Final Report

Effects of SarStart DSC on performance and carcass characteristics of finishing beef steers

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Experimental Procedures

Cattle. One hundred thirty (130) steers of Angus, Red Angus, and Angus and Red Angus x Hereford breeding from one ranch near Ogallala, NE, were received at the Texas Tech University (TTU) Burnett Center at approximately 1900 on May 20, 1999. Steers were unloaded, sorted randomly to four dirt-floor pens (32 or 33 steers per pen) at the Burnett Center, and offered 12 lb per steer of a 60% concentrate diet. On the following morning (May 21, 1999), all cattle were processed beginning at approximately 0800. Processing included placement of an ear tag in each steer's left ear, vaccination with Bovishield 4 + Lepto (Pfizer Animal Health; Serial No. 163791080 – Exp. April 12, 2000), vaccination with Fortress 7 (Pfizer Animal Health; Serial No. 169935280 – Exp. August 1, 2000), treatment down the back line with Dectomax Pour-On (Pfizer Animal Health; Lot No. T81900 – Exp. July, 2000), and individual body weight (BW) measurement. Processing was completed at approximately 1030, and steers were returned to the same pens to which they had been sorted off the truck the evening before.

Treatment and Pen Assignment. Following processing, steer ear tag number, coat color, and processing BW were input to a Microsoft Excel® spreadsheet, and processing BW was ranked from least to greatest. The two lightest steers were designated as Extra cattle, as were the eight heaviest steers. Of the remaining 120 steers, the range in BW was from 704 to 909 lb. Because of this relatively large spread in BW, and relatively uniform distribution of BW across the range, it was decided to arbitrarily split the cattle into Light and Heavy weight blocks. Hence, the 60 steers of lightest BW were designated as the Light block, and the 60 steers of heaviest BW were designated as the Heavy block. Thirty sets of random numbers from 1 to 4 were obtained from a random number table. Within the Light block, 15 sets of random numbers were assigned to the 60 steers, beginning with the four cattle of lightest BW with the 1st set of four random numbers and proceeding to the four cattle of heaviest BW with the 15th set of random numbers. This process was repeated with the 60 steers assigned to the Heavy block. Treatments (two grain processing methods with or without the addition of SarStart DSC – described in a subsequent section) were assigned randomly to the numbers 1 through 4. The resulting assignment was DR0 = 1; SF0 = 2; SF+ = 3; and DR+ = 4. Three sets of random numbers from 1 to 4 were selected and paired with 12 randomly selected numbers that represented Pens 43 to 54 for the Light block. The resulting pen assignments for the four treatments were as follows: DR0 = Pens 45, 50, and 51; DR+ = 43, 46, and 54; SF0 = 47, 49, and 52; and SF+ = 44, 48, and 53. Using the same procedure, pen assignments for the Heavy block were as follows: DR0 = Pens 59, 60, and 66; DR+ = 56, 57, and 61; SF0 = 58, 62, and 63; and SF+ = 55, 64, and 65. Using five sets of random number 1 to 3, steers were assigned to the three pens per treatment within a block, beginning with the three steers of lightest BW and proceeding to the three steers of heaviest BW.

On May 25, 1999, all cattle were sorted to treatment groups (30 steers per treatment) and returned to the dirt-floor pens, with each dirt-floor pen representing all the cattle assigned to a given treatment. The experiment was started on May 27, 1999, when all cattle selected for the experiment were weighed and implanted, after which they were sorted to their assigned concrete, partially slotted floor pens in the Burnett Center. Ear tag numbers were confirmed after sorting to ensure that pen assignments were correct. Light block steers were implanted with Ralgro (Schering Plough Animal Health; Lot No. 7F49 – Exp. June, 2002), and Heavy block steers were implanted with Revalor S (Hoechst Roussel Vet; Lot No. 264 – Exp. December, 2000).

All cattle were switched from the 60% concentrate receiving diet to their assigned 70% concentrate diet at a feeding rate of 17 lb per steer.

Experimental Design. Four dietary treatments, arranged in a 2 x 2 factorial, were used in a randomized block design with replicated pens within blocks. Pen was the experimental unit (six pens per treatment with five steers per pen for a total of 120 steers). The four treatments were as follows:

- **DR0** – diet based on dry-rolled corn without SarStart DSC;

- **DR+** – diet based on dry-rolled corn with 55.6 mg/kg (dry matter [DM] basis) of added SarStart DSC;

- **SF0** – diet based on steam-flaked corn without SarStart DSC

- **SF+** – diet based on steam-flaked corn with 55.6 mg/kg (DM basis) of added SarStart DSC.

The SarStart DSC was added to the diet by means of a premix. The premix comprised .5% of the dietary DM and was a mixture (DM basis) of 1.112% SarStart DSC and 98.888% ground milo. For diets without SarStart DSC, the premix (.5% of the dietary DM) was 100% ground milo.

Experimental Diets. Ingredient composition of the diets fed during the experiment is shown in Table 1. These data reflect adjustments for the average DM matter content of feed ingredients for the period during which a given diet was fed. Each diet contained the same intermediate premix (Table 2), which supplied protein, various minerals and vitamins, Rumensin (30 g/ton, DM basis), and Tylan (8 g/ton, DM basis).

