PEER REVIEWED

Effects of Single Administration of Half-dose Injectable Doramectin, Full-dose Injectable Doramectin, or Fenthion on Fecal Egg Counts, Growth Performance and Carcass Characteristics in Cattle

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Abstract

This clinical trial was designed to compare the effects of a single administration of half-dose doramectin[a], full-dose doramectin, or fenthion[b] only on growth performance, hot carcass weight, carcass quality grade and fecal egg count in a group of cattle of western US origin and finished in eastern Nebraska. Two hundred ninety-five crossbred steers (mean weight 667 lb; 303 kg) were purchased from auction barns in California, processed and allocated to the study in Idaho, and finished in a commercial feedlot in eastern Nebraska. At arrival to the backgrounding yard in Idaho, the calves were randomly assigned to one of three treatment groups: 1) fenthion only (0.5 oz/cwt); 2) half-dose (0.55 ml/cwt) of injectable doramectin; or 3) full-dose (1.1 ml/cwt) of injectable doramectin. Cattle in the fenthion treated group were poured with fenthion for ectoparasite control. At arrival, individual weights were recorded and fecal samples collected and assayed to determine nematode egg counts. Individual cattle weights and fecal samples were collected and recorded again when cattle were reimplanted (day 76). Carcass data were collected at harvest and individual live weights were calculated from individual carcass weight and group dressing percentage. In this study, there was significant improvement ($p = 0.022$) in hot carcass weight (HCW) in cattle administered full-dose doramectin as compared to cattle administered half-dose doramectin or fenthion pour-on only. Average daily gain (ADG) was greater in the group treated with full-dose doramectin than in the fenthion only group ($p = 0.016$). Significant differences in fecal egg counts were not found between experimental treatment groups ($p = 0.078$).

Résumé

Cet essai clinique avait pour but de comparer les effets de l'administration unique d'une demi-dose de doramectine, d'une dose complète de doramectine ou de fenthion seulement sur la performance de croissance, le poids de la carcasse, le niveau de qualité de la carcasse et le nombre d'œufs fécaux dans un groupe de bovins de boucherie de l'ouest des États-Unis dont la croissance s'est terminée au Nebraska. Deux cent quatre vingt-quinze bouvillons d'origine hybride (masse moyenne 667 livres; 303 kg) ont été achetés à l'encan en Californie, alloués à l'étude en Idaho et finalement engraissés dans un parc d'engraissement commercial dans l'est du Nebraska. A leur arrivée au parc de l'Idaho, les veaux ont été distribués de façon aléatoire dans l'un des trois groupes suivants : (1) fenthion seulement (0.5 onces/100 lbs); (2) demi-dose (0.55 ml/100 lbs) de doramectine injectable; or (3) dose complète (1.1 ml/100 lbs) de doramectine injectable. Les animaux dans le groupe traité avec du fenthion ont été aspergés de fenthion pour le contrôle des ectoparasites. A leur arrivée, le poids des individus a été pris et le nombre d'œufs de nématodes dans des échantillons fécaux a été déterminé. Les poids

[a]Dectomax® Injectable. Pfizer Animal Health, Exton, PA 19341
[b]Spotton®. Bayer Corporation, Shawnee Mission, KS 66201

et les échantillons fécaux ont été à nouveau recueillis lorsque les animaux ont été réimplantés pour favoriser la croissance (jour 76). Les données sur les carcasses ont été recueillies à l'abattage et le poids vif des individus a été calculé à partir du poids des carcasses individuelles et du pourcentage de rendement du groupe. Dans cette étude, il y avait une amélioration significative ($p = 0.022$) du poids de la carcasse et de la qualité de la carcasse du bétail qui était traité avec des doses complètes de doramectine en comparaison avec le bétail qui était traité avec des demi-doses ou du fenthion à verser seulement. Le gain moyen quotidien (GMQ) était plus élevé dans le groupe traité avec des doses complètes de doramectine que dans le groupe traité avec le fenthion seulement ($p = 0.016$). Aucune différence significative dans le nombre d'œufs fécaux n'a été observée entre les groupes expérimentaux ($p = 0.078$).

