EFFECTS OF PRENATAL AND PREBREEDING TRACE MINERAL/VITAMIN E INJECTIONS ON CALF HEALTH AND REPRODUCTIVE PERFORMANCE OF BEEF COWS

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Summary

An experiment was conducted to determine the effects of providing precalving and prebreeding injections of Multimin™ (mineral supplement containing zinc (Zn), copper (Cu), selenium (Se) and manganese (Mn)), and vitamin E on the reproductive performance of crossbred beef cows (n = 67), and the health and survival of their calves. Cows were randomly assigned to control or trace mineral/vitamin E (TM/E) treatments, and 30 days prior to the start of calving and 21 days prior to the start of breeding, the TM/E treatment cows received s.c. injections of Multimin™ and vitamin E, whereas, the control cows received s.c. injections of saline. Multimin™ injections effectively improved the Cu status, but not the Zn status of cows during the experiment. The TM/E treated cows tended (P = .17) to have higher whole blood Se concentrations than the control cows. Compared with control cows, liver Cu concentrations of TM/E cows were 105% higher 96 days after the first injections, and 57% higher 161 days after the second injection. Despite finding significant improvements in the Cu status of cows, TM/E treatment had no affect on survival rates or passive immune status of calves, or return to estrus or conception rates of cows.

Introduction

Perinatal calf mortality and cow reproductive inefficiency costs beef producers an estimated $441 to $502 million annually (3). Recent research has demonstrated that sub-clinical or marginal deficiencies in key trace minerals like Cu, Zn, Se and Mn, as well as vitamins A and E are linked to suppression of disease resistance and lower reproductive efficiencies in cattle. Spears et al. (14) found reduced neonatal death loss when cows received prenatal injections of Se and vitamin E. Improvements in passive immunity have also been demonstrated with Se supplementation (13, 16). Supplementation of Cu, Zn and Mn as well as Se and vitamin E has been shown to reduce services per conception (8) and number of days open (1) in cattle.

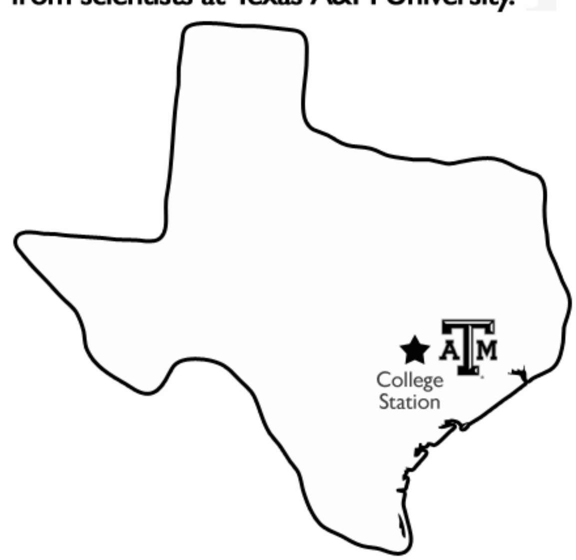
Hardt et al. (9) reported that 76% of the bermudagrass samples tested in Texas were deficient in Cu (< 10 ppm), and that over half of these samples contained more than .3% sulfur (S), with 35% of the native forage samples high in iron (Fe). Sulfur and Fe are known antagonists of Cu absorption and can increase the dietary Cu requirement substantially. Additionally, 97% of bermudagrass and 98% of native forages contained Zn levels below that recommended for beef cattle (40 ppm).

Thus, when evaluating calf health and reproductive efficiency of beef cows in Texas, adequate trace mineral supplementation as well as the presence of antagonist minerals should be considered. Accordingly, the primary objective of this experiment was to determine if supplementation with the trace minerals Cu, Zn, Se and Mn from an injectable source (Multimin™) and vitamin E prior to calving and prior to breeding would enhance survival and health of calves and reproductive performance of cows.

Experimental Procedures

Sixty-seven multiparous crossbred beef cows located at the TAMU Beef Center were used in this

This project included collaboration from scientists at Texas A&M University.



experiment. Due to large variations in initial body weights (average = 1182; SD = 121 lb) and condition scores (average = 4.6; SD = 0.6), cows were sorted into thin and moderate (3.6 vs 5.4 $\pm$ 0.1) body condition groups 72 days prior to calving and provided supplements (Table 1) formulated to achieve body condition scores (BCS) of five at calving. Thereafter, all cows received the same supplement from calving to the start of the breeding season. All three supplements contained elevated levels of S and Fe designed to partially antagonize absorption of trace minerals. Thirty days prior to calving (day 0 of experiment), cows within each group were stratified by BCS and randomly assigned to control or trace mineral/vitamin E (TM/E) treatments. The TM/E cows received s.c. injections of Multimin™ (Walco International, Inc.) and Vitamin E (AgriPharm®) to provide 0.18, 0.18, 0.09, and 0.05 mg/lb BW of Cu, Zn, Mn and Se, respectively and 2.8 IU/lb BW of vitamin E.

Cows had access to pastures that consisted primarily of common bermudagrass and were provided free-choice access to grass hay that contained 12, 28 and .24 mg/kg Cu, Zn and Se, respectively, and .16% S (DM basis).

