PEER REVIEWED

Effects of timing of chlortetracycline in combination with decoquinate on growth performance, health, and carcass characteristics of feeder steers

Daniel U. Thomson[1], *DVM, PhD*; **R. Spencer Swingle**[2], *PhD*; **Mark Branine**[3], *PhD*; **Steven J. Bartle**[1], *PhD*; **David A. Yates**[4], *PhD*

[1]*Department of Clinical Sciences, Kansas State University, College of Veterinary Medicine, Manhattan, KS 66506, formerly with Cactus Research*

[2]*Cactus Research, LTD, Amarillo, TX 79116*

[3]*Zinpro Corporation, Canon City, CO 81212, formerly with Cactus Research*

[4]*Merck Animal Health, Claremore, OK 74017, formerly with Alpharma Animal Health*

Corresponding author: Dr. Dan Thomson, dthomson@vet.k-state.edu; phone: 785-532-4254

Abstract

Steer calves (n = 1690) were used in a 220-day study to evaluate the effects of chlortetracycline (CTC) plus decoquinate (DEQ) on health and performance of feedlot cattle. Treatments were 1) control (CON); 2) CTC + decoquinate early (CTC+DEQ Early), and 3) CTC + decoquinate delayed (CTC+DEQ Delayed). Ten mg of CTC/lb (22 mg/kg) body weight (BW) was fed daily for 5 consecutive days beginning either on day 0 (Early) or day 6 (Delayed); decoquinate was fed at 22.7 mg/100 lb (45.4 kg) BW for 28 days. There were 6 pens per treatment, and 85 to 105 steers per pen. Steers in the CTC+DEQ groups had higher ($P < 0.01$ to 0.05) dry matter intake and average daily gain than CON steers, but feed efficiency did not differ among treatments. Respiratory morbidity and re-treatment rates were lower (17 vs 23%, and 11 vs 22%, respectively, $P < 0.01$) for steers in the CTC+DEQ groups than for those in the CON group. Timing of the initial CTC treatment had minimal effect on health and performance; however, feeding CTC for at least 10 days during the receiving period reduced morbidity and improved overall performance.

Key words: receiving cattle, BRD, chlortetracycline, decoquinate

Résumé

Des bouvillons de boucherie (n = 1690) ont été utilisés dans une étude d'une durée de 220 jours portant sur l'évaluation de l'effet de l'administration de la chlorotétracycline (CTC) en combinaison avec la décoquinate (DEQ) sur la santé et le rendement des bovins en parc d'engraissement. Les traitements suivants ont été utilisés : 1) témoin; 2) CTC + DEQ administré tôt (CTC+DEQ Tôt); et 3) CTC + DEQ avec délai (CTQ+DEQ Délai). Les bovins ont reçu 10 mg de CTC par livre de poids corporel (22 mg/kg) par jour pendant 5 jours consécutifs commençant au jour 0 (Tôt) ou au jour 6 (Délai). La dose de DEQ était de 22.7 mg/100 lb (45.4 kg) de poids corporel pendant 28 jours. Il y avait 6 enclos par traitement et entre 85 et 105 bouvillons par enclos. La prise alimentaire journalière et le gain moyen quotidien étaient plus élevés ($P < 0.01$ jusqu'à 0.05) dans le groupe CTC+DEQ que dans le groupe témoin alors qu'il n'y avait pas de différence entre les traitements au niveau de l'efficacité alimentaire. Le taux de morbidité relié aux maladies respiratoires et le taux de retraitement étaient moins élevés chez les bovins du groupe CTC-DEQ que chez les bovins du groupe témoin (17 v. 23%, et 11 v. 22%, respectivement, $P < 0.01$). Le délai du traitement initial avec la CTC a eu un faible impact sur la santé et le rendement. Toutefois, l'administration de la CTC pendant au moins 10 jours durant la période de réception a réduit la morbidité et amélioré le rendement global.