Management, Feeding, and Weighing Procedures. Standard procedures at the Burnett Center (provided in a Microsoft Word® document included on disk with this report) were used throughout the experiment. The four treatment diets were mixed in a 45-cubic foot capacity Marion paddle mixer. The Burnett Center feed milling system is operated by a computer-controlled WEM batching system (see Appendix B - General Description of the Facilities at the Texas Tech University Burnett Center). A printout of the weight of each dietary ingredient was recorded on a daily ingredient usage output from the computerized batching system. Once the total amount of feed for a given treatment was mixed, the mixed batch was released from the Marion paddle mixer and delivered by a drag-chain conveyer to a Rotomix 84-8 delivery system. The amount of feed allotted to each pen within treatment was then weighed to the nearest 2 lb by use of the load cells and indicator on the Rotomix 84-8 unit. Mixing and feeding order of treatment diets throughout the experiment was DR0, SF0, DR+, and SF+. Clean-out of the Rotomix 84-8 was monitored closely to avoid cross-contamination of diets.

Dry matter determinations on ingredients used in the experimental diets were made every 2 wk throughout the experiment. These ingredient DM values were used to calculate the DM percentage of each dietary ingredient during the experiment. In addition, samples of mixed feed delivered to feed bunks were taken weekly throughout the experiment. These bunk sample DM values were used to compute average DM intake (DMI) by the cattle in each pen. Samples of feed taken from the bunk were composited for each 28-d (or 26-d) period of the experiment. Composited samples were ground to pass a 2-mm screen in a Wiley mill and analyzed for DM, ash, CP, ADF, Ca, and P (AOAC, 1990; Appendix Table 1).

Each feed bunk of the 24 pens was evaluated visually at approximately 0700 to 0730 daily. The quantity of feed remaining in each bunk was estimated, and the suggested daily allotment of feed for each pen was recorded. This bunk-reading process was designed to allow for little or no accumulation of unconsumed feed (0 to 1 lb per pen). A computer printout of the intake by each pen for the previous 3-d period was available each morning to assist with bunk reading. Pens of cattle that maintained a given level of feed intake for a 3-d period were challenged to consume a higher level (.4 lb/steer challenge). Each challenge level was maintained for a 3-d period when the pen accepted the challenge and consumed all the feed offered. The ultimate goal of the challenge process was to ensure that the cattle were consuming the maximum quantity of feed possible. Feed bunks were cleaned, and unconsumed feed was weighed (Ohaus electronic scale, ± .1 lb) at 28-d intervals (corresponding to intermediate weigh dates) throughout the trial. Dry matter content of these bunk weighback samples was determined in a forced-air oven by drying overnight (typically 20 h) at 100^{o}C. All weights for DM determinations were obtained on an Ohaus electronic balance (± .1 g). Bunk weighbacks and DM determinations were used to calculate DMI by each pen.

After 28, 56, and 84 d on feed, steers in all pens were weighed before the morning feeding. All BW measurements taken during the experiment were obtained using a single-animal scale (C & S Single-Animal Squeeze Chute set on four load cells – see Standard Operating Procedures for Burnett Center). The scale was calibrated with 1,000 lb of certified weights (Texas Dept. of Agriculture) on the day before each scheduled weigh day. These BW measurements were taken to assess performance of the cattle on a regular basis. On d 56, at the time of a regularly scheduled BW measurement, each steer in the Light block was implanted with Revalor S (Hoechst Roussel Vet; Lot No. 272). After the 84-d BW measurement, it was estimated that the Heavy block steers would have sufficient finish to grade USDA Choice within 3 to 4 wk. Hence, all steers were weighed at approximately 0500 on September 16, 1999 (d 112), and Heavy block steers were shipped to the Excel Corp. slaughter facility in Plainview, TX. Light block steers remained on feed for an additional 26 d, and on October 12, 1999 (d 138) the Light block steers were weighed at approximately 0600 and shipped to the Excel Corp. slaughter facility in Plainview, TX. Of the original 120 steers that started the experiment, three steers had died or had been removed from the experiment for reasons unrelated to treatment (see details in a subsequent section), resulting in a total of 117 steers (57 Heavy block and 60 Light block steers) being sent to the Excel Corp. facility.

A summary of weather data for the experimental period is in Appendix A. This summary was obtained from the USDA-ARS weather station located approximately 6 miles southwest of the Burnett Center.

Animal Health, Significant Trial Events, and Deviations from Routine Procedures. Sickness of experimental animals, any deviations from routine procedures, and other significant events that occurred during the experiment are detailed in the following sections by date of occurrence.

5/27/99 – All cattle were fed with the Burnett Center belt feeding system because the Rotomix 84-8 unit was out of service for repairs. Feeding would be changed to the Rotomix 84-8 unit after the unit has been repaired.

5/28/99 – As he was walking through the pens at approximately 1100, PI Galyean detected Steer No. 73 (Pen 56) down in the pen. The steer was severely dehydrated and most likely was suffering from acute acidosis. Burnett Center personnel administered 35 mL of LA-200 as a precaution against infection, 240 mL of .9% physiological saline i.v., and 120 mL of .9% physiological saline s.c. Approximately 2 gallons of water with a handful of limestone mixed with it were drenched into the rumen. Burnett Center personnel pulled the steer into the alley for continued evaluation. PI Galyean remained in contact with Burnett Center personnel regarding the status of this steer.

5/28/99 – Burnett Center personnel called PI Galyean to inform him that Steer No. 73 (Pen 56) had died. Burnett Center personnel conducted a post-mortem examination of ruminal contents. The ruminal pH was not indicative of acidosis, (6.8), so a veterinarian was called for a post-mortem examination (findings of the post-mortem examination were inconclusive). PI Galyean requested that Burnett Center personnel move Steer No. 44 (Extra – 721 lb on 5/27/99) into Pen 56 to replace Steer No. 73. This steer had a lighter BW than Steer No. 73, but because he was classified as an Extra steer, he had been implanted with Revalor S and made the most logical replacement. Replacement seemed the correct step to take because the trial was only in its second day. Data files were altered to reflect the replacement.

