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Feedlot Performance of Steers Treated Concurrently with Ceftiofur Crystalline-Free Acid Subcutaneously in the Posterior Aspect of the Ear and a Growth-promoting Implant

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Abstract

Ceftiofur crystalline-free acid sterile suspension (CCFA-SS), a long-acting formulation of ceftiofur formulated for subcutaneous injection in the middle third of the posterior aspect of the ear, is being developed for the control and treatment of bovine respiratory disease. A study was designed to evaluate average daily gain (ADG) and feed efficiency (FE) for cattle through 140 days in the feedlot after CCFA-SS was administered concurrently in the same ear with a growth-promoting implant. On Day 0, steers (n = 207) averaging 189 kg in weight were randomly assigned to the following treatments: Revalor®-S implant (120 mg trenbolone acetate and 24 mg estradiol per implant; Hoechst-Roussel Agri-Vet Company) (n = 64); CCFA-SS at 6.6 mg ceftiofur equivalents/kg and a Revalor®-S implant (n = 64); untreated control (no CCFA-SS or implant) (n = 63); or CCFA-SS only (n = 16). On Day 56, an Implus-S® implant (200 mg progesterone USP plus 20 mg estradiol benzoate; Pharmacia & Upjohn Animal Health) was administered to all cattle. Tolerance of administration of all materials was observed visually and by palpation of the treated ears. Average daily gain and F from Day 0 through Day 56 were significantly ($P < .001$) better for steers of both groups with an implanted growth-promotant than for untreated controls. From Day 0 through Day 140, ADG was

significantly ($P < .05$) better for cattle given an implant or an implant plus CCFA-SS than for untreated controls and FE was significantly ($P < .05$) better for cattle given an implant plus CCFA-SS than for controls. Mild or moderate, transient swelling of the treated ear was observed in two cattle (CCFA-SS plus implant) on Day 52. On Day 56, 88% of cattle treated with CCFA-SS, 84% of the cattle treated with an implant plus CCFA-SS, and 100% of cattle in other groups were normal. Administration of CCFA-SS in the middle third of the posterior aspect of the ear at the same time as growth-promoting implants did not affect performance of cattle in the feedlot and was well tolerated by the animals.

Introduction

The sodium (Naxcel®/Excenel™ Sterile Powder, Pharmacia & Upjohn Animal Health) and hydrochloride (Excenel™ Sterile Suspension, Pharmacia & Upjohn Animal Health) salts of ceftiofur are approved in the United States and many other countries for treatment of bovine respiratory disease (BRD) associated with *Pasteurella haemolytica* (*Mannheimia* spp), *Pasteurella multocida,* and *Haemophilus somnus* when administered intramuscularly or by subcutaneous (SC) injection in the neck at the recommended doses for 3 to 5 days.[1,2]

Products that require only a single administration can reduce costs and stress to the cattle, providing advantages over products that must be administered over several days or longer. Traditional therapeutic programs with limited treatment days may have sacrificed efficacy or tolerated higher retreatment rates. Ceftiofur crystalline-free acid sterile suspension (CCFA-SS) is being developed as a single-administration formulation to be part of the ceftiofur family of products available for the treatment and control of BRD in cattle. Ceftiofur is rapidly metabolized to its major metabolite desfuroylceftiofur, which is extensively metabolized.[3] Ceftiofur is rapidly degraded in animal and environmental ecosystems, resulting in limited exposure of nontarget pathogens.[3] Although initially found to be effective by the SC route,[4] an alternative route of administration was required because of the presence of ceftiofur residues that exceeded established tolerances at the injection site for extended periods.[5] Several routes and sites were investigated, and the middle third of the posterior aspect of the ear was chosen as the ideal site of administration. A patent has been issued for administration of antibiotics by this route,[6] and administration of CCFA-SS by this route has been shown to be effective for treatment and control of BRD.[7]

