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# Pasture Deworming and (or) Subsequent Feedlot Deworming With Fenbendazole. II. Effects on Abomasal Worm Counts and Abomasal Pathology of Yearling Steers

**R. Flint Taylor,** *DVM, MS*[1]; **Donald H. Bliss,** *PhD*[2]; **Robert T. Brandt, Jr.,** *PhD*[3]; **Wade T. Nichols,** *PhD*[3]; **Jerry R. Rains,** *DVM, MS, DACT*[3] *(deceased);* **John P. Hutcheson,** *PhD*[3]; **Robert A. Smith,** *DVM, MS, DABVP*[4]
[1]*Taylor Veterinary Consulting Service, Edgewood, NM 87015*
[2]*MidAmerica Agricultural Research, Inc., Verona, WI 53593*
[3]*Hoechst Roussel Vet, Clinton, NJ 08809*
[4]*College of Veterinary Medicine, Oklahoma State University, Stillwater, OK 74078*

## Abstract

Seven hundred-thirty four steers (629 lb, 286 kg) were utilized during a 118-day grazing period, after which 640 were placed in a feedlot for finishing (average of 121 days, range of 111 to 133 days) to measure the main effects and interactions of two pasture deworming treatments (negative control, strategically dewormed with fenbendazole) and two feedlot deworming treatments (negative control, dewormed with fenbendazole) on fecal egg counts, abomasal worm counts and abomasal pathology. The companion paper in this series discussed the effect of deworming treatments on animal performance, carcass traits and production economics.

Seven to ten abomasa from steers on each of the four pasture-feedlot treatments (pasture control-feedlot control; pasture control-dewormed in the feedlot; strategically dewormed on pasture-feedlot control; strategically dewormed on pasture-dewormed in the feedlot) were selected at slaughter to determine total worm counts, and to evaluate gross pathology and histopathology of the abomasal mucosa. Pasture deworming with fenbendazole (FBZ) in a strategic program on days 0, 28, and 56 reduced ($P < .01$) adult and $L_4$ and $EL_4$ larval stages of *Ostertagia ostertagi* and adult and $L_4$ stages of *Trichostrongylus axei* ($P < .03$) residing in the abomasum at slaughter. Feedlot deworming with FBZ reduced ($P < .05$) $L_4$ and $EL_4$ stages of *Ostertagia ostertagi* and adult and $L_4$ stages of *Trichostrongylus axei*. An interaction ($P < .05$) between pasture deworming treatment and feedlot deworming treatment showed that pasture deworming had a significant effect on reducing the number of *Trichostrongylus* adult parasites, which was not further reduced by feedlot deworming. Strategic pasture deworming with FBZ followed by FBZ administration at the beginning of the finishing period reduced total *Ostertagia ostertagi*, *Trichostrongylus axei* and *Haemonchus* adult and larval stages by 99.13%, compared to untreated controls. There was no relationship between fecal egg counts and total worm counts. Gross pathology data showed that strategic deworming on pasture reduced ($P = .02$) the mean abomasal lesion score at slaughter. An interaction ($P < .01$) between pasture treatment and feedlot treatment showed that feedlot deworming of pasture control steers reduced mean histopathology score, while feedlot deworming of steers strategically dewormed on pasture had no impact. Distribution of histopathology scores showed that strategic deworming on pasture resulted in more steers ($P < .03$; Chi-square statistic) with no histopathological changes to the abomasal mucosa and fewer steers with higher histopathology scores.

## Introduction

Gastrointestinal parasites, particularly *Ostertagia ostertagi*, are a major cause of economic loss in ruminants throughout the world. It has become common practice in North America to administer a broad spec-

trum anthelmintic to calves and yearlings entering a grazing program or a feedlot. This has been done with limited knowledge of the economic benefits of deworming,[10] especially for yearling cattle in the feeding phase of production. As a result, many feedlot veterinarians and feedlot managers had begun to question the economic benefit resulting from deworming cattle, especially yearlings.

There are very few reports of studies comparing the use of modern anthelmintics and untreated controls in modern production settings. There is an abundance of information in the literature on the biology, life cycle and epidemiologic patterns of *O. ostertagi* and other gastrointestinal nematodes.[5,7,14,16] Additionally, the effects of gastrointestinal parasite infection on ruminant nutrition[9] and the pathophysiology of infection have been well reviewed.[2,4,6] Much of this very important information has been generated in well- controlled studies using small numbers of cattle.