Introduction

Bovine respiratory disease (BRD) and coccidiosis are 2 important health concerns when cattle are received into the feedlot. Estimated annual losses due to BRD and coccidiosis are as high as $1 billion[2] and $100 million,[3,5] respectively. Decoquinate (DEQ) is approved for feeding to prevent coccidiosis, and chlortetracycline (CTC) provided in the feed at 10 mg/lb (22 mg/kg) BW is approved to treat bacterial pneumonia in cattle caused by *Pasteurella multocida*. A primary advantage of in-feed delivery is that treatments can be applied at critical times without the stress and labor of re-processing cattle

individually through a chute. The approval that allows concomitant feeding of CTC and DEQ provides a tool for managing these economically important diseases in receiving, growing, and finishing feedlot cattle. Optimal use of these feed additives requires a management plan, in part because DEQ can be fed for 28 days, but CTC treatments are limited to independent 5-day periods. It is important to define the optimal timing for the 5-day CTC feeding period for both economic and animal well-being reasons. One current strategy is to initiate CTC feeding when cattle are received, while an alternate strategy delays initial feeding of CTC for several days until feed intake is more consistent. Implementation of these programs in feedlots has been based on experience of the veterinarian or nutritionist as there is little data in the literature regarding when to initiate the first 5-day feeding period of CTC to achieve optimal response. The objective of this study was to evaluate the effect of CTC plus DEQ programs on the health and performance of feedlot cattle, as well as to determine the timing of CTC treatment in 28-day receiving programs.

Materials and Methods

Facilities

The study was conducted in compliance with FDA guidelines[6] in a commercial feedlot in the Texas panhandle[a]. Research pens had dirt floors, concrete fence line feed bunks, and float-controlled water troughs located in the fence-line between adjacent pens. No shade or other shelter was provided. Depth of all pens was the same, but they varied in width. The number of steers assigned to each pen was adjusted to provide each animal with approximately 9.5 linear inches (24.1 cm) of bunk space and 147 square feet (13.7 sq m) of pen space.

Experimental Design and Study Events

The experiment was conducted using a complete block design with 3 treatments and 6 pen replications per treatment. The following treatments were randomly assigned to pens within blocks of 3 adjacent pens: 1) decoquinate[b] fed for 28 days, with initial chlortetracycline treatment during days 0 to 4 (CTC+DEQ Early); 2) decoquinate fed for 28 days, with the initial CTC treatment during days 7 to 11 (CTC+DEQ Delayed); 3) or a control diet (CON) containing only monensin[d] fed during the 28-day receiving period (Table 2).

The protocol specifically allowed additional 5-day treatments with CTC at the investigators' discretion, and 1 such treatment was applied beginning on day 37 in response to increased health pulls during inclement weather. Due to a miscommunication among study personnel, pens assigned to the CTC+DEQ Early treatment in Replicates 1 to 3 inadvertently received CTC on study days 11 to 15 (Table 2).

All steers were purchased through a single order-buyer in South Dakota, and were predominately Angus or Angus-cross that had previously been vaccinated with bovine herpes virus-1 (BHV-1), bovine viral diarrhea virus (BVDV), and parainfluenza-3 virus (PI3V) vaccine; pasteurella; and clostridial bacterin-toxoid. Upon arrival, calves were placed into receiving pens by arrival load, and provided access to drinking water, loose alfalfa hay, and a moderate-concentrate mixed diet. Two arrival groups were scheduled a week apart to facilitate initial processing, and to accommodate the potentially large number of cattle that might require treatment for BRD. The first arrival group was assigned to Replicates 1 through 3, and the second group to Replicates 4 through 6. A total of 1,827 steers with a mean off-truck weight of 551 lb (249.9 kg) were received to be used in the study.

At processing, each calf was metaphylactically treated with tilmicosin[e] (1.5 mL/100 lb (45.4 kg) BW); 7-way clostridial bacterin-toxoid (*Clostridium chauvoei*, C. *septicum*, C. *novyi*, C. *sordellii*, and C. *perfringens* Types C & D)[f]; modified-live BHV-1, BVDV (types 1 and 2), PI3V, and bovine respiratory syncytial virus vaccine[g]; an autogenous pasturella bacterin[h]; and doramectin[i]. Calves were also dosed orally with 1,000,000 IU vitamin A and 200,000 IU vitamin D, and implanted with an estrogen-trenbolone acetate implant[j] (80 mg trenbolone acetate and 16 mg estradiol).

Steers in each receiving pen were processed separately with 1 block filled at a time. Pen (treatment) assignments were made for individual calves at processing according to a prepared randomization schedule. Calves were individually weighed, and those weighing less than 440 lb (200 kg) or more than 660 lb (300 kg) were excluded from the study. Each steer was identified using 2 ear tags imprinted with the calf's pen assignment and unique number within the pen. Steers were sorted into pen groups as they exited the processing chute. At the completion of randomization, 1,690 steers had been allocated to 18 study pens, each of which housed 85 to 105 steers. Pens were group-weighed on a platform scale to establish starting weights.