Because the posterior aspect of the ear is the site of administration for growth-promoting implants, it was important to determine whether feedlot performance would be affected by concurrent administration of CCFA-SS in the same ear as the growth promotant. The present study was designed to evaluate performance of cattle in the feedlot after concurrent administration of a growth-promoting implant and CCFA-SS compared with administration of an implant, as measured by average daily gain (ADG) and feed efficiency (FE; weight gain/feed [dry matter] consumed). In addition, tolerance of ear administration was measured visually and by palpation. After the study was initiated, the ease of inserting new implants on Day 56 was evaluated, and the study was extended through Day 140. The study was conducted according to Good Clinical Practices guidelines.[8] The Institutional Animal Care and Use Committee approved all procedures used during this study.

Materials and Methods

Animals

Two-hundred forty Angus or Angus-crossbred steers, approximately 6 to 8 months of age, weighing an average of 189 kg each, were purchased at sales and delivered to a feedlot facility in Michigan
. At processing, cattle received standard vaccinations (Bovishield™ 4 and Ultrabac® 7; Pfizer Animal Health) and treatment for internal and external parasites (Ivomec® Pour-on; Merial). The ears of each animal were evaluated and examined for previously applied implants, which, if present, were removed during processing. The better ear was designated for treatment administration, and an ear tag was placed in the opposite ear to facilitate differentiation of the treated ear from the untreated ear. During the 38-day acclimation period, any animal that required treatment for BRD or other disease was treated as directed by an attending veterinarian.

Facilities

Cattle were housed in groups of eight in a facility containing 26 pens (two wings of 13 pens each) with slotted floors measuring approximately 3.7 m x 4.9 m. These facilities meet the space requirement for finishing cattle in enclosed, slotted-floor barns.[9] A previous validation study revealed that the end pen was "different" from the remaining 12 pens in that wing.[10] Thus, the end pens were not used for the primary test groups, and the building provided eight blocks of three contingent pens plus two end pens. Each pen was equipped with a concrete feed bunk on the north side and an automatic waterer on the south side. The facility had a roof and solid walls on the east and west sides, a solid wall with panels that could be removed on the north side, and was partially open to the south. During the study, lighting was natural except when extra lighting was required for animal care and building maintenance. Cattle were acclimated to the facility 38 days before the start of the study.

Diet and Feeding

Hay was provided in all pens, and the animals had access to trace mineral salt blocks after arrival. A few days after arrival, cattle were offered a protein-mineral-vitamin supplement and then corn silage and whole corn. Beginning on the fourth day after arrival, cattle were fed Aureo S 700® (Hoffman LaRoche Ltd.) crumbles at 0.08 kg/head/day for 28 days. The crumbles were hand-fed to each pen after feed was delivered. Hay was gradually reduced and replaced with rations of progressively higher concentrate: roughage ratios (60:40, 75:25, 80:20, and 85:15) on a dry matter basis. Rations were offered ad libitum through an automatic feeding system during the acclimation period. Cattle were acclimated to the top ration for 3 days before the start of the study. The 80:20 and 85:15 rations contained a customized protein-mineral-vitamin supplement that included Rumensin® (270 mg monensin/head/day; Elanco Animal Health) and Tylan® (90 mg tylosin/head/day; Elanco Animal Health). This supplement replaced the one fed previously during the initial days of the acclimation period.

Feed bunks were emptied before the initial feeding during the study on Day 0. The amount of feed delivered to each pen was adjusted and recorded daily based on the total consumed the previous day. The feed remaining in each pen was weighed back weekly during the first 56 days and every 2 weeks thereafter. Spoiled feed was weighed and removed from feed bunks as necessary. The amount of feed offered, estimated amounts remaining daily, and weigh backs were recorded.

Water was available in all pens at all times, except on the mornings cattle were weighed, when the water was shut off at approximately 7am. Water was turned back on for each half of the facility after all cattle on that side had been weighed and returned to their pens.