To address the concerns of the feedlot industry, the impact of deworming on clinically and economically important outcomes, such as daily gain, feed intake, feed efficiency, carcass quality and general health was studied and reported in a companion paper.[13] The effect of different deworming strategies on fecal egg counts, total abomasal worm counts and abomasal pathology evaluated at the end of the feeding period is reported in this paper.

## Materials and Methods

The trial was conducted in two phases, with the pasture phase being conducted in southeastern Oklahoma and the feedlot phase being conducted in Colorado.

*Pasture Phase*

Seven hundred and fifty two crossbred yearling steers (avg. wt 629 lb, 286 kg) were purchased from four different locations (Aetna, KS; Dodge City, KS; El Reno, OK and Oklahoma City, OK). Cattle arrived at the pasture facility 3-7 days prior to the start of the experiment. During this period, all steers were administered a modified-live IBR-BVD-*Leptospira pomona* combination vaccine, a 7-way clostridial bacterin-toxoid, individually identified by a numbered ear clip tag, and kept in grass traps by origin. Seven hundred and thirty-four steers were used in the study.

Steers were individually weighed within each origin, implanted with a trenbolone acetate-estradiol growth implant[a] and randomly assigned to one of two pasture treatments by tossing a coin to determine the first treatment assignment, and then alternating treatments as the calves passed through the chute. Each calf received a second numbered ear tag that was color coded based upon origin and treatment. Pasture treatments were 1) non-dewormed controls, or 2) strategically dewormed with fenbendazole[b] (FBZ). Strategically dewormed steers received 2.27 mg/lb (5 mg/kg) BW of FBZ oral suspension at initial processing and a free-choice mineral at 28 and 56 days that contained FBZ.[13]

Steers grazed predominantly bermuda grass pastures near Hugo, OK. The pastures had been grazed during the previous grazing season. There was no history regarding parasite control programs for cattle previously grazing the pastures. The study pastures (5 replicates) ranged from approximately 120 - 360 acres and were stocked at densities varying from approximately .5 - 1 steers/acre, depending upon forage quantity and grazeable area in each pasture. Aerial photographs were utilized to cross-fence the pastures into two approximately equal halves with electric fencing. The two treatments were randomly assigned to each pasture by flipping a coin. Each source of steers comprised one pasture replicate except that steers originating from Dodge City comprised two pasture replicates. Stocking densities within a replicate were identical. Steers were placed into their respective pastures 24 hr following randomization and remained there until the end of the trial.

All steers had access to a complete, free-choice mineral containing bambermycins[c] formulated to provide an intake of 20 mg/hd/d of the drug. Remaining bambermycins mineral was removed, and the mineral containing FBZ was placed in mineral feeders at days 28 and 56 of the trial for the strategically dewormed steers. The FBZ-containing mineral was consumed over a six day period. Steers had access to stock tanks, ponds or creeks for water. All steers were fed 2 lb (0.91 kg)/hd/d of pelleted wheat midds for 30 days, beginning on day 13, because of less than adequate forage availability. Additionally, all steers were fed 2 lb (0.91 kg)/hd/d of an all-natural 38% protein cube from day 104 until the end of the trial, because of decreasing forage quality.

The trial was conducted from April to August, 1997. Steers were weighed off individually by pasture over a 3-day period on portable scales. To minimize weight variance due to shrinkage, steers within each replicate were mixed prior to being weighed. Average time of grazing was 118 days.

*Feedlot Phase*

Following the pasture phase, steers were shipped to a feedlot research facility near Wellington, Colorado. Steers were kept segregated by origin and pasture treatment groups. Processing included administration of a modified live IBR/BVD vaccine, a pour-on ectoparasiticide for grubs and external parasites,[d] and a zeranol[e] growth implant. Clorsulon[f] was administered to all steers at 28 days to minimize the potential confounding of results by the presence of liver flukes, and all steers received a terminal trenbalone acetate-estradiol combination growth implant[g] at 56 days.

Six hundred and forty steers were used for the feeding phase of the study. Of the original group of steers, the heaviest and lightest cattle, and any lame cattle, were not included in the feeding phase. This resulted in less weight variation across the group. The 640 remaining steers were computer randomized and stratified by weight within pasture replicate to 80 pens (8 head/pen), with 20 pens each assigned to the pasture-feedlot treatment combinations of 1) pasture control-feedlot control, 2) pasture control-dewormed in the feedlot, 3) strategically dewormed on pasture-feedlot control, and 4) strategically dewormed on pasture-dewormed in the feedlot. Steers that were dewormed in the feedlot received FBZ at 2.27 mg/lb (5 mg/kg) of BW. Because pasture replicates differed in size, each 20 pens of steers assigned to the 4 pasture-feedlot treatment combinations were comprised of 3 pens of steers from pasture 1, 5 pens from pasture 2, 2 pens from pasture 3, 7 pens from pasture 4, and 3 pens from pasture 5.

