REPRODUCTIVE PERFORMANCE OF FIRST CALF HEIFERS SUPPLEMENTED WITH AMINO ACID CHELATE MINERALS

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Story in Brief

Forty 2- and 3-year-old heifers nursing their first calves were utilized to determine the response to a mineral supplementation program of amino acid chelates of copper, zinc, magnesium, manganese and potassium relative to inorganic sources. Measurements included estrus activity as determined by standing heat, first service artificial insemination conception rate, conception rate at the end of the breeding season, days from calving to conception of second calf and weaning weight of first calves. At the start of the trial (approximately 45 days post-calving), the cow-calf pairs were randomly assigned to a mineral supplementation program by breed, calving date and body condition score to minimize differences among treatments. Estrus was synchronized to facilitate artificial insemination 70 days post-calving. Three females were removed from the trial due to matters unrelated to the study. Fourteen of the 18 females receiving amino acid-mineral chelates were observed in standing heat within 72 hours of removal of the synchronizing agent implant and 10 of 14 settled on first artificial insemination. Only 8 of 19 females receiving inorganic minerals were observed in standing heat after implant removal and two settled on first service. Sixteen of 18 chelate-supplemented females and 17 of 19 inorganic supplemented females conceived during the 60-day breeding season; however, the inorganic-supplemented females conceived an average of 19 days later than the chelate-supplemented females.

(Key Words: Cattle, Reproduction, Estrus, Minerals.)

Introduction

The Oklahoma State University Beef Cattle Center herd currently consists of over 250 head of producing females of six different breeds - Angus, Polled Hereford, Horned Hereford, Brangus, Limousin and Simmental. Prior to 1986, despite feeding protein and energy levels in excess of 1984 NRC requirements,

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fertility as measured by percentage of females pregnant 90 days after breeding season was relatively low (less than 75%).

An intense investigation was initiated in 1986 to identify the reason for the fertility problems. Soil samples (Table 1), forage samples (Table 2) and feed grains were analyzed for nutrient composition, especially mineral analyses. Initial blood serum analyses are shown in Table 3. Low levels of calcium, phosphorus, magnesium, selenium, copper and zinc were noted. Liver copper levels of a Hereford cow slaughtered was 8.4 ppm (normal > 40 ppm). An Angus calf which died shortly after birth had a liver copper level of 62 ppm (normal > 300 ppm). One of the first clinical symptoms in a copper deficient cow herd is achromotrichia (loss of hair color). Angus cattle typically will exhibit brown pigmentation rather than a black color particularly around the eyes, tips of the ears and over the top, especially behind the shoulders. This condition was prevalent in the Angus herd. In addition, feet and leg problems, reduced weaning weights and general growth and respiratory edema were noted. A mineral mix of 66% dicalcium phosphate, 29% trace mineralized salt and 5% cottonseed meal appeared to improve visually indicated traits. This trace mineral salt contained salt, manganous oxide, iron oxide, ferrous carbonate, copper oxide, ethylenediamine dihydroiodide, zinc oxide, cobalt carbonate and technical white mineral oil. The guaranteed analysis of the trace mineral salt is shown in Table 4.

As a direct result of preliminary findings and a desire to increase the levels of trace minerals, all animals in the herd were placed on a free choice mineral supplementation program consisting of Bluebonnet Tech-Master mineral in a 50:50 mixture with salt. This Tech-Master mineral contains major minerals,

Table 1. Soil mineral composition.

Item	ppm
Phosphorus	3.1
Potassium	141.7
Magnesium	347.1
Calcium	923.0
Sulfur	9.5
Zinc	1.6
Manganese	14.3
Iron	60.9
Copper	1.8
Boron	.5

Table 2. Forage mineral composition.

Item	Analysis
Phosphorus, %	.08
Potassium, %	1.06
Magnesium, %	.10
Calcium, %	.38
Sodium, %	.02
Iron, ppm	122
Aluminum, ppm	103
Manganese, ppm	52
Boron, ppm	14
Copper, ppm	5
Zinc, ppm	21

Table 3. Initial blood serum analyses.