5/31/99 – Burnett Center personnel pulled Steer No. 71 (Pen 63) for treatment of foot rot. The steer was given 30 mL of LA-200 and 20 mL of Pen G, the foot was washed with disinfectant, and the steer was returned to Pen 63. The steer will be retreated in 2 d.

6/2/99 – All cattle were switched to the 80% concentrate diet. Feed was offered at a rate of 93% of the delivery for the previous day.

6/2/99 – Steer No. 71 (Pen 63) was pulled for a second treatment of the foot injury (foot rot) initially treated on 5/31/99. After treatment with LA-200 and Pen G (same amounts as on 5/31/99), this steer was placed in a separate pen for recovery. Steer No. 71 was fed out of the feed delivered to Pen 63 and would be returned to the pen as soon as he recovered sufficiently. Steer No. 97 (Pen 63) also was pulled and treated for sore front feet (35 mL of LA-200 and 20 mL of Pen G). Steer No. 97 was returned to Pen 63 after treatment.

6/3/99 – PI Galyean examined all pens of cattle with Ricardo Rocha, Burnett Center Technician. After evaluating the cattle, it was decided to move Steer No. 97 (Pen 63) to a separate pen where he would be housed with Steer No. 71 until both steers recovered sufficiently from sore foot problems to be returned to Pen 63. Feed was removed from the feed delivered to Pen 63 so that both these steers would remain on trial.

6/8/99 – Burnett Center personnel returned Steer No. 97 to Pen 63. Steer No. 71 was kept in the sick pen until complete recovery from foot problems. Steer No. 71 was eating well and should be capable of returning to Pen 63 in a few days.

6/8/99 – All cattle were switched to the 90% concentrate diet. Feed was offered at a rate of 93% of the delivery on the previous day.

6/10/99 – All cattle were fed by the Rotomix 84-8 delivery system. This system was used instead of the belt feeding system from this point of the experiment on. Steer No. 71 (Pen 63) received 34 mL of Tylan 200 and had his foot washed with Betadine solution. Koppertox was placed on the infected area of the hoof. This steer was eating well and showed a slight weight gain. He should ultimately be able to return to Pen 63; however, it might be necessary to delete his BW data from the first 28 d of the experiment.

6/14/99 – Steer No. 71 (Pen 63) was treated with 22.5 mL of Nuflor, 10 cc of Predef 2X and his foot was washed with Betadine solution and hydrogen peroxide. The affected area of the foot was treated with nitrofurazone paste, and the foot was taped. This steer was eating well and had gained some weight. The steer continued to be fed out of the feed delivered to Pen 63 until he was able to return to Pen 63.

6/15/99 – Steer No. 71 (Pen 63) was treated with 4 Albon SR (12.5 g) boluses and his foot was washed. Nitrofurazone was applied to the hoof area. The steer continued to eat well, but will be treated again with Nuflor.

6/17/99 – After discussion of the condition of the foot of Steer No. 71 (Pen 63) with Burnett Center personnel, PI Galyean decided that this steer would not be able to return to Pen 63 by the next scheduled weigh day (June 24, 1999). Hence, PI Galyean made the decision to remove this steer from the experiment. Burnett Center personnel adjusted the feed intake records to reflect that the steer was removed from the experiment on 6/17/99, and PI Galyean adjusted all other records to reflect removal of this steer from the experiment.

6/23/99 – The Rotomix 84-8 scale was calibrated with 1,000 lb of certified test weights.

7/17/99 – Burnett Center personnel pulled Steer No. 89 (Pen 46) and treated him with 30 mL of LA-200, 10 mL of Pen G, and 3 Albon SR boluses. The steer had swollen rear legs. Steer No. 89 was placed in a dirt-floor pen adjacent to the Burnett Center pens and was fed from feed delivered to Pen 46 until he was able to return to Pen 46. He was scheduled to be evaluated and treated again if necessary on 7/19/99.

7/19/99 – Steer No. 89 (Pen 46) was treated as on 7/17/99 and returned to Pen 46.

7/22/99 – All steers were weighed for 56-d weigh day. Light block were steers implanted with Revalor S (Lot No. 272; Exp. March, 2001).

7/24/99 – PI Galyean evaluated the data for the 56-d BW measurements. Data for Steer No. 44 (Pen 56) indicated that the steer had maintained weight for the period of d 29 to 56. Therefore, PI Galyean instructed Burnett Center personnel to observe Steer No. 44 to determine whether some type of health problem might exist. The steer was pulled from Pen 44, and examination revealed that he suffered from some type of wound or abscess on the left rear leg. The steer was treated with 36 mL of LA-200, 20 mL of Pen G, 3 mL of Predef 2X, and the wound was drained and washed with betadine and hydrogen peroxide. Steer No. 44 was then housed in a small dirt pen adjacent to the Burnett Center pens, where he was fed from the feed delivered to Pen 56 and observed for approximately 2 d before being returned to Pen 56. As a result of this finding, PI Galyean deleted the 56-d BW data for Steer No. 44 from the statistical analysis of the study results.

7/26/99 – Burnett Center personnel informed PI Galyean on 7/25/99 that Steer No. 106 (Pen 59) was found down in the pen on the afternoon of 7/24/99. The steer seemed to have suffered a severe injury to his rear legs and was unable to move his rear legs. The steer was removed from the pen on 7/25/99 and placed in a hospital pen. After discussing the condition of this steer with Burnett Center personnel, PI Galyean instructed Burnett Center personnel to remove this steer from the experiment and to adjust the head count in Pen 59 to four steers as of 7/24/99.