Steers were fed a steam flaked corn-based ration once daily. A series of four adaptation, or "step-up" rations were utilized prior to the finisher.[13] Steers were placed on the final ration at 28 days. The finisher ration contained 13.5% crude protein, and provided 300 mg monensin and 90 mg tylosin per head daily. Initial and final weights were single day, individual full weights obtained in the morning before feeding.

The feedlot phase of the trial was begun August 26 and 27, 1997. Steers were slaughtered when they were appraised to have adequate finish for marketing. There were three slaughter dates, and all steers from the same origin and pasture group were slaughtered on the same day. Time on feed for the different groups ranged from 111 to 133 days, with an average time on feed of 121 days for all steers in a treatment. Steers were slaughtered at a commercial packing plant. Hot carcass weight and liver condemnation scores were obtained at slaughter. Yield grade and quality grade data, including ribeye area, backfat thickness, KPH fat, and marbling score were collected by trained personnel following a 36-hour carcass chill.

*Fecal sampling and egg counts*

Fecal grab samples were obtained per rectum at initial processing prior to the start of the pasture phase from approximately 14% of the steers from each origin. Subsequent fecal samples were obtained from the trial pastures 21 days after each treatment of steers with FBZ (samples obtained on days 21, 49 and 77). Rectal grab samples were obtained from all steers at the end of the grazing phase (118 days). These samples served to establish off-pasture fecal egg counts as well as initial feedlot fecal egg counts.

During the feedlot phase, 25% of the steers in each treatment group were sampled at 14, 28, and 56 days of the study. The same steers were sampled on each of the sampling days. All steers were then sampled upon obtaining final weights before slaughter. Fecal samples were analyzed using the Modified Wisconsin Sugar Flotation Technique to establish worm egg counts. Results are reported as eggs/g of feces.

*Total worm counts and abomasal pathology*

Prior to slaughter, steers within each treatment group were identified as having a fecal egg count in the upper, middle or lower one-third of the range of fecal egg output. At the abattoir, abomasa were collected from 7-10 steers per treatment group. Efforts were made to collect abomasa from each fecal egg count range within each treatment group. Abomasa were washed in tap water and the muscoa was lightly rubbed to remove adhering digesta. Contents were brought to volume with 4 L of tap water, and a 10% aliquot was collected and preserved for parasite enumeration. The washed abomasa were then soaked in 4 L of tap water at room temperature for approximately 12 hr, after which time the mucosa was vigorously rubbed to remove all mucous and sloughing tissue. An aliquot of this material (1 L) was collected and preserved for enumeration. Differential worm and larval counts were done according to Ritchie *et al.*[11]

Washed abomasa were evaluated for presence or absence of gross lesions suggestive of possible parasite involvement or damage. Such lesions characteristically are raised grey nodules (2-10 mm in diameter) in the mucosa, usually circular in shape, and raised above the mucosal surface approximately 1 mm. Lesions were blindly scored by trained personnel according to the following scale:

1 No lesions (nodules) found, mucosal surfaces uniform in color and composition.
2 Very few (1-10) nodules found, scattered irregularly over mucosal surface.
3 Moderate number of nodules (10-50) found on mucosal surface.
4 Large numbers (>50) of nodules found in pyloric region of abomasum.
5 Nodules and nodular lesions predominate over majority of pyloric abomasal mucosa, with many involved nodules coalescing with adjacent nodules to form an overall "rugose" texture on the mucosal surface affected.

Sections measuring 4 $cm^2$ were selected from the same area of the pyloric abomasum and fixed in 10% neutral buffered formalin for several weeks. Four separate subsections were trimmed from representative areas of these tissues, prepared as histological sections and stained with hemotoxylin and eosin stain. Tissue sections were examined under light microscopy. Histopathological changes were blindly evaluated and scored according to the following scale:

1 No lesions seen, no more than 0-3 nodules of normal gut-associated lymphoid tissue (GALT) were observed per tissue section.
2 Slight histopathological changes suggestive of possible parasite involvement; characterized by 3-5 lymphoid nodules, a slight increase in mixed inflammatory cells throughout any or all of the mucosa, submucosa and basement membrane areas of histological section. Abomasal glands may have been slightly dilated and/or irregular.
3 Moderate histopathological changes suggestive of parasite presence and damage cited in #2 above. Five to 10 lymphoid nodes per section, overall increase in inflammatory cells throughout the submucosa, mucosa, muscularis, and basement membranes of the section. Some glands enlarged and/or irregular, some mild necrosis in centers of isolated lymphoid nodules.
4 Severe histopathological damage. Lymphoid nodes frequent (>5/tissue section), accompanied by multifocal areas of lymphoid necrosis, dilated and irregular abomasal glands, necrotic debris in affected glands, suggestion of edema in mucosa, increased inflammation throughout all levels of tissue. Occasional parasitic larval sections seen in the lumina of affected glands.