Mineral	Level	Normal range
Calcium, mg/dl	6.6	9 - 12
Phosphorus, mg/dl	3.4	4.5 - 7
Magnesium, mg/dl	1.4	2 - 3
Potassium, mg/dl	19.4	15 - 23
Selenium, ppm	.047	.07 - .3
Copper, ppm	.217	.7 - 1.0
Zinc, ppm	.913	1.5 - 1.8
Iron, ppm	1.317	.9 - 2.5
Manganese, ppm	.039	.01 - .03

inorganic trace minerals, Albion's patented protein chelated trace minerals plus vitamins A, D_3 and E (Table 5). A 3-oz intake of this mineral salt supplement should supply 63 mg of copper.

Subsequent blood serum analysis suggested that the trace mineral supplementation program had increased blood serum copper levels. All tested animals had an average blood serum copper level of .8 ppm copper, well within the normal range and a 4-fold increase from the first analysis (Table 3).

The objective of this study was to investigate the effectiveness of free choice supplementation of a combination of chelated and inorganic trace

Table 4. Inorganic trace mineral salt composition.

Item	Content
Salt	92-97%
Manganese	>.25%
Iron	>.20%
Copper	>.033%
Iodine	>.007%
Zinc	>.005%
Cobalt	>.0025%

Table 5. Mineral and vitamin composition of Bluebonnet Techmaster mineral.

Component	Content
Calcium	8-9%
Phosphorus	>8.0%
Potassium	>3.0%
Magnesium	>4.75%
Zinc	> .7%
Manganese	> .3%
Copper	> .2%
Cobalt	> .0025%
Iodine	> .001%
Selenium	.002%
Vitamin A	>280,000IU/lb
Vitamin D_3	>59,000IU/lb
Vitamin E	>400IU/lb

minerals in enhancing bovine reproductive performance and calf weaning weights.

Material and Methods

Forty 2- and 3-year-old first calf heifers located at the OSU Purebred Beef Center Range were utilized in the study. Five different breeds were represented:

Angus (15), Horned Herefords (12), Polled Herefords (5), Brangus (5) and Simmental (3). All females calved between January 31, 1988 and March 5, 1988. In addition, all females utilized in the study had free access to a 50% salt:50% Tech-Master mineral supplement consisting of Albion amino acid chelates, inorganic trace minerals, major minerals plus Vitamin A, D_3 and E (Table 5) for one year prior to the start of the study.

Prior to the trial, all females were maintained on dormant Old World Bluestem pasture and supplemented with 20 lb of mature native range grass hay (6% CP, 45% TDN) and 5 lb of 20% CP range protein supplement per head daily plus free access to the 50% salt:50% Tech-Master mineral supplement. The base diet contained 31 ppm zinc, 81 ppm manganese, 5.6 ppm copper and 2.3 ppm molybdenum. The copper:molybdenum and zinc:copper ratios were 2.4 and 5.6, respectively.

A schematic diagram of the trial is presented in Figure 1. On April 4 (start of the trial), the cow-calf pairs were assigned randomly to one of two mineral supplementation programs by breed, calving date and body condition score to minimize the differences among treatments. In addition, the free choice 50% salt:50% Tech-Master mineral supplement consisting of Albion amino acid chelates, inorganic trace minerals, major minerals plus Vitamins A, D_3 and E was removed from the pasture and replaced with a mineral supplement containing 66% dicalcium phosphate, 29% salt and 5% cottonseed meal.