7/26/99 – Steer No. 44 (Pen 56) was treated with 3 mL of Predef 2X and 36 mL of LA-200 and returned to Pen 56.

7/28/99 – Steer No. 106 died. No post-mortem exam was conducted because this steer had already been removed from the study, and the injury was obviously physical in nature and not related to experimental treatments.

8/19/99 – All steers were weighed for the regularly scheduled 84-d weigh day. PI Galyean was not present for the weigh day, but inspected the BW data after returning to the office at approximately 1815. Steer No. 44 in Pen 56 had essentially maintained BW during the period of d 57 to 84. This steer had previously been removed from the pen on d 56 and evaluated in a separate pen for approximately 3 d to ensure that he was eating at the pen average. Based on feed consumption at the appropriate level, Steer No. 44 was returned to Pen 56. After reviewing the 84-d BW data, however, PI Galyean decided that this steer should be removed from the experiment. The BW data for Steer No. 44 was removed from the analysis of BW gain data for the d 57 to 84 period, and feed intake was calculated assuming that Steer No. 44 ate the average intake of the pen.

8/20/99 – PI Galyean telephoned Burnett Center Manager Kirk Robinson and requested that Steer No. 44 be removed from the study immediately. The steer was removed before feed was offered for the day, and the feed intake file was adjusted to reflect the decrease of one animal in Pen 56. Steer No. 44 was housed with a group of extra cattle.

8/23/99 – Because of repairs to the Rotomix 84-8 unit, the cattle in all pens were fed with the Burnett Center belt-feeding system. Use of the belt-feeding system will continue until the Rotomix 84-8 unit is returned in approximately 1 wk.

8/29/99 – The Rotomix 84-8 unit was returned from repairs and used to feed all the cattle on the study as of 8/29/99.

9/16/99 – All cattle were weighed for 112-d weigh day. Heavy block cattle (57 steers) were shipped to the Excel plant in Plainview, TX. Heavy block cattle were shipped in two loads, with the first load leaving the Burnett Center at approximately 0810, and the second load leaving approximately 2 h later. The cattle entered the Excel plant approximately 10 min after the second load arrived at the plant.

9/17/99 – PI Galyean spoke with personnel of the Beef Carcass Research Center at West Texas A&M University. The collection of carcass data for the 57 Heavy block steers had gone smoothly, except that one steer (No. 98) had been railed off for a random *E. coli* swab test. The carcass from this steer was held for an extended period to await test results, which caused this steer to be graded at a different time than the remaining 56 steers. Hence, the carcass data for this steer were not collected. PI Galyean requested that the Beef Carcass Research Center personnel contact the Excel plant and request USDA yield and quality grade information on this carcass.

10/12/99 – All cattle in Light block weighed and shipped to Excel in Plainview, TX at approximately 0830.

No other significant animal health events or deviations from routine procedures were noted during the 138-d study period.

Carcass Evaluation. Personnel of the West Texas A&M University Beef Carcass Research Center obtained all carcass measurements. Measurements included hot carcass weight, longissimus muscle area, marbling score, percentage of kidney, pelvic, and heart (KPH) fat, fat thickness measured between the 12th and 13th ribs, yield grade, and liver abscess score. Liver abscess scores were recorded on a scale of 1 to 7, with 1 = no abscesses, 2 = A-, 3 = A, 4 = A+, 5 = telangiectasis, 6 = distoma (fluke damage), and 7 = fecal contamination that occurred at slaughter.

Because of the speed of processing in modern packing plants, it is not always possible to obtain complete carcass data for all the animals involved in a large-scale experiment. In the present experiment, of the 117 steers sent to the slaughter plant, data were obtained on 116 carcasses for hot carcass weight, yield grade, quality grade, and dressing percent, whereas data were obtained on 113 carcasses for longissiums muscle area, marbling score, KPH, and fat thickness.

Statistical Analyses. All data were analyzed with pen as the experimental unit. A randomized block was employed, and computations were made with the General Linear Models procedure of SAS (1987). Pen means for daily gain and average daily DMI were included in the data file, and feed:gain ratio was computed as the quotient of daily DMI divided by daily gain. The effect of grain processing method, SarStart DSC, grain processing method x SarStart DSC, block, and block x treatment interactions were included in the model for pen-based data. Carcass data were entered on an individual animal basis, and analyzed with a model that included effects of grain processing method, SarStart DSC, grain processing method x SarStart DSC, block, block x treatment interactions, and pen within block x treatment. Pen within block x treatment was specified as the error term for testing treatment effects. Residual mean square in this model for carcass data (not used for testing) would include individual animal variation. Carcass quality grade and liver abscess score data were analyzed by Chi-square procedures (SAS, 1987) using individual animal data.

Results and Discussion

Performance Data. Performance data for the experiment are shown in Table 3. No grain processing method x SarStart DSC or block x treatment interactions ($P > .05$) were noted, so main-effect means (DR vs SF and 0 vs + SarStart DSC) averaged over the two blocks are presented.

Initial BW did not differ ($P \geq .21$) among treatments, averaging 806.1 lb (Table 3). Final live BW was greater ($P < .03$) for cattle fed SF vs DR; however, final BW did not differ as a result of SarStart DSC addition to the diet. Steers fed the SF diet consistently gained faster than those fed the DR diet throughout the study, with an 8.2% increase ($P < .02$) for the overall feeding period for SF compared with DR. Addition of SarStart DSC to the diet resulted in a 3.4% non-significant increase ($P < .26$) daily gain for the overall feeding period.