*Statistical analysis*

Fecal worm egg counts were analyzed by General Linear Models procedures of SAS[12] using split-plot models. For egg counts during the grazing phase, the main plot effect of pasture treatment was tested by the main plot error term of pasture replicate x pasture treatment. The sub-plot effects of sampling day and the pasture treatment x sampling day interaction were tested with residual error. Feedlot fecal egg counts were analyzed with a split-split-plot model. The main plot effect of pasture treatment was tested using pasture replicate x pasture treatment as the error term. Sub-plot effects of feedlot treatment and the pasture treatment x feedlot treatment interaction were tested by the sub-plot error term of pasture replicate x pasture treatment x feedlot treatment. Sub-sub plot effects of sampling day and the resulting two- and three-way interactions of sampling day with pasture treatment and feedlot treatment were tested with residual error.

Abomasal parasite enumeration, gross pathology score and histopathology data were also analyzed using a split-plot model. The main plot effect of pasture treatment was tested using pasture replicate x pasture treatment as the error term. Sub-plot effects of feedlot treatment and the feedlot treatment x pasture treatment interaction were tested with residual error. Abomasal parasite counts were highly variable and were not normally distributed. Therefore, parasite enumeration data were analyzed using the $\log_{10}$ transformations of actual counts.

## Results and Discussion

The summer of 1997 was hot and dry in the region of the country where this experiment was conducted, which likely had a negative impact on forage quantity and (or) quality. The fecal egg count data (Table 1) showed steers shedding an average of 12 to 17 eggs/g at day 0. A treatment x sampling day interaction ($P < .001$) showed that average egg counts for strategically dewormed steers declined throughout the grazing season, while egg counts for control steers increased, and then declined slightly by day 118. Fecal egg counts during the feedlot phase were affected by a pasture treatment x feedlot treatment x sampling day interaction ($P < .01$; Table 2). The data show that strategically dewormed steers entered the feedlot with lower worm egg counts than pasture control steers. Deworming in the feedlot reduced egg counts for both strategically dewormed steers and pasture control steers, but the reduction was much greater for the pasture control steers. Over time, egg counts for steers dewormed in the feedlot remained low, while those of steers not dewormed in the feedlot increased to day 28, then decreased until slaughter. Fecal egg counts at slaughter were similar across all treatments, despite the fact that significant differences in animal performance occurred in both the pasture and feedlot phases of the trial.

Counts for adult and larval stages of *Ostertagia ostertagi*, *Trichostrongylus axei* and *Haemonchus* species were highly variable and not normally distributed, as shown by the extremely high coefficients of variation shown for actual counts in Table 3. Actual counts for *Ostertagia* (adult, $L_4$ and $EL_4$ stages) and *Trichostrongylus* (adult and $L_4$ stages) did not differ from zero for any

**Table 1.** Least squares means for the effects of strategic deworming with fenbendazole and day of sampling on average fecal egg counts of grazing steers.[13]

| | Fecal egg counts (eggs/g)[a] | | |
|---|---|---|---|
| Day | Control | Dewormed | Pooled S.E.M[b] |
| 0 | 12 | 17 | 6.6 |
| 21 | 24 | 11 | 7.6 |
| 49 | 78 | 7 | 7.4 |
| 77 | 67 | 2 | 7.6 |
| 118 | 47 | 9 | 2.6 |

[a]Treatment x sampling day interaction ($P < .0001$).
[b]Pooled standard error of the mean (total n=1033 samples).

treatment other than the negative controls. Strategic deworming on pasture followed by feedlot deworming with FBZ reduced total abomasal parasites by 99.13%. Analysis of the transformed data (Table 4) showed that pasture deworming reduced ($P < .03$) adult and larval stages of both *Ostertagia* and *Trichostrongylus* species in this study. Infestation of steers with *Haemonchus* in this study was low.

