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Effect of supplemental trace-mineral source on bull semen quality

M. P. Rowe,[1] J. G. Powell, E. B. Kegley, T. D. Lester, and R. W. Rorie[2]
Department of Animal Science, University of Arkansas, Fayetteville 72701

ABSTRACT

This study evaluated the effect of trace-mineral supplementation on bull semen quality, as measured by computer-assisted sperm analysis. Angus and Gelbvieh × Angus bulls assigned to inorganic (n = 9) and organic (n = 10) trace-mineral treatments were maintained in drylot pens and fed mixed grass hay. Three times weekly bulls were individually fed rations containing either inorganic or a mixture of inorganic and organic Zn, Cu, Co, and Mn trace mineral for 123 d (mid-May to early September). Starting on d 60, semen was collected by electroejaculation weekly for a 9-wk period (mid-July until early September) and evaluated by computer-assisted sperm analysis for motility parameters within 5 min of collection. Data were analyzed by treatment, week, and their interaction using SAS PROC Mixed for repeated measures. Bulls supplemented with organic trace minerals had a greater (P = 0.02) percentage of motile sperm than those supplemented with inorganic trace minerals (65.5 vs. 56.1%, respectively). Likewise, percentage of progressive sperm was greater (P = 0.01) for bulls receiving organic (47.0%) versus only inorganic (38.4%) trace mineral. Sperm with rapid motility (path velocity >50 μm/s) was also greater (P = 0.03) for bulls supplemented with organic compared with bulls receiving inorganic trace mineral (62.3 vs. 52.8%, respectively). Sperm motility is the single most important semen quality parameter influencing bull fertility. Results suggest organic trace-mineral supplementation may improve bull semen quality. Additional studies are needed to determine whether this improvement in semen quality translates into improved pregnancy rates.

Key words: bull, trace mineral, semen quality

INTRODUCTION

Many mineral supplements commonly fed to livestock are commercially available in inorganic forms. However, trace minerals are present in the body almost entirely as organic complexes or chelates and not as free inorganic ions. Research indicates that organic trace-mineral sources may be more bioavailable, possibly by reducing negative interactions with other compounds in the gut or through improved efficiency of conversion to a physiologically active form (Ledoux and Shannon, 2005). It has been well documented that trace-mineral status has an effect on reproductive performance. Zinc deficiency has a negative effect on spermatogenesis (Hidiroglou, 1979). Supplemental Zn has been shown to improve the percentage of morphologically normal sperm in beef bulls (Arthington et al., 2002). Studies indicate that organic forms of trace minerals can improve dairy cow reproductive performance, particularly during times of stress (Kellogg et al., 2003). Limited information is available on the effects of organic trace-mineral supplementation on bull fertility. Therefore, the objective of this study was to evaluate the effect of source (organic vs. inorganic) of 4 supplemental trace minerals fed as a mixture on bull semen quality.

MATERIALS AND METHODS

Animals and Treatments

This study used Angus (n = 5) and Balancer (Gelbvieh × Angus, n = 14) bulls housed at the University of Arkansas Division of Agriculture Beef Cattle Research Unit near Fayetteville, Arkansas. Bulls averaging 833 kg of BW and ranging from 4 to 9 yr of age at the start of the study were maintained and cared for in accordance to procedures approved by the University of Arkansas Institutional Animal Care and Use Committee (protocol #11001). Semen was collected by electroejaculation and evaluated a minimum of 3 times before the start of the study to ensure all bulls met or exceeded minimum breeding sound-

[1] M. P. Rowe is deceased.
[2] Corresponding author: rrorie@uark.edu

Table 1. Supplemental sources and levels of trace minerals fed to bulls[1]

	Inorganic diet	Organic diet	
Mineral	Inorganic portion, mg/d	Organic portion,[2] mg/d	Inorganic portion, mg/d
Zinc	450 as zinc sulfate	360 as zinc amino acid complex	90 as zinc sulfate
Copper	150 as copper sulfate	125 as copper amino acid complex	25 as copper sulfate
Cobalt	12 as cobalt carbonate	12 as cobalt glucoheptonate	0
Manganese	300 as manganese sulfate	200 as manganese amino acid complex	100 as manganese sulfate
Selenium	3 as sodium selenite	0	3 as sodium selenite
Iodine	5 as calcium iodate	0	5 as calcium iodate

[1]Organic mineral provided via Availa 4 (Zinpro Corporation, Eden Prairie, MN).

