# Interaction of Amprolium and Supplemental Dietary Thiamin on Thiamin Status and Growth Performance of Stressed Calves

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## Story in Brief

Ninety-six mixed-breed steers were used for a 35-d trial to determine the effects of amprolium (a coccidiostat) and supplemental thiamin (vitamin $B_1$) on thiamin status and growth performance of stressed calves. Treatments were 1) no supplemental thiamin and no amprolium, 2) amprolium, 3) supplemental thiamin (147 ppm), and 4) supplemental thiamin (147 ppm) plus amprolium. Amprolium was top-dressed at a rate of 2.3 mg/lb BW for the first 21 d of the study. Calves fed amprolium had increased ($P < 0.01$) ADG from day 0 to 7. Supplemental thiamin tended to increase ADG from day 0 to 21 ($P < 0.10$). Blood thiamin monophosphate concentrations (TMP; day x thiamin interaction) were increased ($P < 0.001$) by supplemental thiamin on every sampling date; however, the magnitude of increase was not as great on day 35 ($P = 0.08$). A day by amprolium interaction was detected on blood TMP ($P < 0.05$) and blood thiamin pyrophosphate (TPP; $P < 0.05$) concentrations. Blood TMP and TPP concentrations were decreased on days 14, 21, and 28 ($P < 0.05$) in the calves fed amprolium, but amprolium did not affect TMP and TPP concentrations on days 7 and 35. Thiamin supplementation had no effect on the number of coccidial oocysts in feces, but calves fed amprolium had reduced numbers of oocysts ($P < 0.05$). Supplemental thiamin and amprolium did not improve overall ADG, ADFI, or feed/gain for the 35-d trial.

## Introduction

Loss of body condition, poor gains, and mortality are effects of acute coccidiosis in cattle. The cost of coccidiosis to the cattle producer was estimated to be $54.25 per animal (Fox, 1983). Amprolium is an effective anticoccidial that may be fed to cattle. Amprolium kills coccidia by preventing thiamin uptake and utilization by the protozoa (Coombs et al., 1997). High concentrations of amprolium have also been used to experimentally induce animals to become thiamin deficient (Rammel and Hill, 1986). Therefore, when administering amprolium at a therapeutic level, there is the possibility for alteration of thiamin status in stressed calves. The purpose of this study was to determine the effects of amprolium and supplemental thiamin on thiamin status, growth performance, and coccidial oocyst numbers in stressed calves.

## Materials and Methods

Forty-five steers and 51 bulls (465 ± 3.3 lb initial BW) were purchased at sale barns and delivered to the Stocker Research Facility in Savoy. Upon arrival, calves were branded with an electric iron, any horns were tipped, and calves were dewormed (Ivomec, Merial Limited, Iselin, NJ), and ear tagged. Calves were vaccinated against bovine respiratory syncytial virus, infectious bovine rhinotracheitis virus, bovine viral diarrhea, and parainfluenza –3 (BRSV – Vac 4, Bayer Corp., Shawnee Mission, KS). All calves were given a vaccine containing *Pasteurella haemolytica, Pasteurella multocida, Haemophilus somnus,* and *Salmonella typhimurium* (Poly-Bac-HS, Texas Veterinary Labs, San Angelo, TX) and a clostridial toxoid injection (Vision 7 and Vision CD-T, Bayer Corp.). All bulls were castrated by banding (Callicrate Bander, St. Francis, KS). Calves were weighed upon arrival, blocked by weight, stratified by castration and horn tipping, and assigned randomly to pens within a block (four pens/block). Calves were housed in 16 drylot pens with six calves/pen and were given ad libitum access to water. Calves were fed a complete ration (Table 1) once a day. Daily feed intake and any refusals were recorded. Calves were offered a small amount of long hay in addition to the complete ration for the first 5 d of the study. Treatments were 1) no supplemental thiamin and no amprolium, 2) amprolium, 3) supplemental thiamin, and 4) supplemental thiamin plus amprolium. Supplemental thiamin was provided as thiamin mononitrate (Nutra Blend Corp., Neosho, MO) at a rate of 147 ppm. The amprolium (Amprolium 1.25% Cattle Pellets, Nutra Blend Corp.) was top-dressed at a rate of 2.3 mg/lb initial BW for 21 d. Calves were observed daily for signs of morbidity. Any calves observed to be depressed were pulled and rectal temperature was measured. Calves with a rectal temperature greater than 104ºF were treated with antibiotics according to a preplanned antibiotic regimen.

