Influence of Sanitizing Feedlot Pens on Microbial Populations and Cattle Performance

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Story in Brief

Ninety crossbred steers (initial BW of 439 lb) were used to test the effects of pen sanitization on microbial populations and cattle performance. Steers were blocked by weight, assigned to pens (6 steers/pen), and, within blocks, pens were allocated randomly to 1 of 3 treatments: 1) untreated pens (Ctrl); 2) pens treated with 1% cetylpyridinium chloride (CPC); or 3) pens treated with 5% lactic acid (LA). Drag-swabs were collected 1, 21, and 50 d after initial pen treatment, as well as 2 d after cattle removal and second treatment application (designated d 55), for enumeration of total coliform, generic E. coli, aerobic plate counts (APC), and E. coli O157:H7. Steer weights collected on d 0, 14, 28, and 50 were used to calculate ADG. Pen sanitization did not (P ≥ 0.41) alter APC, generic E. coli, or total coliform counts. Compared to the uncovered portion of the pens, the covered area had lower (P < 0.05) generic E. coli counts on d 1, 50, and 55 of the trial, whereas APC and total coliform counts were less (P < 0.05) every sampling day (location x day, P < 0.01). On d 1, there was a 1.9-log reduction (P < 0.05) in E. coli O157:H7 by treating pens with either CPC or LA; however, E. coli O157:H7 counts were similar on d 28, 50, and 55 of the trial (treatment x day, P < 0.01). Average daily gains were greater (P ≤ 0.10) for steers fed in LA-treated pens through 14 and 28 d than for those fed in CPC-treated pens with control steers being intermediate; however, these differences were not maintained through d 50. Therefore, sanitizing drylot pens prior to cattle placement can reduce drylot contamination with pathogenic bacteria and may improve cattle performance within the first 28 days in the feedyard.

Introduction

The Centers for Disease Control reported that food-borne illnesses sickened 76 million people at least once a year, hospitalized another 325,000, and caused 5,000 fatalities annually. In 1999, 530 of the 10,697 laboratory-confirmed cases (5%) of foodborne illnesses were due to Escherichia coli (E. coli) O147:H7 infections. Escherichia coli O157:H7 is intermittently shed into the environment by cattle, resulting in contamination of the hide at the time of harvest, potentially entering the food chain (Jordan, 1999). Cattle, when infected with E. coli O157:H7, do not exhibit signs; however, they are the primary reservoir of this organism. Moreover, calves have been shown to shed more E. coli O157:H7 upon entering the feedlot or when fed for a short time versus when fed for longer durations (USDA-APHIS, 2001). The National Animal Health Monitoring System (NAHMS) conducted surveys which found that 63% of 100 feedlots in 1994 and 100% of 73 feedlots in 1999 had at least one positive sample for E. coli O157:H7. Besides contaminating the feedlot floor by shedding in feces, Sargeant et al. (2003) found that other reservoirs of E. coli O157:H7 include water, water sediment, feed bunks and various types of cattle feedstuffs.

To date, most of the preharvest food safety research has focused on the use of bacteriostatic/bacteriocidal feed additives to reduce shedding of E. coli O157:H7, and there is little to no information concerning the efficacy of sanitizing feedlot pens between loads of cattle. In a benchtop study, Kruppelman et al. (2004) indicated that treating cattle manure inoculated with E. coli O157:H7 with cetylpolyrindinium chloride (CPC) or lactic acid (LA) effectively reduced microbial contamination. Thus, based on the results of the benchtop study, the objective of this study was to test the effectiveness of CPC and LA on the reduction of pathogenic bacteria in a typical feedlot environment.