Allocation and Treatments

The two primary treatment groups (n = 64) were given a Revalor®-S growth-promoting implant only (120 mg trenbolone acetate and 24 mg estradiol; Hoechst-Roussel Agri-Vet Company) or a Revalor®-S implant plus CCFA-SS at 6.6 mg ceftiofur equivalents (CE)/kg (200 mg CE/ml formulation). Comparison of responses for these two groups answered the primary hypothesis of whether CCFA-SS affected the growth-promoting performance of the implant. A third treatment group (n = 63) (untreated control with no CCFA-SS and no implant) was included to verify that the growth-promoting implant performed as expected. Finally, a fourth group of 16 steers received only CCFA-SS and was added to fill the two "end" pens and to provide additional experience with the new route of administration; however, data from this group were excluded from statistical analyses.

On Day -3, the posterior aspect of the ear selected for treatment was shaved to facilitate treatments and observations of the treatment sites that would be made throughout the study. The original 208 cattle were ranked from heaviest to lightest and were sequentially blocked into eight groups of 26 cattle each. Two cattle were randomly selected from each weight group thus formed and were randomly allocated to the two end pens and were treated with CCFA-SS only on Day 0. The remaining 192 cattle were reranked and sequentially stratified into eight blocks of 24 cattle each. Cattle within each of these blocks were randomly assigned to a location within the barn and then randomly assigned to a pen within that location until all pens were filled with eight cattle each. The following treatments were then randomly allocated to pens within each pen block: growth-promoting implant alone, CCFA-SS plus implant, and untreated control. Four of the eight pens assigned to treatment with CCFA-SS plus an implant were randomly designated to CCFA-SS treatment first; the other four pens received the implant first.

On Day 0, growth-promoting implants were administered to cattle of the two designated groups in the middle third of the posterior aspect of the ear below the midline. The appropriate implant gun was used according to the manufacturer's instructions. The needle of the implant gun was cleaned using a roller sponge tray and placed in a disinfecting solution between uses.

CCFA-SS was also administered on Day 0 to the assigned animals using a 16-gauge (2.5-cm) sterile needle attached to syringe with an eccentric hub. The ear was folded approximately in half lengthwise, and with the bevel of the needle facing away from the skin, the needle was inserted SC above the midline of the ear, approximately in the middle third of the ear. After the dose of CCFA-SS was injected, the administrator's thumb was placed over the needle and the needle withdrawn while pressure was applied to the injection site.

On Day 56, all cattle received an Implus-S® implant (200 mg progesterone and 20 mg estradiol benzoate; Pharmacia & Upjohn Animal Health) regardless of the treatment administered on Day 0. The implant was administered SC in the middle third of the posterior aspect of the ear according to the manufacturer's instructions. If the animals had received CCFA-SS and an implant on Day 0, the new implant was administered between the CCFA-SS injection site and the previous implant. If only CCFA-SS had been administered on Day 0, the Implus-S® implant was administered as close as possible to the original injection site.

Evaluations

Cattle were individually weighed on Days -3, 0, 28, 56, 84, 112, and 140. The accuracy of the scale was verified before use on each weighing day. A composite sample of the total mixed ration was obtained for proximate analysis during each 28-day period throughout the study. The results from these analyses were used to calculate dry matter intake for each 28-day period. The accuracy of the feed mixer scales was verified daily during Days 0 to 56 and monthly during Days 56 to 140. The accuracy of the scale used to weigh back feed was verified weekly during Days 0 to 56 and monthly during Days 56 to 140. Average daily gain and FE were analyzed over 28-day periods (Days 0 to 28, 28 to 56, 56 to 84, 84 to 112, and 112 to 140) at cumulative intervals of Days 0 to 56 and Days 56 to 140, and for the entire study (Days 0 to 140).