A similar study conducted in Louisiana[17] demonstrated a 98.1% reduction in total abomasal worm counts and a 99.0% reduction in inhibited *Ostertagia* when FBZ was given to yearling cattle prior to grazing, and then twice in the mineral at 30-day intervals. Cattle were necropsied 121-days after trial initiation. The control cattle harbored 40,305 *Ostertagia*, of which 33,744 were early L4 inhibited larvae. The cattle strategically treated with FBZ harbored only 752 *Ostertagia*, of which 336 were early L4 inhibited larvae.

The strategic deworming program used in this trial prevented a parasite build-up on the pasture. The existing parasites in the cattle were removed prior to the start of grazing, thus preventing worm egg shedding at the beginning of the grazing period, thereby reducing the first opportunity for pasture recontamination. The second goal of the strategic deworming program was to prevent worm egg shedding for the first 3 months of the season. If egg shedding can be prevented for the first 3 months of the season, very little pasture contamination

**Table 2.** Least squares means for the effects of strategic deworming on pasture and (or) feedlot deworming with fenbendazole on fecal egg counts[a] (eggs/g) of finishing steers.[13]

| **Pasture trt:** | **Control** | | **Dewormed** | | **Pooled** |
|---|---|---|---|---|---|
| **Feedlot trt:** | **Control** | **Dewormed** | **Control** | **Dewormed** | **S.E.M.[b]** |
| Sampling day | | | | | |
| 0 | 47.5 | 49.6 | 6.5 | 9.6 | 3.32 |
| 14 | 94.8 | 0 | 52.4 | .4 | 6.16 |
| 28 | 71.0 | .6 | 45.1 | 1.4 | 6.18 |
| 56 | 18.8 | 4.1 | 5.7 | 2.8 | 6.16 |
| Slaughter | 7.8 | 7.0 | 4.6 | 5.5 | 3.28 |

[a]Pasture treatment x feedlot treatment x day interaction ($P < .01$).
[b]Pooled standard error of the mean (total n=1653 samples).

**Table 3.** Least squares means for abomasal parasite counts.

| **Pasture trt:** | **Control** | | **Dewormed** | | |
|---|---|---|---|---|---|
| **Feedlot trt:** | **Control** | **Dewormed** | **Control** | **Dewormed** | **CV %[a]** |
| Abomasa, n | 10 | 7 | 9 | 7 | |
| Slaughter EPG | 11.4 | 6.4[b] | 2.7[b] | 5.4[b] | 155 |
| *Ostertagia ostertagi* | | | | | |
| Adult | 17,981 | 7,804[b] | 1,121[b] | 198[b] | 124 |
| $L_4$ | 5,984 | 2,121[b] | 286[b] | 82[b] | 115 |
| $EL_4$ | 2,522 | 932[b] | 147[b] | 20[b] | 142 |
| *Trichostrongylus axei* | | | | | |
| Adult | 10,178 | 246[b] | 6[b] | 22[b] | 280 |
| $L_4$ | 789 | 62[b] | 11[b] | 2[b] | 355 |
| *Haemonchus* sp. | | | | | |
| Adult | 2[b] | 0[b] | 1[b] | 0[b] | 450 |
| Total adults, n | 28,160 | 8,050[b] | 1,128[b] | 219[b] | 117 |
| Total parasites, n | 37,455 | 11,164[b] | 1,572[b] | 324[b] | 106 |

[a] Coefficient of variation.
[b] Counts not statistically different from zero ($P < .05$).

**Table 4.** Least squares means for $\log_{10}$ transformations of abomasal parasite counts.

| Pasture trt: | Control | | Dewormed | | PR > F[a] | | |
|---|---|---|---|---|---|---|---|
| **Feedlot trt:** | **Control** | **Dewormed** | **Control** | **Dewormed** | **P** | **F** | **P*F** |
| *Ostertagia ostertagi* | | | | | | | |
| Adult | 4.06 | 3.31 | 2.55 | 2.02 | .0035 | .057 | .74 |
| $L_4$ | 3.67 | 2.55 | 1.92 | 1.28 | .003 | .009 | .45 |
| $EL_4$ | 3.04 | 1.92 | 1.63 | .72 | .006 | .009 | .77 |
| *Trichostrongylus axei* | | | | | | | |
| Adult | 2.58 | .20 | .29 | .46 | .029 | .035 | .017 |
| $L_4$ | 1.61 | .08 | .23 | .05 | .015 | .030 | .082 |
| *Haemonchus* sp. | | | | | | | |
| Adult | .13 | -.07 | .08 | -.06 | .74 | .16 | .82 |
| Total adults, n | 4.30 | 3.34 | 2.57 | 2.04 | .0007 | .026 | .49 |
| Total parasites, n | 4.46 | 3.43 | 2.74 | 2.16 | .0005 | .0175 | .49 |