Steers were reimplanted with an estrogen-trenbolone acetate terminal implant[k] (120 mg trenbolone acetate and 24 mg estradiol), and weighed individually on study days 94 to 98. The terminal implant was administered approximately 124 days prior to harvest. All steers were group-weighed on study day 223 (blocks 1, 2, and 3) and study day 218 (blocks 4, 5, and 6), and trucked to a commercial harvest facility in Amarillo, TX. A 4% "pencil shrink" was applied to the final scale weights for calculation of performance parameters and dressing percentage. At harvest, livers were scored for incidence and severity of abscesses, and lungs were scored for the presence of pneumonic lesions and classified primarily on the basis of total lung involvement

(data not shown). External fat thickness at the 12th rib, percent internal fat, lean color score, marbling score, and ribeye area tracings were determined for individual carcasses after they were chilled at least 36 hours. Hot weight for each carcass was obtained from packing plant customer sheets. USDA quality and yield grades for each carcass were determined from cooler data. Carcass-adjusted final live-weights were calculated for each pen by multiplying the actual final shrunk live-weight by the pen dressing percentage, and then dividing by the trial average dressing percentage.

Diets and Feeding Methods

Diets were formulated to meet or exceed National Research Council[5] recommendations. Three step-up diets containing approximately 35, 27, and 18% roughage (dry matter (DM) basis) were used to adapt cattle to the finishing diet, which contained 9% roughage (Table 1).

Target dosages for DEQ and CTC were 22.7 mg/lb (50 mg/kg) and 10 mg/lb (22 mg/kg) of initial body weight, respectively. Monensin was included in all diets during the first 28 days, except when CTC was being fed; concurrent feeding of CTC and monensin is not approved by the FDA. Monensin concentration was formulated at 15, 20, and 25 g per ton of DM in diets 1, 2, and 3, respectively. At the conclusion of the 28-day treatment period, all cattle were fed the final diet containing 33 g per ton of monensin and 10 g per ton of tylosin[1] (DM basis) for the remainder of the feeding period.

Decoquinate and monensin were added to the ration through a water-flush system after approximately one-half of the feed was placed on the truck. Because of the large quantity required, CTC was manually distributed across the top of each load of feed.

Cattle were fed twice daily (starting at approximately 0600 and 1230 hours), and were fed to appetite.

Table 1. Basal composition (dry matter basis) of diet fed to feedlot steers.

	Diet			
Item	**1**	**2**	**3**	**Final**
Ingredients, %				
Steam-flaked corn	53.6	60.1	56.0	59.7
High-moisture corn			15.3	17.6
Alfalfa hay, chopped	35.3	26.0	15.4	7.0
Corn silage	4.5	4.5	4.5	4.5
Animal fat		1.4	2.4	3.5
Starter supplement	6.6	8.0		
Finisher supplement			6.4	7.7
Additives*				
Monensin, grams/ton	15	20	25	33
Tylosin, grams/ton				10
Vitamin A, IU/lb	3,500	3,000	2,500	2,100
Vitamin D, IU/lb	350	300	250	210
Vitamin E, IU/lb	20	10	6	5
Calculated composition				
Dry matter, %	72.2	71.9	72.8	72.6
NEm, Mcal/100 lb	84.1	89.5	94.7	99.0
NEg, Mcal/100 lb	55.2	59.8	64.5	68.3
Crude protein, %	14.1	13.7	13.7	13.7
NPN, %	2.2	2.7	2.7	3.3
Crude fat, %	3.3	4.7	6.1	7.3
NDF, %	23.2	19.5	16.0	12.8
Calcium, %	0.91	0.86	0.69	0.66
Phosphorus, %	0.36	0.38	0.30	0.30
Potassium, %	1.30	1.15	0.89	0.82
Magnesium, %	0.21	0.19	0.22	0.22
Sulfur, %	0.23	0.22	0.20	0.20

*Chlortetracycline (CTC), decoquinate, and monensin were hand-added to basal rations fed the first 28 days of the trial, as described in the text of the paper.

Table 2. Summary of study events for cattle fed chlortetracycline[*] (CTC) plus decoquinate[†] (DEQ) compared to cattle fed monensin[‡] alone.