Attitude, ear carriage, and swelling were observed daily on Days 0 to 14 by an observer who remained blinded to the treatment assignments. The following scoring system was used to represent the observed attitude of each animal: 0 = normal; 1 = mildly depressed; 2 = moderately depressed; 3 = severely depressed. Ear carriage was rated as follows: 0 = normal, 1 = abnormal. Swelling of the ear was scored as follows: 0 = normal; 1 = slight thickening of the top posterior ear margin; 2 = moderate thickening of the top posterior ear margin; 3 = slight swelling of the top posterior ear margin, but not extending over the normal margin of the ear; 4 = swelling of the top posterior ear margin, extending over the ear margin; 5 = larger swelling extending over the posterior ear margin and involving greater than one half of the pinna as measured from base to tip; 6 = more extensive swelling. For pens with animals whose injection-site swelling did not return to normal by Day 14, evaluations continued twice weekly through Day 52.

The treated ear of each animal was palpated for swelling on Days 28 and 56. Observations were recorded, and any fluid volume present was assessed. Animal care personnel also observed cattle daily for signs of irritation at or near the treatment site. Ease of implanting was recorded on Day 56 (0 = normally implanted; 1 = could initially disrupt the rhythm of an experienced implanter; 2 = could significantly slow implantation).

Statistical Analysis

For the purpose of analysis, pens were the experimental units and were analyzed as a randomized block design, with blocks considered a random effect.[11] For each analysis, least squares means for ADG and FE were calculated and evaluated by one-way analysis of variance. Treatment comparisons (the group treated with an implant only and the group treated with a CCFA-SS plus implant versus the control group) were made using a two-tailed *t*-test. Differences were declared significant when $P \leq .05$. In addition, ADG and FE for the implant-only group were compared with those for the group treated with CCFA-SS plus an implant using a one-tailed Student's *t*-test with a = .10. The group that received CCFA-SS only was not compared statistically with any other group because the allocation scheme for this group differed from that used for the other groups and performance of this group was observed but was not intended for comparison. The homogeneity for the time for ear-swelling scores to be 1 or less was evaluated for all groups by the Wilcoxon rank-sum test. Other data for the ancillary variables (attitude, ear carriage, swelling) were summarized but not analyzed statistically. Scores for ease of implanting on Day 56 were compared between the subgroups formed (either CCFA-SS or the implant administered first) within the group initially given an implant plus CCFA-SS by Student's *t*-test. Differences were declared significant when $P \leq .05$.

Results

Two steers were removed during the study. One animal in the control group sustained a spinal fracture in the chute on Day 0; this animal was euthanized and was not replaced in the study. The second animal was removed on Day 130 when the animal appeared ataxic. Necropsy examination of this animal revealed the presence of malignant lymphoma. For several time intervals (Days 0 to 28, 28 to 56, 0 to 56, and 0 to 140) the groups that received implant alone or CCFA-SS plus the growth-promoting implant had significantly ($P < .05$) better rate of gain than did controls during the same period (**TABLE 1**).

TABLE 1. Average Daily Gain for Feedlot Steers Given a Growth-Promoting Implant or Treated Concurrently with an Implant and Ceftiofur Crystalline-Free Acid Sterile Suspension (CCFA-SS) Subcutaneously in the Posterior Aspect of the Ear

	*Average Daily Gain (kg/day)**			
Time Interval (days)	*Implant Only (n = 64)*	*CCFA-SS + Implant (n = 64)*	*Control† (n = 63)*	*CCFA-SS Only‡ (n = 16)*
0–28	1.51[b]	1.55[b]	1.18[a]	1.30
28–56	1.68[b]	1.66[b]	1.40[a]	1.45
56–84	1.50[a]	1.54[a]	1.54[a]	1.69
84–112	1.54[a]	1.51[a]	1.67[a]	1.47
112–140	1.75[a]	1.77[a]	1.71[a]	1.59
0–56	1.60[b]	1.60[b]	1.29[a]	1.38
56–140	1.60[a]	1.61[a]	1.64[a]	1.58
0–140	1.60[b]	1.61[b]	1.50[a]	1.50

*Means within a time interval with different superscript letters are significantly different (implant only or CCFA-SS plus implant versus control $P < .05$; implant only versus CCFA-SS plus implant $P < .10$).
†One animal was euthanized on the day of treatment.
‡Data from this group were not included in analysis.