[2]Three times each week, bulls were individually fed 1.2 kg (DM basis) of a grain supplement (Table 2) that provided these desired mineral levels.

ness evaluation requirements. Bulls were stratified by breeding soundness and semen quality, then balanced across inorganic (n = 9) or organic (n = 10) trace-mineral treatments based on breed, BW, and age. Treatment consisted of supplemental Zn (450 mg/d), Cu (150 mg/d), Co (12 mg/d), and Mn (300 mg/d) supplied as either inorganic or a mixture of inorganic and organic sources (Availa 4, ZinPro Corp., Eden Prairie, MN; Table 1). Three times each week, the bulls were separated into individual pens and fed 1.2 kg (DM basis) of a grain supplement (Table 2) that served as the carrier for the desired amounts of inorganic or organic trace-mineral treatments for a 123-d period (mid-May and extending to early September). Based on an intake of 2% of BW, these supplemental trace-mineral levels would be approximately 27 mg of Zn, 9 mg of Cu, 0.7 mg of Co, 18 mg of Mn, 0.18 mg of Se, and 0.3 mg of I per kilogram of DM.

Table 2. Ingredients and nutrient composition of carrier diet containing either inorganic or organic trace-mineral supplement

Supplement constituent	Inorganic diet	Organic diet
Ingredient, % as fed		
Ground corn	83.4	83.4
Salt, white	5.8	5.8
Limestone	5.8	5.8
Molasses	5	5
Inorganic mineral premix[1]	+	−
Organic mineral premix[2]	−	+
Nutrient composition, DM basis		
DM, %	85.2	86.9
CP, %	10.1	10.0
Ca, %	2.91	2.63
P, %	0.25	0.26
Mg, %	0.11	0.11
Zn,[3] mg/kg	907 ± 35	954 ± 50
Cu,[3] mg/kg	338 ± 28	353 ± 7.4
Mn,[3] mg/kg	698 ± 125	769 ± 91
Co,[3] mg/kg	21.5 ± 0.45	27.1 ± 0.60

[1]Premix formulated to provide desired daily level of trace minerals (Table 1) in this supplement that was fed 3 times each week, 1.2 kg/feeding.

[2]Premix formulated to provide desired daily level of trace minerals (Table 1) in this supplement that was fed 3 times each week. Organic premix contained trace-mineral amino acid complexes provided via Availa 4 (Zinpro Corporation, Eden Prairie, MN) and some inorganic trace minerals as sulfates.

[3]Diets mixed 3 times; values reported as the mean ± SD after analyses of samples from each mix.

Bulls were maintained in 2 shaded, drylot pens (0.14 ha each) throughout the study, with approximately the same number of bulls per pen on each treatment. Bulls had ad libitum access to water and were fed mixed grass hay from large round bales (88.9% DM; 11.6% CP; 75% NDF; 44% ADF; 0.32% Ca; 0.24% P; 0.14% Mg; 24.8 mg of Zn/kg; 5.9 mg of Cu/kg; 73.6 mg of Mn/kg; and 0.1 mg of Co/kg; DM basis). Starting on d 60 of the study (July 15), semen was collected by electroejaculation weekly for 9 consecutive weeks.

Semen Evaluation

Within 5 min of collection, semen samples were analyzed using a computer-assisted sperm analysis system (Hamilton Thorne Biosciences, Beverly, MA). Prior to analysis, each semen sample was diluted with Dulbecco's PBS to achieve a concentration of ~25 million sperm/mL before loading onto a 2X-CEL (Hamilton Thorne Biosciences) slide. The computer-assisted sperm analysis system scanned ~10 areas along the length