Event	Replicates 1 to 3		Replicates 4 to 6	
	CTC Early	CTC Delayed	CTC Early	CTC Delayed
Arrival	Day -6 or -5		Day -4 or -3	
Tilmicosin administered	Day -1 or 0		Day -3 or -2	
Pen weights	Day 0		Day 0	
Initial CTC+DEQ	Days 0 to 4	Days 6 to 10	Days 0 to 4	Days 7 to 11
Inadvertent CTC+DEQ	Days 11 to 16			
Second CTC+DEQ	Days 18 to 22	Days 18 to 22	Days 13 to 17	Days 13 to 17
Discretionary CTC+DEQ	Days 37 to 41	Days 37 to 41	Days 37 to 41	Days 37 to 41

[*]Chlormax®, Alpharma Animal Health, Summit NJ, now a product of Zoetis, Florham Park, NJ
[†]Deccox®, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
[‡]Rumensin®, Elanco Animal Health, Greenfield, IN

Diet transitions were made over 2 days, during which the lower energy diet was fed at the first feeding, and the higher energy diet at the second feeding.

Feed samples were collected directly from feed bunks during the morning and afternoon feeding cycles. Samples were composited and submitted at 3-week intervals to commercial laboratories for analysis of nutrient fractions and monensin. Diets fed the first 28 days were assayed for CTC and DEQ.

Morbidity Evaluation and Medical Treatment

Cattle were observed daily by experienced pen checkers for signs of illness or injury. Cattle with signs of illness were removed from the home pen, and taken to a hospital facility for further evaluation and treatment using a uniform set of procedures prepared by the facility veterinarian[m]. Clinical signs used to categorize animals as BRD cases were respiratory abnormalities, including increased and labored inspiratory and expiratory effort, cough or other expiratory noise or presence of purulent nasal discharge; attitude, including depression, muscle weakness, reluctance to rise when stimulated, or uncoordinated movement; dull eyes, drooping head or ears, and excessive salivation or lacrimation; and lack of ruminal fill as evidenced by a depression in the left flank, indicative of decreased appetite or water intake. Rectal temperature was recorded for all suspect BRD cases brought to the hospital, but rectal temperature was not used to qualify them for medical treatment.

Therapeutic regimens used for BRD cases were the same for all 3 experimental feed treatments. From the beginning of the study until about study day 55, calves diagnosed with BRD were first treated with florfenicol[n]; first relapses were treated with tilmicosin[e], and steers relapsing a second time were treated with enrofloxacin[o]. After 55 days-on-feed, first-time BRD cases were treated with oxytetracycline[p], followed by tilmicosin and enrofloxacin as required. Steers were removed from the study if they were non-responsive to therapy, injured, or unthrifty. Those that died were necropsied on-site by research personnel, who assigned a presumptive cause of death and recorded digital images of affected organ systems. The facility staff veterinarian assigned the official cause of death to each fatal case.

Pen feed records were adjusted for animals that died or were removed from the study by deducting the pen average daily dry-matter intake on the date of death or removal, multiplied by the days-on-feed, from the total amount of dry feed provided to the pen. For each animal housed in a hospital pen, feed intake was credited to its home pen daily as 50% of the average dry-matter intake for the home pen.

Data Handling and Statistical Analysis

Pen riders that selected animals for treatment, and hospital staff that treated cattle, were blinded to treatments. For all statistical analyses, probabilities less than 5% ($P < 0.05$) were considered significant. Pen-based performance parameters, hot carcass weight, and dressing percentage were evaluated by standard analysis of variance procedures for a complete block design using the pen as the experimental unit[q]. The model included treatment and replicate as sources of variance, and treatment x replicate was used as the experimental error term. Orthogonal contrasts were used to compare CTC+DEQ treatments with the CON (CTC+DEQ Early + CTC+DEQ Delayed versus CON), and to evaluate the timing of the initial CTC administration (CTC+DEQ Early versus CTC+DEQ Delayed). Discrete variables (health parameters, quality and yield grades, lung scores, and liver abscess data) were analyzed using Chi-square procedures[q]. Liver and lung score data are not reported in this paper. Steers in the 2 CTC+DEQ groups were administered 2 coccidiostats

on separate occasions.

Results and Discussion

All steers were treated with tilmicosin at processing, therefore the morbidity rates in all treatment groups should have been reduced, and in essence the use of CTC+DEQ (fed in combination) was dual metaphylaxis. The intervals between arrival and metaphylactic treatments with tilmicosin, and between tilmicosin treatment and treatment with CTC, differed slightly between the 2 arrival groups (Replicates 1 through 3 and Replicates 4 through 6). Also of importance, all cattle were fed monensin for most days in the study period, therefore no clinical signs of coccidiosis were observed in CON or CTC+DEQ cattle.