[a]Probability values for effects of pasture treatment (P), feedlot treatment (F), and the pasture treatment x feedlot treatment interaction (P*F), respectively.

will occur for the next 2 to 3 months, providing for approximately 5-6 months of "parasite safe" grazing.[1] Two sequential follow-up treatments were thus given 4-weeks apart beginning 4-weeks after the steers began grazing, to eliminate any nematode infections that occurred during the first 2 months of grazing. Since the average prepatent period of nematodes in yearling cattle is approximately 25-30 days, the cattle were treated 4 weeks after turnout to kill nematodes ingested during the first 4 weeks of grazing, before they had a chance to mature and shed eggs on the pasture.

The parasite contamination present from the previous grazing season will decrease through natural attrition and/or through daily consumption by the cattle grazing in early spring. The level of contamination present from the previous grazing season is, therefore, greatly reduced after the first two months of grazing is completed. As cattle ingest parasite larvae that are on the pasture from the previous grazing season they can be removed by a strategic anthelmintic treatment just as the larvae are beginning to mature and lay eggs. After the second treatment is given 56-60 days after turnout, it will be 25-30 days before worms mature, making the total time period of "no or low egg shedding" approximately 90-days. This is sufficient time to prevent severe infections for the rest of the season.

Feedlot deworming also reduced ($P < .01$) larval stages of *Ostertagia*, regardless of pasture treatment. Interactions between pasture deworming treatment and feedlot deworming treatment for *Trichostrongylus* adult parasites ($P = .017$) and $L_4$ larva ($P = .08$) showed that feedlot deworming reduced the number of those parasites in pasture control steers, but did not further reduce the low numbers observed for strategically dewormed steers.

Gross pathology data (Table 5) showed that strategic deworming on pasture reduced ($P = .02$) the mean abomasal lesion score at slaughter. There was a trend ($P = .07$) for an interaction between pasture deworming treatment and feedlot deworming treatment, suggesting that feedlot deworming of pasture control steers reduced gross pathology at slaughter, while feedlot deworming of strategically dewormed steers had no effect on gross pathology. This would be expected since strategically dewormed steers had most of their parasite load removed on pasture. Histopathological changes to gut mucosa (Table 5) were similarly affected by treatment. An interaction ($P < .01$) between pasture treatment and feedlot treatment showed that feedlot deworming of pasture control steers reduced mean histopathology score, while feedlot deworming of strategically dewormed steers had no impact. Distribution of histopathology scores (Table 5) showed that strategic deworming resulted in more steers ($P < .03$; Chi-square statistic) with no histopathological changes to abomasal mucosa, and fewer steers with higher (>1) histopathology scores.

Since little parasite transmission occurs while cattle are confined in feedlots, worm burdens taken after a 121-day feeding period were likely not reflective of total numbers of parasites present in these steers upon arrival in the feedlot. An earlier report[15] demonstrated that at least a 50% reduction in worm counts likely occurred during this feeding period. Most of the parasites removed were likely adult parasites at the time the cattle arrived in the feedlot, which through natural attrition allowed inhib-

**Table 5.** Abomasal gross pathology and histopathology scores.

| Pasture trt: | Control | | Dewormed | | PR > F[a] | | |
|---|---|---|---|---|---|---|---|
| **Feedlot trt:** | **Control** | **Dewormed** | **Control** | **Dewormed** | **P** | **F** | **P*F** |
| No. abomasa | 10 | 7 | 9 | 7 | | | |
| **Gross pathology:** | | | | | | | |
| Average score[b] | 3.89 | 2.45 | 1.96 | 2.14 | .022 | .16 | .07 |
| Distribution of scores, n[b] | | | | | | | |
| 1 | 0 | 2 | 2 | 2 | | | |
| 2 | 0 | 2 | 5 | 2 | | | |
| 3 | 3 | 1 | 1 | 1 | | | |
| 4 | 5 | 2 | 1 | 2 | | | |
| 5 | 2 | 0 | 0 | 0 | | | |
| **Histopathology:** | | | | | | | |
| Average score[b] | 1.94 | 1.32 | 1.06 | 1.24 | .059 | .15 | .01 |
| Distribution of scores, n[b,c] | | | | | | | |
| 1 | 3 | 3 | 9 | 5 | | | |
| 2 | 5 | 4 | 0 | 2 | | | |
| 3 | 2 | 0 | 0 | 0 | | | |
| 4 | 0 | 0 | 0 | 0 | | | |

[a]Probability values for effects of pasture treatment (P), feedlot treatment (F), and the pasture treatment x feedlot treatment interaction (P*F), respectively.
[b]See text for description of gross and histopathological scoring.
[c]Treatment effect (P < .03; Chi-square statistic).

ited and developing larvae to begin maturation. This was supported by the high number of adult parasites (75.2%) found in the present study at slaughter.

