PEER REVIEWED

An Evaluation of Three Methods to Clean Feedlot Water Tanks

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Abstract

Three methods of physically or chemically cleaning cattle feedlot water tanks were tested for their ability to reduce amounts of coliform bacteria in the water and the surface of the tank (biofilm) during the summer months: method 1) water tank was drained and refilled; method 2) water tank was scrubbed with a boot-brush to loosen and remove any visible sediment, drained and refilled; and method 3) water tank was scrubbed with a brush as above, drained and refilled. Household chlorine bleach (5.25% Na hypochlorite) was added to the water tank to a final 1:32 dilution. The disinfectant solution was kept in the tank for 15 minutes before the tank was drained again and refilled. In Trial 1 we found that draining and refilling (method 1) or draining, scrubbing and refilling water tanks (method 2) did not reduce coliform bacteria in water or biofilm. Coliform bacteria in water and biofilm were reduced 99% (p=.0003) and 99.9% (p<.0001), respectively, after draining, scrubbing and 15 minutes of chemical disinfection with chlorine bleach and refilling (method 3). However, coliforms had returned to pretreatment levels 24 hours after treatment (p=0.12). In Trial 2 we demonstrated the rapid re-population in coliform bacteria was due to the cattle drinking from the tanks (p=.0003). These data indicate that coliform bacteria rapidly re-populate water tanks in the summer because cattle re-contaminate them with coliform bacteria and/or substrate. If the overall number of coliforms in a water tank reflects the likelihood of transmitting coliform bacteria from water tanks to cattle, then the benefits of cleaning and disinfecting water tanks to minimize the transmission of coliform bacteria to cattle are short-lived.

Résumé

Trois méthodes pour nettoyer physiquement ou chimiquement les réservoirs d'eau de bovins en parcs d'engraissement ont été testées en fonction de leur aptitude à réduire le nombre de bactéries coliformes dans l'eau et à la surface du réservoir (biofilm) pendant la période estivale : méthode (1) : le réservoir d'eau était vidé et rempli à nouveau; méthode (2) : le réservoir d'eau était frotté avec une brosse pour déloger et enlever les sédiments visibles, vidé par la suite et rempli à nouveau, et méthode (3) : le réservoir était frotté avec une brosse comme dans la méthode (2), vidé et rempli à nouveau. Un javellisant domestique (5.25% hypochlorite de Na) était ajouté au réservoir d'eau à la dilution finale de 1:32. La solution désinfectante était gardée dans le réservoir pendant 15 minutes avant qu'il ne soit vidé et rempli à nouveau. Dans l'essai 1, nous remarquons que la vidange et remplissage propre à la méthode (1) et que le brossage, la vidange et le remplissage propre à la méthode (2) n'avaient pas réduit le nombre de bactéries coliformes ni dans l'eau ni dans le biofilm. Les bactéries coliformes dans l'eau et le biofilm étaient réduites de

99% (p = 0.0003) et de 99.9% (p < 0.0001), respectivement, suite à la vidange, au brossage et au nettoyage de 15 minutes avec la solution désinfectante propre à la méthode (3). Toutefois, les coliformes revinrent à leur niveau initial 24 heures suivant le traitement (p = 0.12). Dans l'essai 2, nous démontrons que la repopulation rapide des bactéries coliformes fait suite à l'abreuvement du bétail dans le réservoir d'eau (p = 0.0003). Ces données indiquent que les bactéries repeuplent rapidement le réservoir l'été parce que le bétail contamine à nouveau le réservoir avec les bactéries coliformes et/ou avec du substrat. Si l'on suppose que le nombre total de bactéries coliformes dans le réservoir d'eau reflète la probabilité de transmission des bactéries coliformes du réservoir d'eau au bétail, on doit conclure que les bénéfices de nettoyer et désinfecter le réservoir d'eau pour minimiser la transmission de bactéries coliformes au bétail sont de courte durée.

Introduction

Some have speculated that the transmission of *Escherichia coli* O157:H7, or other human food-safety pathogens, between cattle might be reduced by routine cleaning of feedlot water tanks.[2,3] The objective of this study was to determine if levels of coliform bacteria in water or the surfaces of feedlot water tanks could be reduced, and for how long, by any of three methods.