Introduction

Anthelmintic products have been used by beef cattle producers at reduced dose to lower processing costs (unpublished observation). However, there are no reports in the refereed literature to support this practice. Dose titration data for injectable doramectin suggests the product is effective against various internal and external parasites at reduced dosages. However, this measure of effectiveness is based on reduced parasite load or egg count reduction rather than growth performance outcomes such as average daily gain (ADG) or feed efficiency. There is evidence that the use of avermectins at reduced dose is only marginally effective against *Cooperia oncophera*.[1] Furthermore, use of the avermectins at reduced dose is considered extra-label drug use (ELDU; Bert Mitchell, FDA-CVM, personal communication). This study was designed to investigate the effect of using one-half of the labeled dose of injectable doramectin on clinically relevant and economically important outcomes, such as ADG and carcass characteristics.

Materials and Methods

Study population. Two hundred ninety-five crossbred steers, weighing 667 lb (303 kg), and approximately 6 to 8 months of age were purchased in auction barns in California and transported to Idaho for allocation to the study. Cattle were purchased over a 2-week period, processed and allocated to the study (day 0). Processing included administration of an individual eartag, a commercially available modified live virus (MLV) vaccine[c] against respiratory viruses (IBRV, PI3, BRSV, BVDV), a *Mannheimia (Pasteurella)* spp. bacterin-toxoid[d], an autogenous foot-rot vaccine[e] and an estradiol benzoate growth implant.[f] Individual weights and fecal samples were collected from each animal on day 0. The cattle were fed in the backgrounding facility for an average of 45 days (range 40 to 50 days). All cattle were fed at the finishing feedlot for 140 days.

Study facilities. The backgrounding yard (Idaho) has a one-time capacity of 5,000 head with 18 pens measuring approximately 200 X 180 ft. In-line, poured feed bunks and individual water tanks were provided for each pen. Processing/receiving and the hospital are separate facilities. The feedlot design is typical of commercial feedyards in Nebraska with 9 pens measuring approximately 350 X 400 ft, and 18 pens measuring 160 X 400 ft. The covered processing and hospital facility share a common hydraulic chute, but separate receiving/shipping pens and sheltered hospital pens are available. The hydraulic chute is equipped with a scale, and linked to a computerized health and performance record system.

Procedure. Allocation of the cattle to the study was done at the backgrounding feedlot in Idaho. Calves selected for this study were processed at arrival and held until allocation to the trial on day 0. Calves were assigned individually at chuteside, using a computer-generated randomization schedule, to one of three experimental treatment groups as follows: 1) topical fenthion (0.5 oz/cwt); 2) half-dose (0.55 ml/cwt) injectable doramectin; or 3) full-dose (1.1 ml/cwt) injectable doramectin. All cattle were commingled in a single 300-head capacity pen throughout the trial period. Ten days following initial processing, cattle were revaccinated with a commercially available MLV vaccine (IBRV, PI3, BRSV)[g]. Following the 45-day backgrounding phase in Idaho, cattle were transported to a commercial feedlot in eastern Nebraska with a one-time capacity of 6,500 head. Approximately 30 days post-arrival, cattle were administered a terminal implant[h] and individual weights and fecal samples were collected (day 76).

Diet. Cattle were adapted to a finishing ration over the course of 15 days and three increases (Table 1). All cattle were started on the #2 ration since they had been backgrounded for 45 days. Rations were mixed in the feed truck and delivered to the cattle twice daily.