Performance Data

In a meta-analysis conducted prior to FDA approval of the higher dose for CTC (10 mg/lb or 22 mg/kg), Van Dongkersgoed reported few studies critically evaluated the efficacy of metaphylactic administration of feed-based antibiotics, and that there was insufficient data to make conclusions on their efficacy.[7] Little research data has been published since. A Kansas State University study found that feeding CTC (10 mg/lb; 22 mg/kg), starting on day 1, reduced morbidity due to BRD from 81% to 60%, and improved gains compared to control cattle (average daily gain = 2.4 vs 2.2 lb; 1.09 vs 1.0 kg).[4] Duff et al reported no performance advantages when feeding CTC (starting on day 5) during a 28-day trial.[1]

In the present study, feeding DEQ with periodic 5-day administration of CTC during the first 28 days improved ($P < 0.05$) interim and final growth performance (3.51 vs 3.44 lb/day; 1.59 vs 1.56 kg) compared to the CON treatment (Table 3); however, timing of the initial CTC treatment period had little effect (Table 3). Dry matter intake was approximately 0.5 lb (0.23 kg)/day greater for CTC+DEQ treatments compared to CON steers at reimplant (day 94 or 98; $P = 0.01$), and 0.3 lb (0.136 kg)/day higher at trial end ($P < 0.01$). As a result, steers on the CTC+DEQ treatments gained more rapidly ($P < 0.05$) than those on the CON treatment to reimplant and at trial end, and the carcass-adjusted

Table 3. Effects of chlortetracycline (CTC)* plus decoquinate† (DEQ) programs during the receiving period on growth performance of steers with dead and rejected steers excluded.

	Treatment			SEM	Probability > F	
	Control	CTC+DEQ Early	CTC+DEQ Delayed		CTC+DEQ vs Control	CTC Early vs CTC Delayed
Pens, no.	6	6	6			
Final steer count, no.	510	557	527			
Net live weight, lb‡						
Initial	552	551	554	2.8	0.87	0.50
Reimplant	868	879	884	4.2	0.03	0.38
Final, actual	1,314	1,321	1,328	6.4	0.22	0.41
Final, carcass adjusted	1,311	1,323	1,329	6.0	0.08	0.51
Daily gain, lb						
Day 0 to reimplant	3.29	3.41	3.44	0.036	0.01	0.57
Day 0 to end, actual	3.46	3.49	3.51	0.024	0.19	0.51
Day 0 to end, adjusted	3.44	3.50	3.52	0.023	0.04	0.69
Daily DM intake, lb						
Day 0 to reimplant	14.51	15.04	15.04	0.142	0.01	0.99
Day 0 to end	17.49	17.70	17.95	0.084	<0.01	0.06
DMI:Gain						
Day 0 to reimplant	4.41	4.41	4.37	0.057	0.86	0.64
Day 0 to end, actual	5.08	5.08	5.12	0.035	0.34	0.45
Day 0 to end, adjusted	5.08	5.06	5.11	0.035	0.88	0.33

*Chlormax®, Alpharma Animal Health, Summit NJ, now a product of Zoetis, Florham Park, NJ
†Deccox®, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
‡Initial weight = scale weight after randomization with no "pencil shrink". Interim weight = sum of individual animal weights at reimplant on days 98 (Replicates 1 to 3) and 94 (Replicates 4 to 6) with a 4% "pencil shrink". Actual final weight = scale weight on final day of study with a 4% "pencil shrink". Final carcass-adjusted weight = actual final weight * (pen dressing percentage / trial average dressing percentage).

final live-weight tended to be 10 to 20 lb (4.54 to 9.07 kg) heavier (P = 0.08). Feed efficiency was not affected by CTC+DEQ treatments.

Final DMI was the only performance parameter affected by timing of initial CTC treatment, 17.95 lb (8.14 kg)/day for CTC+DEQ Delayed compared to 17.70 lb (8.03 kg)/day for steers in the CTC+DEQ Early ($P = 0.06$).