Daily DMI was greater ($P < .01$) by cattle fed DR vs SF for each of the cumulative periods of the study (Table 3). For the overall feeding period, cattle fed DR consumed 7.5% more DM than those fed SF. Addition of SarStart DSC to the diet did not affect DMI during any of the cumulative periods or the overall trial ($P \geq .83$). Consumption of SarStart DSC averaged 494 mg/animal daily, compared with a target consumption of 500 mg/animal daily.

The increased DMI and lower daily gain by cattle fed DR resulted in a greater ($P < .01$) feed:gain ratio than for cattle fed SF for each of the cumulative periods of the study. For the overall feeding period, feed:gain ratio was improved by 14.3% for SF vs DR. Addition of SarStart DSC to the diet resulted in a numerical improvement in feed:gain ratio during each of the cumulative periods of the study; however, differences were not significant. For the overall feeding period, SarStart DSC tended ($P < .16$) to improve feed:gain ratio by 3.4%.

Zinn et al. (1998) applied either 43, 172, or 430 mg of SarTemp per kilogram of corn as a tempering agent (all levels of SarTemp were sprayed on to corn in 40 g of water per kilogram of corn) for rolled corn in beef cattle finishing and metabolism studies. The three levels of SarTemp-treated rolled corn were compared with dry-rolled and steam-flaked corn control diets. Tempering rolled corn with SarTemp increased daily gain 9% and improved feed:gain by 5% compared with untreated dry-rolled corn. It is difficult to compare the results of the present experiment with those of Zinn et al. (1998). In the present experiment, SarStart DSC was added to the diet as a dry premix rather than in liquid form as a tempering agent in the Zinn et al. (1998) study. Consumption of SarStart DSC averaged 494 mg/animal daily in the present study; the equivalent level of sarsaponin in the Zinn et al (1998) study was provided by the 172 mg of SarTemp/kg of corn treatment (C. McNeff, personal communication).

Dietary NEm and NEg concentrations were calculated (NRC, 1996) from performance data for the main effects of grain processing method and SarStart DSC. Calculated values for NEm of DR and SF were 2.05 and 2.27, respectively, whereas NEm values for the diet without SarStart DSC were 2.14 and 2.17 Mcal/kg of DM, respectively. Corresponding NEg values were 1.39

and 1.58 for DR vs SF and 1.47 and 1.50 Mcal/kg of DM for 0 vs + SarStart DSC, respectively. Values for NEm and NEg based on dietary ingredient composition (NRC, 1996) were 2.08 and 1.42 Mcal/kg of DM for DR diets and 2.15 and 1.47 Mcal/kg of DM for SF diets. The increase in NE values calculated from performance data for the SF diet would require tabular NEm and NEg values of 2.49 and 1.77 Mcal/kg of DM to achieve the performance-based results. Current values suggested by NRC (1996) for steam-flaked corn are 2.33 and 1.62 Mcal/kg of DM for NEm and NEg, respectively. Zinn (1987) suggested that, based on performance data, NEm and NEg values of steam-flaked corn should be 2.54 and 1.77 Mcal/kg of DM, respectively.

Carcass Data. Carcass data are shown in Table 4. As with performance data, no grain processing method x SarStart DSC interactions ($P > .10$) were noted. Hot carcass weight was greater ($P < .05$) in cattle fed SF vs DR corn, reflecting the greater daily gain by cattle fed SF corn. Fat thickness was greater ($P < .01$) in carcasses of cattle fed SF than in those fed DR, and yield graded tended ($P < .07$) to be greater for cattle fed SF corn. Marbling score tended ($P < .13$) to be slightly lower for the carcasses of cattle fed SF than for those fed DR corn. Percentage of carcasses grading USDA Choice was 30% greater with DR corn than with SF corn. Conversely, percentage of carcasses grading Select was 93.3% greater with SF corn than with DR corn. This distribution of quality grades tended to differ ($P < .06$) between grain processing methods. Reasons for this large increase in percentage of Choice carcasses with DR vs SF corn are not readily apparent. No other carcass characteristics were affected by grain processing method.

Addition of SarStart DSC to the diet did not affect any of the carcass measurements except dressing percent, which was lower ($P < .05$) in cattle fed the diet with SarStart DSC than in those fed the diet without SarStart DSC. Examination of the analysis of variance for dressing percent revealed that the Block x SarStart DSC term in the model was significant ($P < .01$), which resulted from cattle in the Heavy block fed a diet with added SarStart DSC having a much lower dressing percent (60.68) than Heavy-block cattle that were not fed SarStart DSC (62.15%), whereas dressing percent was similar with or without SarStart DSC (61.35 vs 61.07%) in cattle in the Light block. Because of the Block x SarStart DSC interaction for dressing percent, no attempt was made to calculate a carcass-adjusted final weight (hot carcass weight divided by dressing percent).

The distribution of USDA quality grades was not affected ($P \geq .58$) by the addition of SarStart DSC to the diet (Table 3). The percentage of carcasses that graded Choice was 66.67% for carcasses from cattle that did not receive SarStart DSC vs 69.49% for carcasses from cattle that were fed SarStart DSC.

Liver score data are shown in Table 5. The distribution of liver scores did not differ ($P \geq .55$) between grain processing methods or between diets with or without SarStart DSC. On average, 84.04% of the livers were not condemned, and contamination in the slaughter process was the most common reason for liver condemnation. Actual rates of liver abscesses (A- or A+ in Table 5) were relatively low, averaging 3.7 and 6.78% for DR and SF and 5.55 and 5.08% for diets with or without SarStart DSC, respectively.