Table 1. Ingredient and nutrient composition of supplements fed during late gestation and lactation

Item	Thin Cows[a]	Moderate Cows[a]	Lactation[b]
Ingredient composition (AF basis)			
Cottonseed meal	---	56.3	36.5
Whole cottonseed	47	---	34
Corn	47.4	19.3	24.3
Molasses	---	8.0	---
CaSO4	4.0	12.0	3.4
FeSO4	1.6	4.5	1.8
Nutrient composition (DM basis)			
CP, %	19	29	21
TDN, %	75	82	77
Ca, %	1.2	3.5	.7
P, %	.50	.74	.62
S, %	1.8	3.2	1.0
Cu, ppm	4	5	2
Zn, ppm	83	206	68
Fe, ppm	3920	12200	3380
Supplement intake, lb/day			
Targeted	5.7	1.8	5.9
Actual	5.1	.8	5.9

[a]Thin and moderate cow supplements were fed to calving.
[b]Lactation supplement was fed to all cows from calving to the start of the breeding season.

Cows were weighed and BCS recorded 72 days prior to the start of the calving season and on days 0 (time of 1st injections), 28 (prior to calving), 96 (time of 2nd injections), 117 (start of breeding season), 179 (end of breeding season) and 257 (weaning) of the experiment. Cows were also weighed and BCS recorded at calving (calving season was 72 days). Eighteen cow/calf pairs were randomly selected from each treatment group for sampling. Cow blood and liver samples were obtained on days 0, 28, 96, 179 and 257, calf blood samples on days 117, 179 and 257 and calf liver samples on days 179 and 257 of the experiment to determine treatment effects on trace mineral status. Additionally, calf blood samples were obtained at 12 hours of age and analyzed for serum IgG1 concentrations to determine effect of treatment on passive immune transfer. Calves were weighed at parturition and on days 96, 117, 179 and 257. Rectal ultrasonography of cows was conducted at the end of the breeding season and 42 days later for determination of date of conception.

Trace mineral data were analyzed using MIXED model procedures for repeated measures in SAS. The CAT MOD procedure of SAS was used to analyze reproductive data.

Results and Discussion

Providing additionally supplemental energy and protein to thin condition cows prior to calving successfully improved BCS of these cows such that there were minimal differences in BW (1153 vs 1177 $\pm$ 20 lb) and BCS (4.5 vs 5.0 $\pm$ .11) between thin and moderate cows at parturition, respectively. The level of supplemental energy and protein fed prior to calving did not affect subsequent reproductive performance of cows or the growth performance of calves (data not shown). Moreover, the level of supplemental energy and protein fed to cows prior to calving did not affect treatment responses to Multimin™ and vitamin E injections. Therefore, only the overall TM/E treatment responses will be presented below.

There was a significant ($P < .01$) treatment x day of experiment interaction for cow liver Cu concentration (Figure 1). Cows in the TM/E treatment had 59, 105, 164, and 57% higher liver Cu than control on days 28, 96, 179 and 257, respectively. Bohman et al. (4) reported a 72% increase in liver Cu concentrations 14 days following s.c. injection of Cu EDTA, however it is a significant finding that TM/E cows remained significantly higher in liver Cu concentration than control 161 days after the last injection.

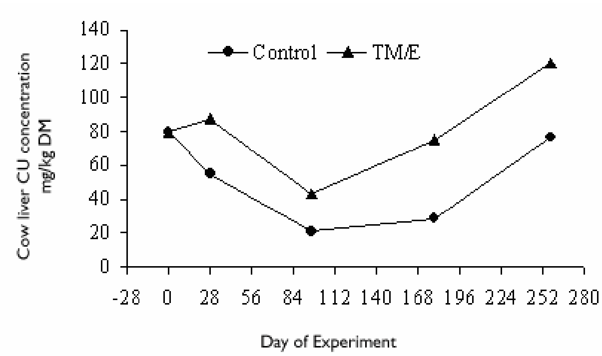


Figure 1. The effects of trace mineral (Multimin™) and vitamin E injections 30 days prior to calving (day 0) and 21 days prior to breeding (day 96) on liver copper (Cu) concentrations in cows (SE = 7.7). Treatment differences were significantly different (P < .01) at each measurement.

Cow liver Zn and plasma Cu and Zn were unaffected by treatment (Table 2), this is in agreement with other research (2, 13) when cows were in similar TM status. Whole blood Se concentrations tended to be higher (P = .17) for TM/E versus control cows and were well within the range considered normal with adequate levels being between 200-1200 µg/L (10) (Table 2). Ishak et al. (8) found no differences between cows injected with sodium selenite and vitamin E compared to controls when cows were in similar Se status (267 µg/L). Calf TM status was not affected by cow TM/E treatment (Table 2).