[c]Pyramid® 4. Fort Dodge Animal Health, Fort Dodge, IA 50501
[d]Presponse®. Fort Dodge Animal Health, Fort Dodge, IA 50501
[e]Immtech Biologics, Bucyrus, KS 66013
[f]Synovex-S®. Fort Dodge Animal Health, Fort Dodge, IA 50501
[g]BRSV Vac® 3. Bayer Corporation, Shawnee Mission, KS 66201
[h]Revalor-S. Hoechst Roussel Vet, Warren, NJ 07059

Clinical evaluation. Cattle were evaluated daily by feedlot personnel. Animals determined to be unhealthy by the pen riders were removed from the pen and taken to the hospital for further evaluation and therapy. Treatment administration was done in accordance with the consulting veterinarian's recommendations and treatment protocol. Following treatment, cattle were kept in hospital pens and observed daily for clinical response. Treated cattle were returned to the home pen upon satisfactory recovery from disease.

Seven cattle were treated for footrot, respiratory disease, or gastrointestinal disease in each of the fenthion and the full-dose doramectin groups. Four head were treated in the half-dose doramectin group. There was one death in each of the three treatment groups. Treatment records were kept on a chute-side computerized health record program.

Of the 295 cattle initially enrolled in the study, 293 were accounted for at the beginning of the finishing phase in Nebraska. Additionally, three cattle were missing tags and three died, resulting in 287 that finished the study. Of the 287 cattle that finished the study, carcass data were missing from three.

Average daily gain was calculated both with dead cattle included and with dead cattle excluded from the data. Since an actual live finish weight was not obtained prior to harvest, an extrapolated live finish weight was calculated by dividing individual hot carcass weights (HCW) by the population dressing percentage (64.86%). It should be noted that dressing percentages can vary between and within groups of cattle (unpublished observation).

Marketing. Cattle were marketed on a dressed basis and sold at $113.00/cwt with a population dressing percentage of 64.86%, and an average hot carcass weight of 855 lb. An independent party collected individual carcass information.

Study design. The experimental design for this study was a completely randomized clinical trial.

Statistical analysis. Continuous outcome variables in this study were evaluated for normality of distribution using the Wilk-Shapiro test and for equality of variances using Bartlett's test. Outcomes that violated ($p < 0.05$) either normality of distribution or equality of variances were analyzed using the Kruskal-Wallis test. Outcome variables that were normally distributed and met the assumption of equality of variances were analyzed for statistical significance using analysis of variance (ANOVA). Worm count data were transformed using the geometric mean transformation, and analysis for statistical significance was done using the Kruskal-Wallis test. Proportion data were analyzed for statistical significance using the Chi-square goodness-of-fit test. Analyses were done using SAS 6.12,[i] Statistix 1.0[j] and EpiInfo 6.04.[k]

[i]SAS version 6.0, SAS, Cary, NC 27513
[j]Statistix version 1.0, Statistix, Tallahassee, FL 32317
[k]EpiInfo version 6.04, EpiInfo, CDC, Atlanta, GA 30333

Results

No significant difference in live body weight (BW) at arrival was found between treatment groups. On day 76, the mean live BW of cattle treated with full-dose doramectin, half-dose doramectin or fenthion were 912.3, 897.2 and 892.6 lb, respectively ($p = 0.087$; Table 2).

When dead cattle were excluded from the analysis, close-out ADG of calves treated with full-dose doramectin was greater ($p = 0.016$) than the gain of calves in the fenthion group. The ADG of calves in the half-dose doramectin group and those in the fenthion group were similar. When dead cattle were included in the analysis,

Table 1. As-fed rations for cattle in all three treatment groups and nutrient analysis.

	As-fed formula (%)			
Ingredient	**#2**	**#3**	**#4**	**#5**
#2 corn	36.10	48.10	60.10	67.00
Finisher	1.10	1.60	2.10	2.50
Liquid corn	17.00	16.00	15.00	15.00
Alfalfa hay	36.80	26.30	15.80	6.50
Micro room	1.00	1.00	1.00	1.00
Tortillas	8.00	7.00	6.00	8.00
Total	100.00	100.00	100.00	100.00
	Nutrient analysis (100% DM)			
	%	%	%	%
Dry matter	76.12	76.68	77.23	77.40
Crude protein	14.18	13.83	13.48	13.25
Moisture	23.88	23.32	22.77	22.60
NPN	1.35	1.86	2.35	2.77
Crude fiber	16.36	12.22	8.13	4.59
Fat	4.32	4.44	4.55	4.66
Calcium	0.91	0.85	0.80	0.75
Phosphorus	0.43	0.42	0.40	0.40
Potassium	1.35	1.13	0.91	0.74
Magnesium	0.24	0.23	0.21	0.21
Sulfur	0.19	0.19	0.18	0.18
Salt	0.20	0.24	0.27	0.30
NEm	83.10	87.36	91.59	95.32
NEg	53.97	57.99	61.98	65.49