Carcass Characteristics

Carcasses from steers in CTC+DEQ treatments tended to be heavier ($P = 0.08$) than those from steers in the CON treatment group (Table 4), because of heavier final live-weight and a higher dressing percentage (64.9 vs 64.6%; $P = 0.03$). As a result of heavier carcass weights, CTC+DEQ treated cattle had greater fat thickness at the 12th rib ($P = 0.04$) and larger ribeye area ($P = 0.02$) than CON steers. However, when expressed on a 100 lb (45.5 kg) carcass-weight basis, differences between CTC+DEQ and CON treatments for these parameters diminished. Quality grade distribution was not affected by CTC+DEQ feeding, but there were fewer Yield Grade 1 carcasses ($P = 0.05$) and tended to be more Yield Grade 4 and 5 carcasses ($P = 0.10$) for the CTC+DEQ treatments compared with those in the CON group (Table 5).

Carcass traits were similar between CTC+DEQ Early and CTC+DEQ Delayed groups (Table 4), except that ribeye area was smaller in carcasses from the CTC+DEQ Delayed cattle (P < 0.01). The smaller rib eye area caused the calculated Yield Grade to be higher, and the percentage of carcasses with Yield Grade 3 and 4 to be greater (P < 0.01). Mean marbling score was similar ($P = 0.16$) for the CTC+DEQ Early and CTC+DEQ Delayed treatments, but the percentage of carcasses grading USDA Choice or better tended to be higher ($P = 0.08$) for the CTC+DEQ Delayed treatment (Table 5).

There were no differences ($P > 0.20$) between CTC+DEQ and CON treatments on the incidence of heavy carcasses (8.7%) or liver abscesses (13.3%), and no differences between CTC+DEQ Early and CTC+DEQ Delayed treatments in liver abscess incidence. Percentage of heavy weight carcasses tended to be higher (7 vs 10%, $P = 0.10$) for the CTC+DEQ Delayed treatment.

Health Outcomes

Death loss and removal rates from all causes were 4.0% and 1.7%. Respiratory disease was the major cause of death and removal from the study, accounting for over 70% of deaths and 50% of removals. Other deaths and removals were attributed to a variety of causes; however, because the incidence of these health-related issues did not appear related to the experimental treatments, they are not presented in detail. No clinical coccidiosis

Table 4. Effects of chlortetracycline* (CTC) plus decoquinate† (DEQ) programs during the receiving period on carcass characteristics of steers.

Item	Treatment			SEM	Probability > F	
	Control	CTC+DEQ Early	CTC+DEQ Delayed		CTC+DEQ vs Control	CTC Early vs CTC Delayed
Pens, No.	6	6	6			
Carcasses, No.	509	556	527			
Dressing percentage‡	64.6	64.9	64.8	0.065	0.03	0.32
Hot carcass weight, lb	849	857	861	3.9	0.08	0.50
Marbling score§	42.0	41.9	42.7	0.39	0.54	0.16
Lean color score‖	4.5	4.4	4.4	0.04	0.12	1.00
Rib fat, inches	0.72	0.75	0.78	0.016	0.04	0.22
Rib fat, in/100 lb HCW	0.085	0.088	0.091	0.002	0.10	0.30
KPH fat, %	1.96	1.93	1.92	0.015	0.12	0.70
Ribeye area, sq inches	13.4	13.8	13.5	0.07	0.02	<0.01
Ribeye area/100 lb HCW	1.58	1.61	1.57	0.007	0.21	<0.01
Calculated yield grade	3.6	3.6	3.7	0.04	0.27	<0.01

*Chlormax®, Alpharma Animal Health, Summit, NJ, now a product of Zoetis, Florham Park, NJ
†Deccox®, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
‡Mean hot carcass weight / mean actual final net weight *100
§Marbling score: 30 to 39 = slight; 40 to 49 = small; 50 to 59 = modest, etc.
‖Color score: 1 to 3 = very pink; 4 to 6 = normal cherry red; 7 to 9 = dark cutting

Table 5. Effects of chlortetracycline* (CTC) plus decoquinate† (DEQ) programs during the receiving period on carcass quality and yield grade distributions.

Item	Treatment			Chi-square P value‡	
	Control	CTC+DEQ Early	CTC+DEQ Delayed	CTC+DEQ vs Control	CTC Early vs CTC Delayed
Carcasses, no.	509	556	527		
Quality grades, %					
Prime + Choice	58.5	55.6	60.9	0.89	0.08
Select	40.7	43.9	39.1	0.74	0.11
Standard	0.8	0.5	0.0	NR[c]	NR[c]
Yield grades, %					
YG 1	2.6	2.0	0.4	0.05	0.02
YG 2	20.4	18.0	17.2	0.17	0.73
YG 3	47.2	51.3	42.7	0.99	<0.01
YG 4 + YG 5	29.9	28.8	39.7	0.10	<0.01

*Chlormax®, Alpharma Animal Health, Summit NJ, now a product of Zoetis, Florham Park, NJ
†Deccox®, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
‡NR = not reported. Probabilities were considered unreliable due to low expected counts in one or more cells.

was observed in any treatment group, which was not unexpected due to the described feeding of DEQ and monensin.