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Two consecutive weights were measured at the beginning and end of the study, and interim body weights were obtained on days 7, 14, 21, and 28. Fecal samples were obtained on days 1, 7, 14, 21, 28, and 35 for coccidia oocyst counts. Blood samples were obtained via jugular venipuncture on days 1, 7, 14, 21, 28, and 35 for blood thiamin monophosphate (TMP) and thiamin pyrophosphate (TPP) concentrations.

Weights, ADG, ADFI, feed/gain, initial concentrations of blood TMP and TPP, incidence of morbidity, medication costs, and number of antibiotic treatments were analyzed using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). Blood TMP and TPP concentrations were analyzed using the MIXED procedure of SAS with day 0 as a covariant. The model included block, thiamin, amprolium, the thiamin x amprolium interaction, day, the day x thiamin interaction, the day x amprolium interaction, the day x thiamin by amprolium interaction and initial concentration as a covariant. The natural log of the coccidia oocyst counts were analyzed using the MIXED procedure of SAS.

## Results and Discussion

Average daily gain for the 35-d study (Table 2) was not affected ($P > 0.10$) by dietary supplementation of thiamin or amprolium. Gains during the period from day 0 to 14 were greater in thiamin supplemented calves ($P < 0.05$) compared with those fed no supplemental thiamin. Calves fed amprolium had increased ADG from day 0 to 7 ($P < 0.01$). There was no ($P > 0.10$) thiamin x amprolium interaction on ADG.

The ADFI (Table 2) for day 0 to 35 was not different ($P > 0.10$) among treatments. Average daily feed intake from day 0 to 28 had a tendency for a thiamin by amprolium interaction ($P = 0.10$). Amprolium decreased ($P < 0.05$) ADFI among calves fed no supplemental thiamin, but ADFI did not differ among other treatment combinations. The feed/gain from day 0 to 21 tended to improve as a result of thiamin supplementation ($P = 0.08$). There were no differences in the feed/gain over the entire 35-d study because of supplemental thiamin or amprolium.

Zinn et al. (1987) reported that feeding two levels of supplemental thiamin (20 or 200 mg thiamin/d) to stressed calves reduced morbidity the first 10 d of a 56-d study. In the present study, there were no differences ($P > 0.10$) due to supplemental thiamin or amprolium on morbidity rates, or medication costs (data not shown).

There was a day x thiamin interaction on TMP concentrations ($P < 0.001$; Figure 1). Thiamin monophosphate concentrations were increased by supplemental thiamin ($P < 0.001$) on days 7, 14, 21, and 28; however, the magnitude of increase was not as great on day 35 ($P = 0.08$). A thiamin x day interaction ($P < 0.01$) was detected on TPP concentrations, with an increase in TPP concentrations on days 7, 14, and 21 ($P < 0.001$) due to thiamin supplementation. A day x amprolium interaction was detected on TMP ($P < 0.05$) and TPP ($P < 0.05$) concentrations. Thiamin monophosphate and TPP concentrations were decreased on days 14, 21, and 28 ($P < 0.05$) in the calves fed amprolium, but were not different on day 7 and 35.

Coccidial oocyst counts (Table 2) decreased ($P < 0.05$) when amprolium was fed. There was also an effect of day on number of oocysts present ($P < 0.001$), with the greatest numbers observed on day 1 ($P < 0.001$). Numbers of oocysts and incidence of oocyst presence were greater on days 28 and 35 than on day 14 ($P < 0.05$). Cattle fed amprolium also had lower incidence of coccidial oocyst presence ($P < 0.05$). There was no thiamin x amprolium interaction detected on fecal oocyst numbers or the incidence of oocyst presence. Supplementation of thiamin did not interfere with the efficacy of the amprolium.

## Implications

Amprolium reduced thiamin status compared to controls in stressed receiving cattle; however, there were no clinical incidences of thiamin deficiency (polio-encepholomacia), and no detrimental effects on growth performance as a result of using amprolium for 21 d as a coccidiostat. Dietary thiamin supplementation did increase thiamin concentrations in blood and did not interfere with the efficacy of amprolium.

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**Table 1. Ingredient and chemical composition of basal diets, DM basis.[a]**

| Ingredient | % |
|---|---|
| Corn, cracked | 52.25 |
| Cottonseed hulls | 30.05 |
| Fat | 1.13 |
| Soybean meal | 11.23 |
| Molasses, mixture of cane and beet | 3.41 |
| Dicalcium phosphate | 0.44 |
| Limestone | 1.31 |
| Salt, white | 0.16 |
| Vitamin A, D, E premix[b] | 0.01 |
| Trace mineral premix[c] | 0.01 |

[a] Diets contained 0 or 147 ppm of thiamin as thiamin mononitrate. Diets analyzed to contain 87% DM, 12% CP, 24.4% acid detergent fiber, 39.5% neutral detergent fiber, and 4.65% ash.