Table 2. Live body weights (BW) (std error) and geometric mean (std error) fecal egg counts (eggs/gram) from cattle treated with full-dose doramectin, half-dose doramectin, or fenthion only.

	Full-dose doramectin	Half-dose doramectin	Fenthion	p=
Day 0:				
BW (lb)	679.6 (3.94)	675.9 (4.14)	677.5 (3.55)	0.804
Egg ct	5.91 (1.08)	6.23 (1.09)	5.12 (1.09)	0.219
Day 76:				
BW (lb)	912.3[c] (7.24)	897.2[cd] (6.21)	892.6[d] (6.30)	0.087
Egg ct	2.23[c] (1.08)	1.78[d] (1.08)	1.87[cd] (1.07)	0.078
ADG (lb)	3.08[c] (0.08)	2.91[cd] (0.08)	2.84[d] (0.07)	0.095

[c,d]Values with different superscripts differ at $p < 0.10$.

cattle in the full-dose doramectin group, half-dose doramectin group or fenthion treated group gained 3.53, 3.41 and 3.36 lb per day, respectively ($p = 0.089$; Table 3).

Hot carcass weight was greater in the group treated with full-dose doramectin than in either the group treated with half-dose doramectin or fenthion only ($p = 0.022$; Table 3). A greater proportion of carcasses grading choice or prime was found in the group treated with full-dose doramectin than in the group treated with half-dose doramectin or in the fenthion only group ($p = 0.054$; Table 3).

Median yield grades were 3.0, 3.0 and 2.0 for the full-dose doramectin group, half-dose doramectin group and the fenthion group, respectively ($p = 0.1466$). No significant difference was found in geometric mean fecal egg counts between any of the treatment groups on day 0 ($p = 0.219$). On day 76, geometric mean fecal egg counts were 2.23, 1.78 and 1.87 eggs per gram for cattle in the full-dose doramectin, half-dose doramectin and fenthion treatment groups, respectively ($p = 0.078$; Table 2).

Discussion

Although use of anthelmintic products at dosages below that prescribed on the label is ELDU, this practice is relatively common among producers in order to reduce cost. However, there are no reports in the refereed literature that report clinically relevant outcomes supporting the use of anthelmintics at reduced dosages. Dose titration studies found in freedom of information (FOI) summaries provided by the manufacturer report only parasite load or egg count reduction.[2]

In this study, significantly greater HCW and increased ADG of cattle (calculated with deads excluded) treated with full-dose doramectin justifies the use of this product as per label in cattle on arrival to the feedyard. The HCW and ADG in the half-dose doramectin and fenthion groups did not differ, which further supports the labeled use of doramectin. The proportion of choice-prime carcasses from cattle treated with full-dose doramectin was higher ($p = 0.054$) than in the groups treated with half-dose doramectin or fenthion. Others have reported a growth performance and carcass quality benefit in cattle treated with fenbendazole at labeled dose on arrival to the feedyard. This benefit was greater if the cattle had not been treated with fenbendazole during the grazing phase.[7] Since the cattle in the current study had not been treated with an anthelmintic during the grazing phase, it is expected that the benefits found may have been more pronounced than if they had been previously dewormed.