Summary and Conclusions. Under the conditions of the present experiment, feeding steam-flaked corn-based diets to finishing beef steers resulted in substantial improvements in daily gain and feed:gain ratio compared with feeding dry-rolled corn-based diets. This finding is consistent with previous reports in the literature (e.g., Zinn, 1987). The effects of adding SarStart DSC did not interact with grain processing method. Averaged over grain processing method, addition of SarStart DSC to the diet increased daily gain by 3.4% ($P < .26$) and improved feed:gain by 3.4% ($P < .16$). Because only one level of SarStart DSC was used in this experiment (55.6 mg/kg of dietary DM), and the general trend in gain and feed:gain ratio with the addition of SarStart DSC was positive throughout the feeding period, additional research to evaluate the dose-response relationship for this product might prove beneficial.

Literature Cited

AOAC. 1990. Official Methods of Analysis (15th Ed.). Association of Official Analytical Chemists. Washington, DC.

NRC. 1996. Nutrient Requirements of Beef Cattle (7th Ed.). National Academy Press, Washington, DC.

SAS. 1987. SAS/STAT Guide for Personal Computers (Version 6 Ed.). SAS Inst. Inc., Cary, NC.

Zinn, R. A. 1987. Influence of lasalocid and monensin plus tylosin on comparative feeding value of steam-flaked versus dry-rolled corn in diets for feedlot cattle. J. Anim. Sci. 65:256-266.

Zinn, R. A., E. G. Alvarez, M. F. Montaño, A. Plascencia, and J. E. Ramirez. 1998. Influence of tempering on the feeding value of rolled corn in finishing diets for feedlot cattle. J. Anim. Sci. 76:2239-2246.

Table 1. Ingredient composition (%, DM basis) of the experimental diets[a]

	Percentage of dietary concentrate											
	70				80				90			
Ingredient	DR0	DR+	SF0	SF+	DR0	DR+	SF0	SF+	DR0	DR+	SF0	SF+
Cottonseed hulls	15.09	15.09	15.14	15.14	9.79	9.79	10.09	10.09	4.97	4.96	5.01	5.01
Ground alfalfa hay	15.27	15.27	15.32	15.32	9.84	9.84	10.14	10.14	4.92	4.92	4.97	4.97
Corn[b]	54.55	54.55	54.46	54.46	65.54	65.54	64.56	64.56	75.20	75.20	75.14	75.14
Cottonseed meal	3.99	3.99	3.98	3.98	3.94	3.94	3.98	3.98	3.85	3.85	3.91	3.91
Molasses	4.11	4.11	4.10	4.10	4.05	4.05	4.19	4.19	4.20	4.20	4.17	4.17
Fat (yellow grease)	3.06	3.06	3.06	3.06	2.98	2.98	3.09	3.09	3.00	3.00	2.92	2.92
Urea	.92	.92	.92	.92	.91	.91	.94	.94	.89	.89	.89	.89
Treatment premix[c]	.51	.51	.52	.52	.50	.50	.51	.50	.49	.50	.50	.51
TTU premix[d]	2.50	2.50	2.50	2.50	2.45	2.45	2.50	2.50	2.48	2.48	2.49	2.48

[a]DR0 = dry-rolled corn-based diet without SarStart DSC; DR+= dry-rolled corn-based diet with SarStart DSC; SF0 = steam-flaked corn-based diet without SarStart DSC; and SF+ = steam-flaked corn-based diet with SarStart DSC.

[b]Dry-rolled (DR) or steam-flaked (SF)corn.

[c]Treatment premixes for DR0 and SF0 diets contained ground milo only, whereas treatment premixes for DR+ and SF+ diets contained 1.112% (DM basis) SarStart DSC mixed with ground milo.

[d]Premix composition, which included the three limestone sources, is shown in Table 2.

Table 2. Composition of the TTU premix used in experimental diets

Ingredient	%, DM basis
Cottonseed meal	23.9733
Limestone[a]	42.1053
Dicalcium phosphate	1.0363
Potassium chloride	8.0000
Magnesium oxide	3.5587
Ammonium sulfate	6.6667
Salt	12.0000
Cobalt carbonate	.0017
Copper sulfate	.1572
Iron sulfate	.1333
EDDI	.0025
Manganese oxide	.2667
Selenium premix, .2% Se	.1000
Zinc sulfate	.8251
Vitamin A, 650,000 IU/g[a]	.0122
Vitamin E, 275 IU/g[a]	.1260
Rumensin, 80 mg/lb[a]	.6750
Tylan, 40 mg/lb[a]	.3600

[a]Concentrations noted by the ingredient are on a 90% DM basis.

