THE EFFECT OF DIETARY ZINC LEVEL AND SOURCE ON YEARLING BULL GROWTH AND FERTILITY [1]

J. D. Arthington, K. R. Johnson [2], L. R. Corah, C. L. Willms [3], and D. A. Hill [4]

Summary

To study the effect of dietary zinc level and source on bull growth and fertility, 325 yearling Angus bulls were allotted by weight into six pens (three pens of heavy and three pens of lightweight bulls). The three supplemental zinc (Zn) treatments were 1) 40 ppm inorganic Zn all supplied by Zn sulfate (ZnI); 2) 40 ppm Zn with 1/3 supplied by Zn proteinate and 2/3 supplied by Zn sulfate (ZnPI); and 3) 60 ppm ZnI all supplied by Zn sulfate (ZnHi). Initial and final liver biopsies (10 per pen) were collected and analyzed for zinc concentration. Individual weights and scrotal circumferences also were recorded at the start and conclusion of the trial. Bulls intended for public sale (n=167) had their semen collected and evaluated for motility and morphological abnormalities. Bulls with percent normal sperm cell counts of less than 70% or with motility scores less than fair (motility scores = poor, fair, good, very good) were considered classification deferred (CD). Following 126 days of treatment, ZnHi bulls had a greater (P=.058) percent change in liver Zn concentration than ZnI, but similar increases to ZnPI. No differences in bull ADG or percent change in scrotal circumference were detected. ZnPI and ZnHi bulls had a higher (P<.05) percent of normal sperm cells than ZnI bulls. ZnPI and ZnHi treatments had fewer (P<.05) CD bulls than ZnI. In all fertility measures observed, bulls receiving the Zn proteinate/Zn sulfate combination at 40 ppm had improved semen quality when compared to bulls supplemented with 40 ppm Zn sulfate.

(Key Words: Zinc, Bull, Growth, Fertility.)

Introduction

The important role of Zn in male fertility has been realized for some time. Recently, however, the use of "minerals" in livestock nutrition has gained considerable interest from commercial and purebred producers alike. The generic term "organic mineral" is used to describe any of the three forms of protected minerals available in the feed industry: chelates, proteinates, and complexes. The support for their use stems from research studies and field experience that suggesting that organic minerals are more biologically available than inorganic forms. Nevertheless, controlled experiments continue to produce conflicting results. Our study investigated the potential use of organic Zn as Zn proteinate in growing bull diets. Growth, sexual maturation, and fertility were compared when bulls were supplemented with either inorganic (Zn sulfate) or organic Zn sources. Additionally, a third treatment, consisting of inorganic Zn at an increased level, was included to answer the important question: will increased levels of the less expensive inorganic Zn achieve the same benefits as organic Zn?

[1]Authors express their thanks to Audy Spell and Jamie Orth for their assistance in conducting this trial.

[2]University of Nebraska, Clay Center.
[3]Harvest States Cooperatives, Sioux Falls, South Dakota.
[4]Nutribasics Company, Willmar, Minnesota.

Experimental Procedures

Yearling Angus bulls (n=325) were allotted by weight into six pens of similar size resulting in three pens of heavy- and three pens of lightweight bulls. One of three supplemental zinc treatments consisting of 1) 40 ppm, all supplied by Zn sulfate (ZnI); 2) 40 ppm Zn with 1/3 supplied by Zn proteinate and 2/3 supplied by Zn sulfate (Zn PI); or 3) 60 ppm, all supplied by Zn sulfate (ZnHi). Each Zn treatment was given to cattle in two pens, one heavy- and one lightweight, for 126 days. Initial and final liver biopsies (10 per pen) were collected and analyzed for Zn concentration via inductively coupled plasma spectroscopy. Individual bull weights and scrotal measures also were recorded at the start and conclusion of the trial. One person measured all scrotal circumferences at each time period. Semen from bulls intended for public sale (n=167) was collected by electro-ejaculation and evaluated for motility and morphological abnormalities prior to the conclusion of the study. Bulls with fewer than 70% normal sperm cells or with motility scores of poor (motility scores = poor, fair, good, very good) were considered classification deferred (CD).

Results and Discussion

Following 126 days, ZnHi bulls had greater (P=.058) increases in liver Zn concentration than ZnI, but were similar to ZnPI treatments (-9.8, 1.2, and 20.6 ppm for ZnI, ZnPI, and ZnHi, respectively). No differences in ADG or change in scrotal circumference were detected (Table 1). ZnPI and ZnHi treatments had a higher (P<.05) percent of normal sperm cells and, consequently, fewer CD bulls than the ZnI treatment. In all fertility measures studied, bulls receiving the Zn proteinate/Zn sulfate combination at 40 ppm rated highest, followed by those receiving Zn sulfate at 60 ppm, and lastly by those receiving Zn sulfate at 40 ppm.

These data support the importance of dietary Zn in male fertility. The use of organic Zn in growing bull diets may improve subsequent fertility measures. However, inorganic Zn at an increased level also improved fertility. For growing bulls, the NRC-recommended level of 30 ppm in the diet may be too low. Further studies that investigate higher levels of Zn both in the organic and inorganic forms are merited.

Table 1. Effect of Zinc Level and Source on Yearling Bull Growth, Sexual Maturation, and Fertility

Item	ZnI[c]	ZnPI[c]	ZnHi[c]
ADG, lb	2.9	3.3	3.3
Change in scrotal circumference, cm	8.6	9.3	9.1
Normal sperm cells in the ejaculate, %	55.8[a]	68.9[b]	62.5[b]
Bulls classification deferred, %	77.6[a]	51.5[b]	58.8[b]

[a,b]Means with unlike superscripts within a row differ (P < .05).
[c]ZnI = 40 ppm Zn as Zn sulfate; ZnPI = 40 ppm Zn, 2/3 as Zn sulfate and 1/3 as Zn proteinate; and ZnHi = 60 ppm Zn as Zn sulfate.