[b] Vitamin A, D, E premix added to provide 2,000 IU vitamin A, 400 IU vitamin D, and 5.3 IU vitamin E/lb diet.

[c] Trace minerals added to provide 26 ppm zinc as zinc sulfate, and 0.1 ppm selenium as sodium selenite.

**Table 2. Effect of amprolium and supplemental thiamin on growth performance, number of oocysts, and incidence of coccidial oocyst presence of stressed calves.**

| | Control | | Thiamin[a] | | | |
|---|---|---|---|---|---|---|
| | No amprolium[b] | Amprolium | No amprolium | Amprolium | SE | Significance |
| ADG, lb | | | | | | |
| Day 0 to 7 | 1.8 | 2.9 | 2.4 | 3.3 | 0.26 | T†, A** |
| Day 0 to 14 | 1.2 | 1.4 | 1.9 | 2.2 | 0.32 | T* |
| Day 0 to 21 | 2.0 | 1.8 | 2.4 | 2.4 | 0.27 | T† |
| Day 0 to 28 | 2.8 | 2.4 | 2.9 | 2.7 | 0.21 | |
| Day 0 to 35 | 2.3 | 2.3 | 2.6 | 2.6 | 0.24 | |
| Day 21 to 35 | 2.9 | 3.0 | 3.0 | 2.8 | 0.38 | |
| ADFI, lb | | | | | | |
| Day 0 to 7 | 8.1 | 8.0 | 8.1 | 8.7 | 0.25 | |
| Day 0 to 14 | 9.4[x,y] | 8.4[y] | 9.0[x,y] | 9.7[x] | 0.37 | T x A† |
| Day 0 to 21 | 10.6[x,y] | 9.2[y] | 10.4[x,y] | 10.7[x] | 0.46 | T x A† |
| Day 0 to 28 | 11.9[x,y] | 10.3[z] | 11.7[y] | 11.8[y] | 0.45 | T x A† |
| Day 0 to 35 | 12.7 | 11.3 | 12.7 | 12.7 | 0.42 | |
| Day 21 to 35 | 15.9 | 14.6 | 16.2 | 15.7 | 0.50 | A† |
| Feed/gain | | | | | | |
| Day 0 to 7 | 5.6 | 2.9 | 9.4 | 2.7 | 3.12 | |
| Day 0 to 14 | 9.7 | 8.3 | 5.0 | 4.7 | 1.56 | T* |
| Day 0 to 21 | 5.7 | 5.3 | 4.3 | 4.5 | 0.48 | T† |
| Day 0 to 28 | 4.3 | 4.2 | 4.0 | 4.4 | 0.22 | |
| Day 0 to 35 | 5.7 | 5.0 | 4.9 | 5.0 | 0.41 | |
| Day 21 to 35 | 6.2 | 4.8 | 5.7 | 5.9 | 0.84 | |
| Oocysts, No./g of feces (geometric mean)[c] | | | | | | A*, D*** |
| Day 0 | 52.9 | 46.5 | 53.6 | 53.3 | 0.31 | |
| Day 7 | 4.3 | 0.3 | 1.6 | 0.6 | 0.31 | |
| Day 14 | 0.6 | 0.4 | 0.7 | 0.01 | 0.31 | |
| Day 21 | 1.3 | 0.2 | 1.3 | 1.2 | 0.31 | |
| Day 28 | 1.7 | 0.1 | 4.2 | 1.5 | 0.31 | |
| Day 35 | 0.5 | 0.8 | 4.4 | 2.2 | 0.31 | |
| Incidence of oocyst presence, % | | | | | | A*, D*** |
| Day 0 | 96 | 92 | 92 | 96 | 7.4 | |
| Day 7 | 49 | 25 | 33 | 29 | 7.4 | |
| Day 14 | 25 | 21 | 29 | 4 | 7.4 | |
| Day 21 | 29 | 17 | 33 | 25 | 7.4 | |
| Day 28 | 42 | 12 | 46 | 38 | 7.4 | |
| Day 35 | 25 | 33 | 42 | 38 | 7.4 | |

Means within the same row lacking common superscripts differ ($P < 0.05$).

A = effect of amprolium; T = effect of supplemental thiamin; T x A = thiamin by amprolium interaction; D = effect of day.

[a] Thiamin supplemented to provide 147 ppm thiamin.

[b] With or without amprolium (2.3 mg/lb initial BW) from day 1 to 21.

[c] Counts were log-transformed for statistical analysis and geometric means are shown.

† $P < 0.10$. *$P < 0.05$. **$P < 0.01$. ***$P < 0.001$.