A 90 acre Old World Bluestem pasture was split into two 45 acre pastures by electric fence. All females remained on the base nutritional program (Old World Bluestem pasture, 20 lb of native grass hay, 5 lb of a 20% CP range supplement). The mineral treatments consisted of amino acid chelates (copper, zinc, manganese, magnesium and potassium) vs inorganic trace minerals

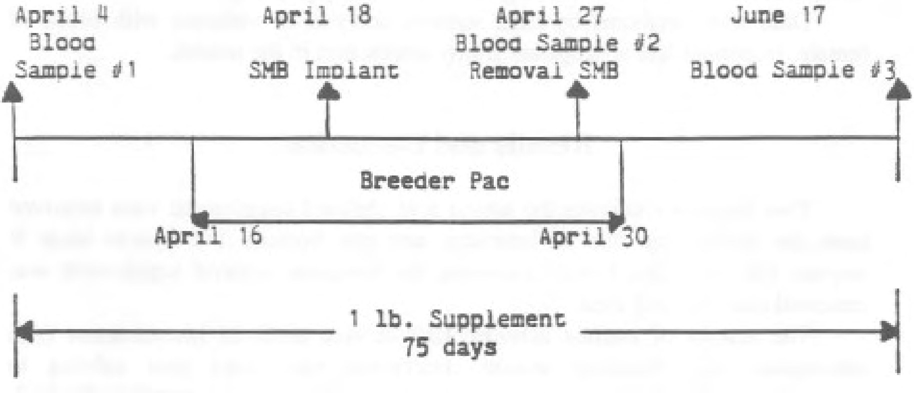

Figure 1. Schematic design of trial, SMB is Synchro-Mate B.

(copper sulfate, zinc sulfate, manganese oxide, magnesium oxide and potassium chloride) to supply identical levels of copper, zinc, magnesium, manganese and potassium. The mineral mixes were incorporated into a 20% CP range pelleted supplement fortified with 14,687 IU Vitamin A/lb, 3,125 IU Vitamin D_3/lb, 150 IU Vitamin E/lb and 2.5 mg Selenium/lb. The total mineral analyses of both treatment diets are presented in Table 6. Both treatment supplements were fed at the rate of 1 lb per day to supply 178 mg copper, 275 mg manganese, 563 mg zinc, 1,352 mg magnesium and 823 mg potassium. Including the basal nutritional program, the diets were formulated to supply a total of 18 ppm copper, 71 ppm zinc and 89 ppm manganese. The supplemental native grass hay and 5 lb of 20% CP range supplement were discontinued on April 30 (Figure 1). The 1 lb per head daily treatment supplements were fed until June 15, 1988.

An Albion Breeder Pac was utilized 14 days prior to breeding at the level of 2 oz per head per day in 1 lb ground corn. The amino acid chelated group received the standard Albion Breeder Pac formula which contains 5.5% Mg, 3.8% K, 400,00 IU Vitamin A/lb, 85,000 IU Vitamin D/lb, 570 IU Vitamin E/lb as well as 21 mg copper, 44 mg manganese and 110 mg zinc per oz in an amino acid chelate form. The inorganic trace mineral group received a similar Breeder Pac except the copper, manganese, zinc, magnesium and potassium amino acid chelates were replaced by inorganic sources (Table 6).

The Breeder Pac was supplied to treatment groups from April 17 to April 30. On April 17, all females were injected with 2 ml of Synchro-Mate B Injectable (Norgestomet plus estradiol valerate) and implanted with the Synchro-mate B implant (Norgestomet). The implant was removed on April 27 (Day 10). Females were observed four times daily for signs of estrus starting on April 28. Females exhibiting estrus were artificially inseminated approximately 12 h after observed heat. Actual conception and days post calving to conception were determined by actual calving date the following spring.

Data were analyzed by least squares analysis of variance with breed of female, treatment and appropriate 2-way interaction in the model.

Results and Discussion

Two females receiving the amino acid chelated supplement were removed from the study, one due to lameness and one because the Syncro-Mate B implant fell out. One female receiving the inorganic mineral supplement was removed after her calf died.

The results of estrous activity, first service artificial insemination (AI) conception rate, breeding season conception rate, days post calving to conception and 205-day weaning weight of first calves are presented in Table 7. The amino acid chelate supplemented cows exhibited more standing heats and

Table 6. Treatment group levels (mg) of copper, manganese, zinc, magnesium and potassium.