Experimental Procedures

Crossbred steers (n = 90) with an initial BW of 435 lb were purchased from sale barns throughout Arkansas, and transported to the University of Arkansas Stocker Cattle Research Center at Savoy. Steers were blocked by initial BW into 5 blocks and allotted randomly within blocks to pens (6 steers/pen). Then, the pens within each block were assigned randomly to 1 of 3 pen sanitation treatments: 1) untreated control pens (Ctrl); 2) pens treated with 1% CPC (CPC); or 3) pens treated with 5% LA (LA). Each partially-covered pen measured 12.1 x 100 ft and had a single concrete feedbunk and automatic waterer. Steers had ad libitum access to water and a concentrate-based diet formulated to meet NRC (1996) requirements. Additionally, steers were weighed on d 0 (initial), 14, 28, and 50 for calculation of ADG.

Application of treatments. Treatment pens were sanitized 3 d before placement of steers, as well as 2 d after cattle removal. The 1% CPC (Zeeland Chemical, Zeeland, Mich.) solution was made by mixing 151.2 g of CPC into 4 gal of tap water until dissolved, whereas the 5% LA solution was made by mixing 0.23 gal of 88% food grade lactic acid (Purac America, Lincolnshire, Ill.) with 3.77 gal of tap water. Treatments were then applied to pens using 4-gal backpack sprayers (Solo®, Newport News, Va.; 2 per treatment) as to saturate the ground of each pen entirely (24 gal/pen).

Bacterial enumeration. On collection days (d 1, 21, and 50 after initial treatment, and 2 d following cattle removal and second treatment [designated as d 55]), drag swabs were plated for enumeration of total coliform, generic E. coli, and aerobic plate counts (APC). Each pen was swabbed with 4 sterile drag swabs by attaching a 40.5 g sterile weight to each sponge. These were drug across the ground for 1 min, with 3 drag swabs being a composite sample for the portion of the pen that was always in the sun and the last

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sterile drag swab was collected for the shaded portion near the feedbunk (Fig. 1). Sterile swabs were enriched with 75 ml (sun portion) and 25 ml (shaded portion) of 0.1% sterile peptone water in a sterile Whirl-pak bag (International Bioproducts, Bothell, Wash.) and macerated in a Seward Stomacher (Seward, London, England) for 2 min at low speed. Dilutions were prepared using 0.1% sterile peptone water and 0.1-ml portions of each dilution until reached desired dilutions. One milliliter of each desired dilution was spread in duplicate on Petrifilm™ Aerobic Count Plate (APC; 3M, St. Paul, Minn.) and incubated at 95°F for 48 h. Another one milliliter of each dilution was spread in duplicate on Petrifilm™ E. coli/Coliform Count Plate (3M) and incubated at 95°F for 24 h to determine coliform counts and for 48 h to determine generic E. coli counts. Afterwards on the same day, samples were priority shipped to Texas Tech University for E. coli O157:H7 enumeration and immunomagnetic separation.

Statistical analysis. Microbiological data were converted to log_{10} CFU/m² for statistical analysis. Data were analyzed as a randomized complete block design using PROC MIXED of SAS (SAS Inst. Inc., Cary, N.C.), with blocks based on initial BW, pen considered the experimental unit, and repeated measures across sampling time by location. Least squares means were computed and statistically separated by pair-wise t-tests (PDIFF option) when the F-test was significant (P < 0.05).

Results and Discussion

There was a treatment by sampling day interaction (P < 0.001; Fig. 2) for E. coli O157:H7. On d 1, there was a 1.9-log reduction in E. coli O157:H7 in pens treated with CPC or LA. On d 21, no positive samples were noted for any pens; however, by d 50 (when cattle were removed) all pens had positive samples. After the second sanitation spray on d 53, all drag swabs were negative for APC, coliform, and E. coli O157:H7 on d 55. In a previous study by Kruppelman et al. (2004), CPC and LA decreased E. coli O157:H7 by 1.99 and 1.98 log_{10} CFU/g of manure, respectively. Thus, the regrowth of E. coli O157:H7 in this study may be due to the revival of the injured bacteria, growth of bacteria that survived bacteriostatic treatments, or the possibility that calves were continuing to shed the organism after the first 3 wk in the feedlot environment.