Death loss and removal rate due to BRD were 2.5% and 0.9% for steers in the CTC+DEQ treatment groups, and 3.8% and 0.9% in CON steers (P = 0.18; Table 6). Although the numbers were small, fewer steers (P = 0.05) were removed from the study due to BRD when initial CTC treatment was early rather than delayed (0.3 vs 1.4%). Combined mortality and animal removal was 2.6% for steers in the CTC+DEQ Early treatment group vs 4.1% in those in the Delayed group (P = 0.15).

Over the entire trial, 19% of 1,690 steers allotted to the study were treated for BRD (Table 7). Morbidity was lower (P < 0.01) for steers in the CTC+DEQ treatments than for those in the CON group (17 vs 23.5%), as was the percentage of respiratory cases that required ≥ 1 treatment (11 vs 22%; P < 0.01). The reduction in morbidity was most evident during the first 30 days of the study when 7% of the steers on the CTC+DEQ treatments were treated compared with 11% of those in the CON group (P < 0.01). Respiratory morbidity did not differ (P > 0.20) between CTC+DEQ Early and CTC+DEQ Delayed treatments.

Steers were first pulled because of BRD from day-3 to day-144 of the study. Feeding CTC+DEQ to the steers did not affect (P > 0.20) minimum, maximum, or mean days to first pull. First pulls occurred sooner (3 vs 9 days; P = 0.02) when initial CTC treatment was delayed. Across treatments, first pulls for BRD occurred within the first 10 days of the study, and mean days to first pull ranged from 49 to 61 days.

Decoquinate was not fed without CTC, therefore it was not possible to assess the effects of DEQ alone on the study results. Clinical signs of coccidiosis were not observed, and treatment effects on fecal oocyst counts were not monitored. Replicates 1 to 3 of the CTC+DEQ Early treatment inadvertently received CTC on study days 11 to 15. Because the treatments imposed involved the timing of the initial CTC feeding, and because the study investigators believed the cattle health issues required a discretionary treatment with CTC during this time, the extra feeding of CTC was not thought to impact results of this study.

Conclusions

The percentage of animals requiring individual therapy for respiratory disease was reduced by periodic 5-day feed treatments with CTC at 10 mg/lb (22 mg/kg) of BW during the initial 28 days-on-feed. Improved respiratory health was accompanied by increased dry-matter intake, rate of gain, and carcass weight. Timing of the initial CTC treatment had few effects on carcass characteristics. However, ribeye area was statistically smaller for carcasses from the CTC+DEQ Delayed treatment, and the percentage of carcasses grading USDA Choice or better was higher (P = 0.08). First pulls occurred sooner (3 versus 9 days; P = 0.02) when the initial CTC treatment was delayed. In conclusion, timing of the initial CTC treatment (0 to 4 days post-arrival versus 7 to 11 days) did not appear critical to the efficacy of the CTC treatment, although feeding CTC for at least 10 days during the receiving period improved overall health and productivity.

Endnotes

[a]Cactus Feeders, Amarillo, TX
[b]Deccox®, Pfizer Animal Health, New York, NY, now a

Table 6. Effects of chlortetracycline* (CTC) plus decoquinate† (DEQ) programs during the receiving period on removal and death loss due to respiratory disease.

Item	Treatment			Chi-square P value‡	
	Control	CTC+DEQ Early	CTC+DEQ Delayed	CTC+DEQ vs Control	CTC Early vs CTC Delayed
Initial steer count, no.	556	579	555		
Respiratory removals, no.					
< 30 days on feed	1	1	4	NR‡	NR
> 30 days on feed	4	1	4	NR	NR
Total removed	5	2	8	0.97	0.05
% of initial no.	0.9	0.3	1.4		
Respiratory mortality, no.					
< 30 days on feed	6	4	3	NR	NR
> 30 days on feed	15	9	12	0.26	0.45
Total dead	21	13	15	0.13	0.62
% of initial no.	3.8	2.2	2.7		
Total dead + removed, no.	26	15	23	0.18	0.15
% of initial no.	4.7	2.6	4.1		

*Chlormax®, Alpharma Animal Health, Summit, NJ, now a product of Zoetis, Florham Park, NJ
†Deccox®, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
‡NR = not reported. Probabilities were considered unreliable due to low expected counts in 1 or more cells.