	1 lb. 20% Supplement		2 oz Breeder Pac		Total supplement	
	Chelated	Inorganic	Chelated	Inorganic	Chelated	Inorganic
Cu S04	—	178 mg	—	48 mg	—	226 mg
Cu Chelate	154 mg	24 mg	45 mg	3 mg	199 mg	27 mg
MnO	—	275 mg	—	80 mg	—	355 mg
Mn Chelate	231 mg	44 mg	65 mg	15 mg	296 mg	59 mg
ZnSO4	—	563 mg	—	258 mg	—	821 mg
Zn Chelate	466 mg	97 mg	233 mg	25 mg	699 mg	122 mg
MgO	—	1352 mg	—	3660 mg	—	5012 mg
Mg Chelate	142 mg	1210 mg	368 mg	3292 mg	510 mg	4502 mg
KCl	—	823 mg	—	2452 mg	—	3275 mg
K Chelate	142 mg	681 mg	368 mg	2084 mg	510 mg	2765 mg

Table 7. Estrous activity, first service conception rate, breeding season conception rate, days post calving to conception and 205-day adjusted weaning weights.

Item	Mineral supplements	
	Chelates	Inorganic
Females, total	18	19
Females, exhibiting estrus	14	8
Females exhibiting estrus, %	77.8[a]	42.1[b]
Females, first service conception	10	2
Females exhibiting estrus that conceived on first services, %	71.4[a]	25.0[b]
Total females conceiving on first service, %	55.6[a]	10.5[b]
Females conceiving during breeding season	16	17
Days post calving to conception	86	105
Body condition score	5.0	5.3
Weaning weight (205 day), lb	575[c]	527[d]

[a,b] Means in the same row with different superscripts differ ($P<.05$).
[c,d] Means in the same row with different superscripts differ ($P<.01$).

had a greater percentage of females conceiving on first service than the inorganic mineral supplemented cows. Fourteen of the 18 amino acid chelate supplemented cows exhibited a standing heat after removal of the Syncro-Mate B implant. Of the 14 females that cycled, 10 conceived on first AI service. The reproductive performance of the females receiving the inorganic trace mineral supplement was poorer ($P<.05$). Only 8 of the 19 females receiving inorganic trace minerals cycled after removal of the Synchro-Mate B implant. In addition, only two of those eight conceived. Therefore, 55.6% of the amino acid chelate supplemented cows conceived compared with 10.5% of the inorganic trace mineral supplemented females on first service ($P<.05$).

Addition of increased trace mineral supplementation to all females improved reproductive performance during the breeding season. Only two females in each treatment group failed to conceive during the 60-day breeding season. The supplementation trial started approximately 45 days post calving, the first AI service was 70 days post calving and the last possible AI breeding date was 130 days post calving. The average days post calving to actual conception was 86 days for the chelate supplemented females as compared to 105 days for the inorganic mineral supplemented females.

The females first calf weaning weights were adjusted for age in days to a 205-day equivalent. No age of dam corrections were made since all females were nursing their first calf. The amino acid chelate supplemented females weaned 47 lb more calf than the inorganic supplemented females (P<.01). The reason for the magnitude of this difference is not apparent. A large breed effect (P<.01) was noted for weaning weight.

The results of this trial indicate early breeding season estrus activity and conception rate may be improved by the addition of amino acid chelated minerals to a mineral program; however, total breeding season conception rate was not improved over addition of inorganic traced minerals at higher levels than commonly found in commercial mineral mixes. Though the number of females were limited, the differences in early reproductive performance were large. Previous indications of trace mineral deficiencies were noted and may account for the reduced reproductive performance early in the breeding season.

Literature Cited

NRC. 1984. Nutrient Requirements of Beef Cattle (6th Ed.). National Academy Press, Washington, DC.