Table 3. Effects of grain processing method and SarStart DSC on performance by finishing beef steers

	Grain processing method[a]			SarStart DSC[b]			
Item	DR	SF	OSL[c]	0	+	OSL[c]	SE[d]
Initial BW, lb	806.4	805.7	.86	808.6	803.5	.21	2.74
Final BW, lb	1,236.9	1,269.8	.03	1,248.0	1,258.7	.43	9.26
Daily gain, lb							
d 0 to 28	3.82	4.08	.14	3.83	4.07	.18	.119
d 0 to 56	3.96	4.37	.01	4.09	4.24	.31	.098
d 0 to 84	3.45	3.92	.01	3.65	3.72	.57	.092
d 0 to 112	3.38	3.63	.06	3.45	3.57	.32	.082
d 0 to end[e]	3.42	3.70	.02	3.50	3.62	.26	.076
Daily DMI, lb/steer							
d 0 to 28	17.98	16.52	.01	17.19	17.30	.27	.068
d 0 to 56	19.76	18.49	.01	19.02	19.23	.33	.152
d 0 to 84	19.89	18.70	.01	19.24	19.34	.71	.183
d 0 to 112	20.05	18.72	.01	19.37	19.39	.95	.217
d 0 to end[e]	20.27	18.85	.01	19.53	19.60	.83	.226
Feed:gain							
d 0 to 28	4.76	4.08	.01	4.55	4.29	.18	.131
d 0 to 56	5.02	4.25	.01	4.69	4.57	.40	.093
d 0 to 84	5.79	4.79	.01	5.34	5.24	.54	.111
d 0 to 112	5.95	5.18	.01	5.66	5.46	.17	.096
d 0 to end[e]	5.96	5.11	.01	5.63	5.44	.16	.091

[a]Grain processing method main effect: DR = dry-rolled corn; SF = steam-flaked corn.

Table 3 (continued). Effects of grain processing method and SarStart DSC on performance by finishing beef steers

[b]SarStart DSC main effect: 0 = no added SarStart DSC; + = 55.6 mg/kg of SarStart DSC in the dietary DM.

[c]Observed significance level for grain processing method or SarStart DSC main-effect comparisons.

[d]Pooled standard error of main-effect means, n = 12 pens per main-effect mean.

[e]Cattle in the Heavy block were on feed for 112 d, whereas cattle in the Light block were on feed for 138 d, resulting in an average of 125 d on feed.

Table 4. Effects of grain processing method and SarStart DSC on carcass characteristics of finishing beef steers

	Grain processing method[a]			SarStart DSC[b]			
Item	DR	SF	OSL[c]	0	+	OSL[c]	SE[d]
Hot carcass wt, lb	759.6	777.6	.05	769.0	768.3	.94	5.85
Dressing percent	61.39	61.24	.58	61.61	61.02	.05	.192
LM area, sq. in.[e]	12.47	12.76	.36	12.67	12.57	.76	.225
Fat thickness, in.	.48	.54	.01	.52	.50	.21	.014
KPH, %[f]	2.09	2.03	.31	2.06	2.07	.88	.039
Yield grade	2.95	3.12	.07	3.08	2.99	.31	.060
Marbling score[g]	446.2	420.6	.13	440.2	426.7	.41	11.30
Choice, %	77.20	59.32	*	66.67	69.49	**	-
Select, %	21.05	40.68	*	31.58	30.51	**	-
Standard, %	1.75	0.00	*	1.75	0.00	**	-

[a]Grain type main effect: DR = dry-rolled corn; SF = steam-flaked corn.

[b]SarStart DSC main effect: 0 = no added SarStart DSC; + = 55.6 mg/kg of SarStart DSC in the dietary DM.

[c]Observed significance level for grain processing method or SarStart DSC main-effect comparisons.

[d]Pooled standard error of main-effect means, n = 12 pens per main-effect mean.

[e]LM = longissimus muscle.

[f]KPH = kidney, pelvic, and heart fat.

[g]300 = Slight^0; 400 = Small^0; 500 = Modest^0.

*Distribution differs by Chi-square test, P < .06; **Distribution does not differ by Chi-square test, P ≥ .58.

Table 5. Distribution of liver scores (% of total) in finishing beef steers as affected by grain processing method and SarStart DSC

Item[c]	Grain processing method[a]		SarStart DSC[b]	
	DR	SF	0	+
Not condemned	83.33	84.75	83.33	84.75
A-	1.85	3.39	3.70	1.69
A	0.00	0.00	0.00	0.00
A+	1.85	3.39	1.85	3.39
Distoma (fluke)	5.56	1.69	5.56	1.69
Telangiectasis	0.00	1.69	1.85	0.00
Contamination[d]	7.41	5.09	3.71	8.48

[a]Grain type main effect: DR = dry-rolled corn; SF = steam-flaked corn.

[b]SarStart DSC main effect: 0 = no added SarStart DSC; + = 55.6 mg/kg of SarStart DSC in the dietary DM.

[c]Distribution of liver scores within main-effect means does not differ by Chi-square test, $P \geq .55$.

[d]Liver condemned because of contamination with feces or digestive tract contents at the plant.

Appendix Table 1. Chemical composition of the experimental diets

	Percentage of dietary concentrate											
	70				80				90			
Ingredient	DR0	DR+	SF0	SF+	DR0	DR+	SF0	SF+	DR0	DR+	SF0	SF+
Dry matter, %[b]	88.55	89.05	85.45	85.49	88.82	89.02	83.39	83.09	87.74	87.50	82.17	82.01
Ash, %	4.67	4.45	4.86	4.72	4.25	4.36	4.44	4.58	4.64	4.57	4.78	4.67
Crude protein, %	11.55	11.80	12.61	11.50	11.78	12.25	11.57	11.77	12.89	12.81	12.83	13.46
ADF, %[c]	16.11	17.25	15.96	16.95	9.57	11.62	9.49	10.55	5.45	5.36	5.44	5.52
Calcium, %	.69	.71	.70	.69	.58	.60	.59	.60	.61	.61	.62	.61
Phosphorus, %	.23	.22	.23	.22	.28	.27	.24	.24	.31	.32	.31	.31

[a]DR0 = dry-rolled corn-based diet without SarStart DSC; DR+= dry-rolled corn-based diet with SarStart DSC; SF0 = steam-flaked corn-based diet without SarStart DSC; and SF+ = steam-flaked corn-based diet with SarStart DSC.