Table 7. Effects of chlortetracycline* (CTC) plus decoquinate† (DEQ) feeding programs during the receiving period on the incidence and timing of respiratory disease cases.

Item	Treatment			Chi-square P value	
	Control	CTC+DEQ Early	CTC+DEQ Delayed	CTC vs Control	CTC Early vs CTC Delayed
Initial steer count, no.	556	579	555		
Respiratory cases, no.					
< 30 days on feed	63	41	38	<0.01	0.88
> 30 days on feed	67	55	59	0.21	0.53
Total unique cases	130	96	97	<0.01	0.69
% of initial no.	23.5	16.6	17.5		
Respiratory repulls‡, no.	29	9	12	<0.01	0.50
% of unique cases	22.3	9.4	12.3		

*Chlormax, Alpharma Animal Health, Summit NJ , now a product of Zoetis, Florham Park, NJ
†Deccox, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
‡Individuals pulled and treated for respiratory disease more than once.

product of Zoetis, Florham Park, NJ
[c]ChlorMax®, Alpharma Animal Health, Summit NJ, now a product of Zoetis, Florham Park, NJ
[d]Rumensin®, Elanco Animal Health, Greenfield, IN
[e]Micotil® 300, Elanco Animal Health, Greenfield, IN
[f]Vision® 7, Intervet, Merck Animal Health, Summit NJ
[g]Bovi-Shield Gold® 5, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
[h]*Pasteurella* bacterin, CAVL, Amarillo, TX
[i]Dectomax®, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
[j]Revalor®-IS, Intervet, Merck Animal Health, Summit NJ
[k]Revalor®-S, Intervet, Merck Animal Health, Summit NJ
[l]Tylan®, Elanco Animal Health, Greenfield, IN
[m]Dr. Daniel U. Thomson, Cactus Research staff veterinarian, Amarillo, TX
[n]Nuflor®, Merck Animal Health, Summit NJ

[o]Baytril® 100, Bayer Animal Health, Shawnee Mission, KS
[p]LA-200®, Pfizer Animal Health, New York, NY, now a product of Zoetis, Florham Park, NJ
[q]Statistix 7.0, Analytical Software, Inc., Tallahassee, FL

Acknowledgements

The authors acknowledge and appreciate the assistance of Dr. Michael Galyean and Dr. Daniel Rivera, Texas Tech University, who conducted the statistical analysis on the individual animal data set. Alpharma Animal Health provided partial funding for the study. Dr. David Yates was an employee of Alpharma at the time of the study. The remaining authors declare no conflict of interest.

References

1. Duff GC, Walker DA, Malcolm-Callis KJ, Wiseman MW, Hallford DM. Effects of preshipping vs arrival medication with tilmicosin phosphate and feeding chlortetracycline on health and performance of newly received beef cattle. *J Anim Sci* 2000;78:267-274.
2. Griffin D, Chengappa MM, Kuszak J, McVey DS. Bacterial pathogens of the bovine respiratory disease complex. *Vet Clin North Am Food Anim Pract* 2010;26: 381-394.
3. Kirkpatrick JG, Selk G. *Coccidosis in cattle*. Oklahoma Cooperative Extension Service VTMD-9129, 2010. Available at: pods.dasnr.okstate.edu/docushare/dsweb/Get/.../VTMD-9129web.pdf. Accessed September 2014.
4. Kreikemeier K, Stokka G, Marston T. Influence of delayed processing and mass medication with either chlortetracycline (CT) or tilmicosin phosphate (Micotil) on health and growth of highly stressed calves. *Southwest Research-Extension Center Progress Report* 1996; 773:23-27.
5. National Research Council. *Nutrient requirements of beef cattle*. 7th rev ed. Washington, DC: National Academy Press. 1996.
6. US Department of Health and Human Services. Conduct of clinical investigations: Responsibilities of clinical investigators and monitors for investigational new animal drug studies. *Federal Register* 1992;57:49480.
7. Van Donkersgoed J. Meta-analysis of field trials of antimicrobial mass medication for prophylaxis of bovine respiratory disease in feedlot cattle. *Can Vet J* 1992;33:786-795.