Rate of gain for cattle receiving an implant alone and those given an implant plus CCFA-SS was similar during all trial intervals.

Feed efficiency was significantly ($P < .05$) better Days 0 to 28, 0 to 56, and 0 to 140 for cattle that received an implant or CCFA-SS plus implant than for controls (**TABLE 2**).

TABLE 2. Feed Efficiency for Feedlot Steers Given a Growth-Promoting Implant or Treated Concurrently with an Implant and Ceftiofur Crystalline-Free Acid Sterile Suspension (CCFA-SS) Subcutaneously in the Posterior Aspect of the Ear

	*Feed Efficiency (kg gain/day dry matter fed)**			
Time Interval (days)	*Implant Only (n = 64)*	*CCFA-SS + Implant (n = 64)*	*Control† (n = 63)*	*CCFA-SS Only‡ (n = 16)*
0–28	0.263[b]	0.267[b]	0.206[a]	0.219
28–56	0.223[b]	0.224[b]	0.200[a]	0.204
56–84	0.182[b]	0.184[b]	0.197[a]	0.211
84–112	0.170[ab]	0.166[b]	0.188[a]	0.169
112–140	0.177[a]	0.179[a]	0.177[a]	0.172
0–56	0.241[b]	0.243[b]	0.203[a]	0.211
56–140	0.176[b]	0.176[b]	0.187[a]	0.183
0–140	0.197[ab]	0.198[b]	0.192[a]	0.193

*Means within a time interval with different superscript letters are significantly different (implant only or CCFA-SS plus implant versus control $P < .05$; implant only versus CCFA-SS plus implant $P < .10$).
†One animal was euthanized on the day of treatment.
‡Data from this group were not included in analysis.

Untreated controls appeared to experience compensatory weight gains Days 56 to 84 and Days 56 to 140, and therefore demonstrated significantly ($P < .05$) better FE than did cattle that received an implant or CCFA-SS plus implant during those periods. Feed efficiency was similar for cattle given an implant only and those given an implant plus CCFA-SS at all time intervals evaluated.

A summary of the visual ear observations is presented in **FIGURE 1**, showing the percentage of animals in each group that had ear-swelling scores greater than 1 between Days 0 and 52.

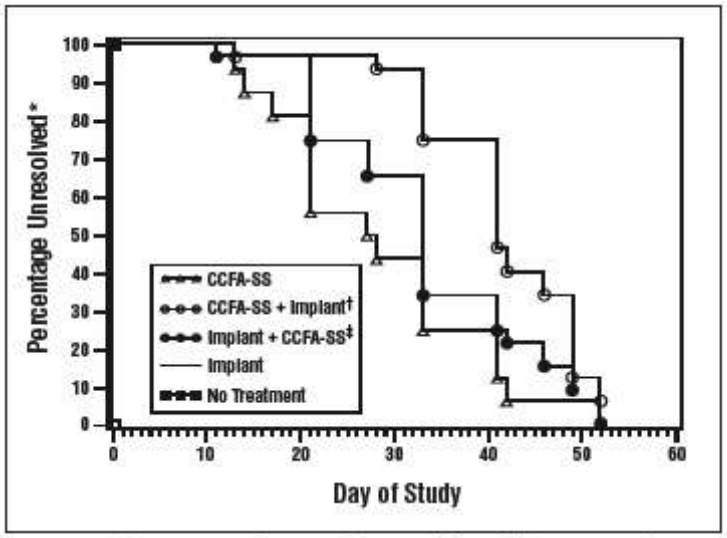

Figure 1. *Time to resolution of ear swelling following application of growth-promoting implant with and without concurrent administration of ceftiofur crystalline-free acid sterile suspension (CCFA-SS) in the middle third of the posterior aspect of the ear in feedlot steers.*
Ear swelling was scored as follows: 0 = normal; 1 = slight thickening of the top posterior ear margin; 2 = moderate thickening of the top posterior ear margin; 3 = slight swelling of the top posterior ear margin, but not extending over the normal margin of the ear; 4 = swelling of the top posterior ear margin, extending over the ear margin; 5 = larger swelling extending over the posterior ear margin and involving greater than one half of the pinna as measured from base to tip; 6 = more extensive swelling.
**Percentage of animals with ear swelling score greater than 1.*
†CCFA-SS administered first, then implant.
‡Implant administered first, then CCFA-SS.