The efficacy of a single FBZ treatment in cattle carrying a high level of inhibited *Ostertagia* in this study was 59.0%. This number is probably 15 percentage points lower than what would have been found had worm counts been conducted immediately following treatment going into the feedlot. Most of the adult parasites harbored in the steers in the pasture control-feedlot control group at the time they arrived in the feedlot would have been lost through natural attrition. The majority of the parasites present in the control animals at the time of slaughter, therefore, were probably in an inhibited or early development phase at the time cattle arrived in the feedlot. This, therefore, lowers the efficacy value of a single treatment given at arrival and checked at slaughter, because as many as 50% of the worms could have been lost due to natural attrition.[15]

Miller[8] reported the efficacy of FBZ for treatment of inhibited *Ostertagia* sp. to be in the range of 60-90% when dosed at 2.27 mg/lb (5 mg/kg). Fenbendazole destroys the parasite by interrupting the parasite's metabolism; if the parasite is in an inhibited phase and metabolic rates are low, a higher dose of FBZ (4.54 mg/lb; 10 mg/kg) may be necessary to achieve 95% or greater efficacy. When using a strategic parasite control program for grazing cattle, worm burdens for the season are kept at a low level and inhibition of *Ostertagia* is not likely to occur, as demonstrated in the group strategically treated in the present study, where the seasonal efficacy of FBZ was 95%.

Overall, steers from control pastures treated with FBZ upon arrival in the feedlot gained 68 lb (31 kg) more during the feeding period than steers in the pasture control-feedlot control group, despite the high level of inhibited *Ostertagi* present. Steers strategically dewormed on pasture but not dewormed in the feedlot gained 79 lb (36 kg) more during the combined grazing-finishing period than the pasture control-feedlot control steers, while steers dewormed both on pasture and at feedlot arrival gained 102 lb (46 kg) more than control steers (Table 6).[13]

Higher total worm counts were associated with lower total gain, reduced dressing percentage, lower hot carcass weights and a notable reduction in the percentage of steers grading USDA choice (Table 6). Live steer weight, dressing percentage, carcass weight, and quality grade are all economically important traits. Interestingly, there was no correlation of fecal worm egg counts during the feeding period with gain or carcass traits, or with total worm counts. The lack of correlation between fecal egg counts and total worm counts at the end of the feeding period are in agreement with Gasbarre,[3] who reported that fecal egg counts are poor indicators of infection levels of *Ostertagia* sp, and only moderately correlate with the level of *Cooperia* infec-

**Table 6.** Relationship of deworming treatment, fecal egg count at slaughter and total worm count to gain, feed efficiency and selected carcass traits.

| Pasture trt: | Control | | Dewormed | |
|---|---|---|---|---|
| **Feedlot trt:** | **Control** | **Dewormed** | **Control** | **Dewormed** |
| EPG, slaughter[a,c] | 7.8 | 7.0 | 4.6 | 5.5 |
| Total worm count | 37,455 | 11,164[b] | 1,572[b] | 324[b] |
| Total gain, lb[c] (past/feedlot) | 584 | 652 (+68) | 663(+79) | 686(+102) |
| Dressing pct.[c] | 59.66 | 60.61 | 60.37 | 61.02 |
| Hot weight, lb[c] | 723 | 772 | 781 | 802 |
| Choice, %[c] | 29.0 | 52.0 | 44.6 | 55.2 |

[a]Least square means of fecal egg counts. Based on samples from all steers prior to slaughter.
[b]Values with same superscript do not differ from zero.
[c]See reference 13 for detailed discussion and statistical anslysis.

tion. These data further emphasize that low fecal egg counts can be a misleading parameter. Results of fecal examination can be a good indicator of the presence of parasites, but not a reliable indicator of the severity of parasite infection.

Controlling parasite development on pasture for the entire grazing season is a powerful management tool for producers. Strategic deworming of steers on pasture in this study was more effective than allowing parasite loads to build-up during the grazing period. Strategic deworming on pasture resulted in improved gain both on pasture and in the feedlot, improved feed efficiency and more desirable carcass traits. The detrimental effects of clinical parasitism have been well characterized in many publications. However, more subtle, subclinical parasitism seen in this study demonstrated that relatively low worm counts can have a significant impact on important production parameters.