Cow BW and BCS were not affected by TM/E treatment (Table 3). In addition, calf performance was unaffected by cow TM/E treatment (Table 3). One calf died 3 days after birth and, along with its dam, was removed from subsequent analysis. Previous research has shown improved performance and/or immune function with trace mineral supplementation when animals are marginal to deficient in Cu, Zn (9) and Se (11, 14), however results are variable when animals have adequate trace minerals. Stanton et al. (13) evaluated the effects of two levels of supplemental organic and inorganic Cu, Zn, Mn and Co on the performance of beef calves. Calves fed the high level supplement contained 2.1 times higher Cu, 1.44 times higher Zn and Mn and 10 times higher Co than low level supplement. Daily gains tended to be higher for calves with access to the organic - high level than the other two groups. Additionally, weaning weights were lowest for calves offered the inorganic - high level of TM. This result contrasts with Baker et al. (2) who found that calves born to cows supplemented with organic TM had the lowest weaning weights compared to calves born to cows supplemented with inorganic TM and controls. The organic supplement contained Cu, Zn and Mn in a 50% inorganic and 50% organic form, the inorganic supplement was from 100% inorganic sources while controls received no supplemental Cu, Zn or Mn.

Previous research reports that pre-calving Se and vitamin E injections had no affect on calf birth weight, daily gain or weaning weight compared to controls when cows were in marginal Se status (95 µg/L) (5). In addition, with calves of marginal to adequate Se status (140 to 193 µg/L), no differences were observed in birth weights, although daily gain and

Table 2. Overall effects of prenatal and prebreeding injection with Multimin™ and vitamin E on trace mineral status of cows and calves†

	Treatment		
Item	Control	TM/E	SE
Cow data:			
Liver Cu, mg/kg	45.1	81.3	4.3
Liver Zn, mg/kg	109.8	108.9	1.9
Plasma Cu, mg/L	.72	.74	.03
Plasma Zn, mg/L	1.00	.99	.02
Blood Se, µg/L	231.5	252.3	9.7
Calf data:			
Liver Cu, mg/kg	59.1	65.5	5.3
Liver Zn, mg/kg	113.6	118.8	2.9
Plasma Cu, mg/L	.66	.64	.10
Plasma Zn, mg/L	1.15	1.20	.03
Blood Se, µg/L	231.2	236.3	8.5

†Injections were administered 30 days prior to calving (day 0) and 21 days prior to breeding (day 96)

Table 3. Overall effects of prenatal and prebreeding injection with Multimin™ and vitamin E on cow and calf performance and calf serum IgG1†

	Treatment		
Item	Control	TM/E	SE
Cow data:			
Body weight, lb	1203.5	1200.8	20.3
BCS (1-9)	4.7	4.6	.1
Calf data:			
Birth weight, lb	90.8	88.2	2.4
Daily gain, lb/day	2.50	2.39	.04
Weaning weight, lb	564.2	544.8	15.0
Serum IgG1, mg/dL	4567	4429	488

†Injections were administered 30 days prior to calving (day 0) and 21 days prior to breeding (day 96)

adjusted weaning weights tended to be higher for the Se and Vitamin E treated calves compared with controls (11). Calf serum IgG_1 concentrations were not affected by TM/E treatment. Trace mineral/vitamin E treatment did not influence return to estrus (data not shown), or the interval to pregnancy (Table 4). A numeric improvement in pregnant cows was observed for TM/E cows. Using the log odds technique, cows in the control treatment were 2.4 times more likely to be open than cows in the TM/E treatment (P = .25).

Table 4. Effects of prenatal and prebreeding injection with Multimin™ and vitamin E on reproductive performance

	Treatment		
Item	Control	TM/E	SE
No. of cows	32	34	
No. of open cows	6	3	
Conception rate, %	81	94	
Odds ratio[a]	2.4	--	.8
Interval to pregnancy[b]	70.5	67.9	2.9

[a]Using the log odds technique, cows in the control treatment were 2.4 times more likely to be open than cows in the TM/E treatment (P = .25).

[b]Days from calving to conception (P = .53).

DiCostanso et al. (6) found no differences in days to first estrus, but a numeric improvement in conception rates of multiparous Angus cows consuming supplemental Mn or Cu, Mn and Zn compared to controls. More recently, Stanton et al. (13) found that Cu-deficient cows (liver Cu < 25 mg/kg DM) supplemented with a high level of organic Cu, Zn, Mn and Co had elevated pregnancy rates to AI compared to cows supplemented with either a high or low level of inorganic trace minerals. Overall pregnancy rate was not affected. Baker et al. (2) found no differences in overall conception rates due to trace mineral supplementation with cows in adequate liver Cu (50 to 150 mg/kg), Zn (89 to 106 mg/kg) and Mn (8 to 9 mg/kg) status. Additionally, Spears et al. (12) found no effects of Se and vitamin E injections versus controls on conception rate and calving interval of beef cows in adequate Se status (133 and 210 µg/L for control and Se/Vitamin E treated cows, respectively).

Implications

Multimin™ and vitamin E injections were effective at improving the Cu status of cows. The minimal response to Se and Zn concentrations as well as production measures was probably due to the adequate TM status of this herd at the start of the trial. Trace mineral injections produced no negative effects. Injections of Multimin™ may be a useful method to ensure adequate TM without creating toxicity, especially when dietary antagonists are present.

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