Generic E. coli, APC, and coliform counts were all greatly reduced (P < 0.001) from d 1 to 21 when looking at location x day interactions, with generic E. coli having the greatest reduction. There was a 2-log reduction in APC from d 1 to 21 in the sun portion, and a 1.5-log reduction in the shaded portion, of the pens (location x sampling day interaction; P < 0.001; Fig. 3); however, no change was observed between d 50 and 55. This was possibly due to the torrential rain that occurred in the time between cattle removal (d 50), resanitation, and last sampling period (d 55). A 4- and 3-log reduction in generic E. coli was observed in the sun and shaded portions, respectively, between d 1 to 21 (location x sampling day interaction, P < 0.001; Fig. 4), whereas, total coliform counts were reduced 1.5- and 0.5-log in the sun and shaded portions of the pens, respectively, between d 1 to 21 (location x sampling day interaction, P < 0.001; Fig. 5). Greater counts were observed in the sun portion of the pens than in the shaded portion, which was possibly a response to a larger sampling area (approximately 3-times larger) in the sun portion as compared to the shaded area. Additionally, discrepancies in bacterial counts between d 50 and 55 could be accounted for by a 2-d torrential rainfall that occurred between the second application of pen treatments and pen sampling. Even though water across pens due to this rainfall probably allowed treatments to wash across all pens and into untreated, control pens; unfortunately, there was no way to account for the rain that occurred in the last part of the study.

There was a treatment x weigh-date interaction (P < 0.05) for BW, with heavier steers housed in LA-treated pens than those housed in CPC-treated pens on d 14 and 28 (Fig. 6). Furthermore, ADG was greater (P < 0.05) in steers fed in LA-treated pens after 14 and 28 d than those fed in CPC-treated pens; ADG of steers in untreated pens were intermediate to those in treated pens during the first 28 d on feed (treatment x day interaction; P < 0.05; Fig. 7). The difference observed in ADG between LA-treated and CPC-treated pens may be a response to possible bacteriostatic effects of LA on other bacteria that are not pathogenic, per se, but affect the health and well-being of growing-finishing cattle.

Implications

The results of this study suggested that sanitizing drylot pens prior to cattle placement lowered the prevalence of E. coli O157:H7 in a drylot environment similar to that of typical cattle feedlots. Moreover, sanitizing drylot pens may also provide a cleaner and healthier environment for newly-arrived calves, resulting in improvements in animal performance.

Literature Cited

Fig. 1. Pen Design – Sun portion of pen (69.5 ft.), drain (12.1 ft), shade portion of pen (18.4 ft.), and feedbunk on outside of pen.

Fig. 2. Mean *E. coli* O157:H7 counts from swabs taken in pens housing stocker calves from each treatment (Ctrl = untreated control; CPC = 1% cetylpyridinium chloride; and LA = 5% lactic acid) on d 1, 21, 50, and 55.

Means with different letters differ (treatment x sampling day interaction; *P* < 0.001).
**Aerobic Plate Count**

Fig. 3. Mean aerobic plate counts (APC) from swabs taken in either the shade or sun portion of pens (n = 15) housing stocker calves. *a* Means with different letters differ (location x sampling day interaction; P < 0.001).

**Generic E. coli**

Fig. 4. Mean generic *E. coli* counts from swabs taken in either the shade or sun portion of pens (n = 15) housing stocker calves. *a-d* Means with different letters differ (location x sampling day interaction; P < 0.001).

**Total Coliform**

Fig. 5. Mean total coliform counts from swabs taken in either the shade or sun portion of pens (n = 15) housing stocker calves. *a-d* Means with different letters differ (location x sampling day interaction; P < 0.001).
Fig. 6. Mean body weights of stocker calves in pens for each treatment (Ctrl = untreated control; CPC = 1% cetylpyridinium chloride; and LA = 5% lactic acid) on days 0, 14, 28, and 50. 

Means, within day, with different letters differ (P < 0.05).

Fig. 7. Mean ADG of stocker calves in pens for each treatment (Ctrl = untreated control; CPC = 1% cetylpyridinium chloride; and LA = 5% lactic acid). 

Means, within day, with different letters differ (P < 0.05).