## Conclusions

Strategic deworming of yearling steers on pasture and at feedlot entry resulted in lower total worm counts and less abomasal pathology than found in steers not strategically dewormed while grazing. There was no correlation between fecal egg counts prior to slaughter and total worm counts, abomasal pathology and production parameters. To achieve optimal parasite control and production, the veterinarian must understand both the usefulness and limitations of fecal examinations in relation to production parameters, and must have a good understanding of the biology of the parasite, the interaction between the host, parasite and environment, and the proper application of control measures.

## Footnotes

[a]Revalor® - G. Hoechst Roussel Vet, Clinton, NJ 08809
[b]Safe-Guard®. Hoechst Roussel Vet, Clinton, NJ 08809
[c]Gainpro®. Hoechst Roussel Vet, Clinton, NJ 08809
[d]Tiguvon® (fenthion). Bayer Corp, Shawnee Mission, KS 66201
[e]Ralgro® Implants. Schering-Plough Animal Health, Union NJ 07083
[f]Curatrem®. Merial Limited, Iselin, NJ 08830
[g]Revalor® - S. Hoechst Roussel Vet, Clinton, NJ 08809

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# Abstracts

## Calf Pneumonia Costs!

A.H. Andrews

*Cattle Practice* (2000) 8(2): 109-114

The study involved an investigation into the cost of twelve outbreaks of pneumonia (eight dairy-bred herds and four suckler herds) as they occurred on farm. The outbreaks, on ordinary commercial farms, were followed throughout their duration and involved all calves with apparent clinical infection, and some calves without as controls. Calves were examined and weighed at weekly intervals until five weeks after the end of the outbreak. The study took place in the winters of 1997-98 and 1998-99. Most outbreaks occurred in mild moist weather with a high humidity. The ventilation was adequate on four farms, but on the other farms it was unsatisfactory. Because of the husbandry systems used and the fact that most calves were homebred, on all farms different age groups shared the same air space. While all the suckler herds were adequately fed, six of the eight herds with dairy-bred calves had inadequate diets. The cost per ill dairy-bred calf varied from £8.59 to £78.74. These were the two extremes and all the other six outbreaks were within ± £5.00 of the overall average of £43.26. The average cost of pneumonia per dairy-bred calf within the group was £29.58. The overall costs per outbreak were higher in the suckler herds and the average cost per ill calf (£82.10) was nearly double that in the dairy herd and the cost per animal within the group was £74.10 (2.5 times the cost for dairy calves). In the suckler herds the morbidity (90.3%) and mortality (3.9%) were higher than in the dairy herds (68.4% and 1.5% respectively). Looking at the overall costs, those immediately tangible to the farmer, namely veterinary and medicine costs, came to about 40% of the total costs of an outbreak. The remaining costs, which included mortality, weight loss, extra labour and other costs were higher. In all studies, weight reductions or reduced weight gains during the outbreaks were the highest cost in both dairy and suckler herds. The second highest cost was that of medicines. When mortality occurred, it became a major cost input. In the dairy herds, costs tended to increase when the outbreak was protracted and in the suckler herds it was more dependent on the scverity of the illness. In many herds the consequences of the pneumonia outbreak were still apparent after the end of the study.

## Efficacy of Two Non-antibiotic Therapies, Oxytocin and Topical Liniment, Against Bovine Staphylococcal Mastitis

C. H. Knight, J. L. Fitzpatrick, D. N. Logue, D. J. Peatt

*Veterinary Record* (2000) 146, 311-316

Eight cows were challenged by a single quarter intramammary infusion of a relatively low-virulence strain of *Staphylococcus aureus* on four occasions five weeks apart and, after each challenge, each cow received one of four treatments, according to a duplicated Latin-square design. The treatments were massage alone (negative control), massage with a proprietary liniment, oxytocin, and a single course of a proprietary intramammary antibiotic. The massage treatments were applied at every milking for three weeks, oxytocin was given for one week, and the antibiotic was given after three successive milkings. Milk samples were collected immediately before and for three weeks after each challenge, and a scoring system was used to quantify the presence of bacteria during the whole of the period. None of the treatments completely eliminated bacteria from all the cows. Relative to the negative control, the liniment had no significant effect, but both oxytocin and the antibiotic reduced the numbers of bacteria significantly and did not differ significantly in efficacy.