For this plot, the data for the CCFA-SS plus implant group is subdivided based on the sequence of administration of the implant and CCFA-SS. All cattle in the control group and those treated with the implant only had ear-swelling scores of 1 or less throughout the study. There were only two animals in the CCFA-SS plus implant group that had scores greater than 1 on Day 52; all other cattle in that group had scores of 0 or 1 on that day. Cattle that were implanted before they were treated with CCFA-SS attained a score of 1 or less in significantly (P = .001) fewer days (33.8) than those that were given CCFA-SS before implanting (41.8).

Two animals received a score of 1 for attitude on one day (one on Day 1 from the group given an implant only and one on Day 46 from the group given an implant plus CCFA-SS) during the study, and one animal from the group treated with an implant plus CCFA-SS had a droopy ear on Day 10. The scores for these animals were normal at the next observation. No animals were observed rubbing their ears on the gates or feed bunks, providing further support for the tolerance of the middle third of the posterior aspect of the ear as an acceptable site for administering CCFA-SS.

Ear palpation observations on Days 28 and 56, and implant scores for Day 56 are summarized in **TABLE 3**.

TABLE 3. Ear Palpation Scores and Ease of Administering New Implant on Day 56 for Feedlot Steers Given a Growth-Promoting Implant or Treated Concurrently with an Implant and Ceftiofur Crystalline-Free Acid Sterile Suspension (CCFA-SS) Subcutaneously in the Posterior Aspect of the Ear

Ear Palpation Observation	*Implant Only*	*CCFA-SS + Implant*	*Control**	*CCFA-SS Only*
Palpably normal ears by Day 28†	100% (64/64)	56% (36/64)	100% (63/63)	69% (11/16)
Palpably normal ears by Day 56†	100% (64/64)	84% (54/64)	100% (63/63)	88% (14/16)
Visually normal ears by Day 52‡	100% (64/64)	97% (62/64)	100% (63/63)	100% (16/16)
Required extreme force to implant on Day 56	0% (0/64)	7.8% (5/64)	0% (0/63)	0% (0/16)

*One animal in this group was euthanized on the day of treatment after sustaining an injury in the chute.
†No swelling or may exhibit a knot (with no fluid) present by palpation.
‡No or slight thickening of the top posterior ear margin by visual observation.

Palpable swellings (> 1 ml of fluid) observed on Day 56 were associated with moderate-to-extensive swelling previously noted and scored accordingly on Day 52. As determined by both methods of evaluation, ear swelling continued to decrease through Day 56 in cattle that had received CCFA-SS on Day 0. Ear palpations on Day 28 revealed that seven cattle that received an implant only had a bunched implant; one implant was in the cartilage; and one had been lost. In the group given an implant plus CCFA-SS, one implant was bunched, one was lost, and one was situated in an area of swelling. On Day 56, all implants in the implant-only group were normal; two cattle given an implant plus the CCFA-SS had lost their implants and one implant was walled off.