Interestingly, there were more overweight carcasses (> 950 lb) in the full-dose doramectin group (10/96) than in the half-dose doramectin group (4/96) or the fenthion group (0/95). This effect was significant ($p < 0.01$) and was not due to differences in the number of days on feed (DOF) since all trial cattle were harvested on the same day. This suggests that management of DOF may be an important consideration in cattle treated with anthelmintics, particularly those not previously treated.[7]

Since no negative control group was included in this study, it is possible that the apparent benefit of doramectin in some outcomes may have actually been due to a negative effect of fenthion on growth performance, but to our knowledge this has never been reported. However, the study objective was to compare growth performance and carcass quality characteristics of cattle treated with full-dose or half-dose injectable doramectin. It is difficult to get producer participation and compliance for a truly negative, untreated control in "real world" production systems.

The relative value of using the full-dose of doramectin in feedlot cattle can be assessed by considering the major parameters of economic interest when applying this data to a specific operation. Specifically, the following factors of economic importance must be considered in an economic model: 1) increased price in the fed cattle market, e.g., in this study, the relative value of using doramectin at full-dose was increased since an increase in HCW of approximately 18 lb was found; 2) increased spread between the value of choice-prime and select carcasses increased the relative value of full-dose doramectin;[3] and 3) changes in

Table 3. Average daily gain (std error) through close-out, hot carcass weights, and quality grade of carcasses from cattle treated with full-dose doramectin, half-dose doramectin, or fenthion only.

	Full-dose doramectin	Half-dose doramectin	Fenthion	p=
ADG (lb), deads-in	3.53[c] (0.06)	3.41[cd] (0.05)	3.36[d] (0.05)	0.089
ADG (lb), deads-out	3.57[a] (0.05)	3.44[ab] (0.04)	3.40[b] (0.04)	0.016
HCW (lb)	869.05[a] (6.56)	851.09[b] (5.75)	847.35[b] (5.30)	0.022
Prime & Choice % (n)	52.0 (50/96)[c]	37.5 (36/96)[d]	36.8 (35/95)[d]	0.054
Select % (n)	47.0 (45/96)[c]	62.5 (60/96)[d]	61.1 (58/95)[d]	0.054
No roll % (n)	1.0 (1/96)	0	2.1 (2/95)	NS

[a,b]Values with different superscripts differ at $p < 0.05$.
[c,d]Values with different superscripts differ at $p < 0.10$.

feedstuff prices or other contributors to the cost of gain or other significant contributors to profit potential; these were not substantial during the study period.

The development of a more inclusive economic model would require answers to specific questions of economic interest to individual producers or veterinarians.[5] Factors that are likely to vary among producers include cattle type and source, previous deworming history,[7] geography and climate, projected DOF, route of administration preferences, cattle pricing formulas and individual manager preferences. For these reasons, our specific economic analysis would be irrelevant to individual producers.[1,4,5]

In addition to growth performance and perceived economic justification for using the labeled dose of doramectin, producers should be aware that manufacturers of animal health products are unlikely to financially compensate for lack of efficacy or adverse reactions in cases of ELDU. It is the veterinarian's responsibility to inform producers of this liability associated with ELDU.

No significant difference was found in arrival BW between treatment groups, suggesting that the randomization scheme used in this study was effective. Geometric mean fecal egg count was not associated with growth performance or carcass quality grade. Others have found conflicting results between growth performance and fecal egg counts or parasite load.[6,8] These findings demonstrate that substitution indicators, such as parasite load or fecal egg counts, are not reliably associated with clinically relevant, economically important outcomes.

The deads-in vs. deads-out discrepancy in ADG differences among treatment groups is interesting, especially since the number of dead cattle were equal across treatment groups (one per each group). This demonstrates the relative importance of degrees of freedom in ANOVA, since the variance (standard error of the means) did not change between the two analyses. Our estimates revealed that the experimental design used in this study had sufficient statistical power to detect a difference of approximately 18 lb live weight on day 76, a yield grade difference of 0.25, a closeout ADG difference of 0.16 lb/hd/d and a parasite egg count difference of approximately 0.80 eggs/gram of feces. While this level of statistical power seems reasonable, greater power would be necessary to find economic break-evens.

In conclusion, improved HCW and growth performance support the use of full-dose doramectin as compared to half-dose doramectin or fenthion only in cattle entering the feedyard.

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