Zn |
| Initial wt., kg | 346 | 346 | 347 | 347 | 346 | 347 | .55 | NS | NS |
| Final wt., kg | 572 | 590 | 584 | 577 | 584 | 589 | 6.18 | NS | NS |
| | | | | | | | | | |
| Daily gain, kg | 1.74 | 1.87 | 1.82 | 1.77 | 1.83 | 1.86 | .05 | NS | NS |
| | | | | | | | | | |
| DM intake, kg/d | 9.66 | 10.24 | 10.28 | 10.49 | 10.47 | 10.19 | .25 | NS | NS |
| | | | | | | | | | |
| Feed:Gain | 5.57 | 5.49 | 5.63 | 5.92 | 5.72 | 5.49 | .02 | NS | .07 |

[a]Standard error of the least squares means

[b]NS = not significant.

**Table 4. Effects of zinc level and source on carcass characteristics of feedlot steers fed for 130 d**

| | | 60 ppm Zn $SO_4$ | | | 60 ppm Zn $SO_4$ | | |
|---|---|---|---|---|---|---|---|
| Item | 60 ppm $ZnSO_4$ | 30 ppm $ZnSO_4$ | 30 ppm AvailaZn | 30.ppm ZnMet | 60 ppm $ZnSO_4$ | 60 ppm AvailaZn | SEM[a] |
| Dressing % | 65 | 65 | 66 | 66 | 65 | 66 | .4 |
| Hot Carcass Wt., kg | 376 | 385 | 382 | 378 | 383 | 385 | 3.1 |
| Marbling[b] | 385 | 396 | 393 | 425 | 386 | 422 | 11.4 |
| Quality Grade[c] | 272 | 276 | 275 | 291 | 273 | 293 | 6.7 |
| External fat, cm | 1.16 | 1.21 | 1.18 | 1.16 | 1.28 | 1.18 | .06 |
| Ribeye Area, $cm^2$ | 93.08 | 96.43 | 95.91 | 92.61 | 95.04 | 95.68 | 1.28 |
| KPH, % | 1.31 | 1.40 | 1.39 | 1.44 | 1.42 | 1.49 | .48 |
| Yield Grade | 2.44 | 2.41 | 2.38 | 2.51 | 2.53 | 2.43 | .11 |

[a]Standard error of the least squares means

[b]Practically devoid = 100; traces = 200; slight = 300; small = 400; modest = 500; moderate = 600; slightly

abundant = 700

[c]Standard = 100; select = 200; choice = 300; prime = 400

**Table 5. Frequency distribution for various individual carcass measurements**

| | | 60 ppm $ZnSO_4$ | | | 60 ppm $ZnSO_4$ | |
|---|---|---|---|---|---|---|
| Item | 60 ppm $ZnSO_4$ | 30 ppm $ZnSO_4$ | 30 ppm AvailaZn | 30.ppm ZnMet | 60 ppm $ZnSO_4$ | 60 ppm AvailaZn |
| N | 55 | 56 | 55 | 55 | 56 | 55 |
| USDA Quality Grade[a] | | | | | | |
| Prime | 0 | 0 | 0 | 2 | 0 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Choice | 23 | 26 | 26 | 34 | 27 | 34 |
| Select | 30 | 28 | 28 | 18 | 27 | 18 |
| Standard | 2 | 2 | 1 | 1 | 2 | 2 |
| USDA Yield Grade[b] | | | | | | |
| One | 2 | 5 | 2 | 2 | 2 | 4 |
| Two | 30 | 31 | 32 | 31 | 33 | 28 |
| Three | 22 | 19 | 18 | 21 | 18 | 21 |
| Four | 1 | 1 | 2 | 1 | 1 | 1 |
| Five | 0 | 0 | 0 | 0 | 1 | 0 |

[a]Chi square value = 17.40; Probability > F = .30

[b]Chi square value = 9.99; Probability > F = .97

## Implications

In our experiment, Availa®Zn resulted in similar or greater performance compared with ZINPRO® Zn methionine, and numerically greater improvements in performance were observed when 60 ppm Availa Zn was added to the basal diet compared with 60 ppm $ZnSO_4$. When 120 ppm Zn was fed, 50:50 $ZnSO_4$:Availa®Zn resulted in 1.6% greater daily gain, 2.7% lower DMI, 4.2% improved efficiency, and 28.2% more choice carcasses than when 120 ppm of $ZnSO_4$ was fed. Adding 30 ppm of Zn methionine resulted in similar carcass advantages; however feedlot performance was numerically lower compared with feeding 90 ppm Zn from $ZnSO_4$.

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