Evaluation of the ease of implanting on Day 56 revealed that one control steer and one in the implant-only group required extra force for implantation (score = 1). The remaining animals in the control and implant-only groups implanted normally and easily (score = 0). In the subgroup given an implant after administration of CCFA-SS (n = 32), 11 cattle were scored 1, three were scored 2 (extreme force required), and the remaining animals were scored 0. In the subgroup given the implant before administration of CCFA-SS (n = 32), 10 cattle were scored 1, two were scored 2, and the others were scored 0. The order of treatment administration on Day 0 did not appear to affect the ease of implantation on Day 56 (P = .559). Results of this procedure indicated that scores of 1 could initially disrupt the rhythm of an experienced implanter, while scores of 2 could significantly slow implantation. In the group given CCFA-SS only (n = 16), four animals had a score of 1 and the other cattle were scored 0 for ease of implanting on Day 56.

Discussion

Cattle used in this study were from the northern part of the United States. Based on the average weight and condition of the cattle when they arrived (November), they were most likely spring-born calves. The overall rate of gain per group throughout the study averaged 1.50 to 1.61 kg/day

and rate of gain was not adversely impacted by administration of CCFA-SS by SC injection in the same ear as a growth-promoting implant (1.61 kg/day) compared with rate of gain for cattle that received only implants (1.60 kg/day).

In addition to demonstrating that feedlot performance was not adversely affected by administration of CCFA-SS by SC injection in the middle third of the posterior aspect of the ear, this study demonstrated the local tolerance of cattle to administration of CCFA-SS, even when administered concurrently in the same ear as a growth-promoting implant. Local tolerance was evaluated by palpation and visual observation of the shaved ear on Days 28 and 56. Visual observations of the ears revealed swelling in the posterior margin of the injected ear in many of the cattle treated with CCFA-SS. Although visible swelling persisted in some of these affected cattle through Day 52, there were no signs that the animals were attempting to rub their ears or that any swelling adversely affected the animals. Additionally, there was no evidence of extensive tissue damage caused by administering CCFA-SS SC in the middle third of the posterior aspect of the ear. There was some evidence that administering CCFA-SS in the same ear did impact future implant placement at the same site on Day 56 in some cattle. In the present study, the implant on Day 56 was purposely placed as close as possible to the previous CCFA-SS injection site, thus creating the greatest potential for a problem to occur. Ease of future implant administration would likely be improved if the site were slightly adjusted.

The majority of the injection-site swelling would most likely have been hidden by hair cover if the ears had not been shaved. In a later multi-location field study, CCFA-SS was administered SC in the unshaved posterior aspect of the ear at 4.4 or 6.6 mg CE/kg body weight during arrival processing.[7] In that study, differences were seen in the number of site reactions palpated on Day 29. As with the present study, swelling did not adversely affect the cattle.

One factor that may influence the rate of resolution of the swelling of the injected material is the sequence of administration for CCFA-SS and the growth-promoting implant. In this study, ears of cattle that received CCFA-SS first appeared to take longer to resolve (i.e., to achieve a score of 1 or less) compared with those that received the implant first. The reason for this difference is not clear, and there was no apparent effect of treatment sequence regarding ease of administering a new implant on Day 56.

This study demonstrated that administering CCFA-SS SC in the middle third of the posterior aspect of the ear is an effective and readily implemented technique that can be used concurrently with growth-promoting implants. In addition, since the ear is considered inedible tissue in the United States[12] and is removed from the edible tissues at slaughter, there is no injection-site trimming, and a short meat withdrawal time applies.

It should be noted that the appearance of a 2 x 2 factorial design in this study was incidental. To achieve a 2 x 2 factorial design would have necessitated allocating additional animals from the available herd to treatment with CCFA-SS only and modification of the pen allocation scheme for distribution of this group in a manner similar to the other treatment groups. These changes would have reduced the number of animals for the primary comparison and thus lowered the power of the study.

Conclusions

Feedlot performance, as measured by ADG and FE, was not affected by concurrent administration of CCFA-SS (200 mg CE/ml) at 6.6 mg CE/kg SC in the middle third of the posterior aspect of the ear and an approved growth-promoting steroid implant. These results indicate there was no interference from the CCFA-SS with implant performance. Administration of CCFA-SS in the middle third of the posterior aspect of the ear, with or without a growth-promoting implant, was well tolerated in cattle.

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