[b]All values except Dry matter, % are expressed on a DM basis. Values for the 90%concentrate diet represent the average of analyses conducted on a sample of each diet composited across the 28-d (or 26-d) periods experiment.

[c]ADF = Acid detergent fiber.

APPENDIX A

Weather Data for the Experimental Period

APPENDIX B

General Description of Facilities at the Texas Tech University Burnett Center

The **Burnett Center for Beef Cattle Research and Instruction** consists of a computer-controlled feed mill and state-of-the-art experimental cattle feedlot at Texas Tech University located at the Northeast Lubbock County Field Laboratories, 15 miles north of Lubbock and 6 miles east of the town of New Deal, TX.

THE FEED MILL

The Burnett Center feed mill complex consists of two adjoining primary buildings. The first was constructed in 1976 and designed to facilitate the production of completely mixed, all-concentrated diets. The three-level, computer-operated, dust controlled, mixing plant completed in 1984 is a fully automated premix and batch-mixing facility that serves the research feedlot. It was designed to give maximum flexibility in the number of different diet formulations that could be produced in any one-time period. The two buildings have separate inside storage, premix, and bath-mixing capabilities but depend on common grain receiving, grain processing, liquid storage and weighing, and pelleting systems.

The feed mill complex was designed and constructed to meet standards required to: a) achieve high accuracy and precision of weighing, ingredient and feed handling and processing, premixing, mixing, and delivery of diets, and b) accommodate class instruction and individual hands-on training for undergraduate, graduate, and continuing education students. These facilities have allowed Texas Tech University to become a world leader in feedlot cattle research, feed industry research, and student education.

Auxiliary facilities include a compartmentalized forage building with belt conveyor to the research feedlot mixing plant, conventional and oxygen-free grain storage, supplement storage, a hay barn, silage bunkers, and a truck scale. Feed mill capabilities and design include:

- Two separate premixing and batch mixing systems,
- Computer or manual operation,
- A teaching laboratory with facilities for grain and roughage grinding, pelleting, steam flaking, feed microscopy investigations, particle size determination, pellet durability testing, and mixing,
- A 24-bin unit micro-premix system with scale beneath, which discharges into the main mixer,
- A premix room for hand-weighed and -added ingredients,
- Liquid storage and a direct-weight system for adding fat, molasses, and water,

- Flexibility to use three grain types and four roughage types in any one experimental design,
- Mixed feed delivery via belt or self-propelled mixer/delivery vehicle to the research feedlot,
- Mixed feed delivery via bags or bulk loadout to other livestock centers,
- Abort systems throughout in the research feedlot mixing plant,
- Grain processing via hammer mill grinding, dry rolling, steam flaking, and reconstitution,
- Roughage processing via tub grinding and chemical treatment,
- Feed and(or) ingredient processing via pelleting,
- Grain cleaning equipment,
- Inside bin systems
    - 8 for receiving grain
    - 5 for processed grain
    - 14 supplement bins
    - 24 for micro-ingredients
    - 2 for finished-feed bagging
    - 6 for bulk feeds

THE FEEDLOT

The feedlot was designed to maximize experimental flexibility, to give proper control, and to provide sufficient replication. The following criteria were an essential part of the design:

1. Uniform conditions across the entire feedlot.
2. Sufficient number of pens to provide adequate replication of experimental treatments.
3. Accuracy in weighing feeds and micro-ingredients, diet mixing, and delivery of diets to the pens.
4. Speed in delivering mixed diets to the feed bunks.
5. Ease of handling cattle during experimental procedures and accuracy in weighing experimental cattle.
6. Efficient use of land, minimizing mud problems, and providing ease of cattle waste removal, with potential for research on cattle waste.

The Feedlot has 114 pens with a capacity of four to eight animals per pen. Pen floors are partially slotted concrete. Ten conventional, dirt-floor pens with a capacity of 16 animals per pen are located adjacent to the 114 slotted-floor pens. In addition, four dirt-floor pens located next to these 10 pens are equipped with Calan headgates to allow individual feeding of up to 48 animals. Cattle in the slotted floor pens are fed daily, either directly from the feed mill via an automated, belt-feeder system or through the use of a batch-based system, with delivery of feed to pens via a self-propelled, 1-ton capacity Rotomix mixer. Accurate weights of feed ingredients and micro-ingredients mixed in diets are obtained and electronically recorded from stationary scales in the feed mill or on the self-propelled mixer.

The cattle working facility allows cattle to be handled with ease during various experimental procedures. An individual scale and an eight-animal platform scale electronically record cattle weights, which are merged with feed data in an IBM-compatible computer for data computation and statistical analyses. Eighteen sorting pens are included in the cattle working area, as well as a circular chute system, an individual restraining chute, a tilt chute, eight holding stanchions, and an office with a sample preparation laboratory.

Animal waste is removed from beneath the slotted-floor pens by a scraper system that moves the waste material to collection pits. From these pits, the waste is pumped into a large surge pit from which the material can be: 1) run over a solids separator; 2) used for irrigation directly on crop fields; or 3) hauled directly to crop fields with a liquid tank for dispersal and injection directly into the soil. The surge pit can be modified to allow methane conversion of the animal waste.

The Burnett Center feedlot facilities were designed to conduct accurate research under controlled conditions. These are research facilities, and are not intended to be a prototype for commercial feedlots. Nonetheless, cattle and feed management at the Burnett Center feedlot is designed to mimic industry conditions as closely as possible, thereby ensuring applicability of research results to the commercial feedlot industry.