Materials and Methods

Samples and Microbiology

Coliform bacteria include aerobic or facultative, non-sporeforming gram-negative rods that ferment lactose and form acid and gas within 48 hours at 95°F (35°C).[4] The coliform bacteria density of water and biofilm was estimated as the most probable number of coliform bacteria per 100 ml (MPN of coliforms)[1] from samples obtained before and after the treatments. Samples were either 1) 100 ml of water collected from the tank; or 2) a swab of the bottom surface of the empty water tank (prior to refilling) to collect adhering bacteria (biofilm), using a 10 cm x 10 cm piece of sterile gauze. Water tanks were each identical float-controlled automatic tanks of steel construction located approximately 26 ft (8 meters) from the feedbunk (Figure 1). Cleaning efficacy was measured as: 1) the change in each tank's MPN of coliforms in water or biofilm from before to immediately following cleaning; 2) the change in each tank's MPN of coliforms in water from before to 24 hours after cleaning (Trial 1); and 3) the change in each tank's MPN of coliforms from immediately following cleaning to 24, 48 and 96 hours after cleaning (Trial 2). Both trials were conducted in September and October of 1998.

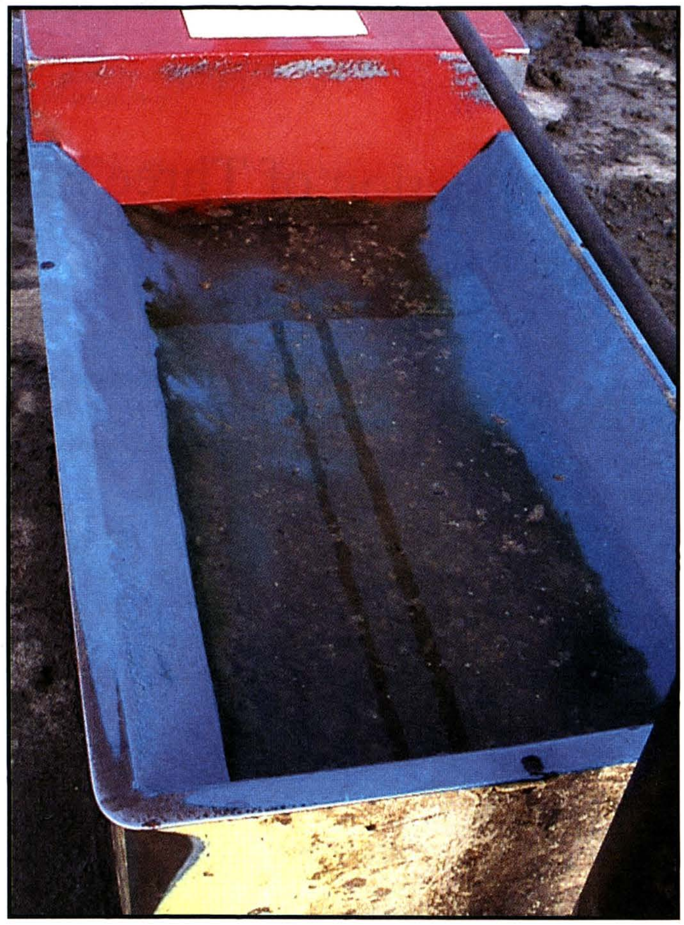

Figure 1. Water tank prior to cleaning.

Statistics

The logarithmic values (base 10) of the MPN of coliforms were used for all statistical analyses. Differences in the pre-treatment coliform levels and cleaning efficacy were tested by paired t-test, one-way analysis of variance (ANOVA) using Tukey's HSD to separate means, or repeated-measures ANOVA as appropriate for the hypothesis.[a] Significance was tested at $p<0.05$.

Study design, Trial 1

In Trial 1 we tested the hypothesis that different water tank cleaning methods would vary in cleaning efficacy. Three methods of cleaning were assigned systematically to six feedlot water tanks for three periods at 3-week intervals (6 repetitions of 3 methods) as follows:

- Method 1)–water tank was drained and refilled
- Method 2)–water tank was scrubbed with a bootbrush to loosen and remove any visible sediment, drained and refilled
- Method 3)–water tank was scrubbed with a brush as above, drained and refilled. Household chlorine bleach (5.25% Na hypochlorite) was added to the water tank to a final 1:32 dilution. The disin-

fectant solution was kept in the tank for 15 minutes before the tank was drained again and refilled.

Study design, Trial 2

The hypothesis we tested in Trial 2 was that the change in MPN of coliforms after chemical disinfection (bacterial regrowth) would be different in water tanks with cattle drinking from them compared to tanks in empty feedlot pens, because cattle drinking from the tanks would re-contaminate the water with bacteria or substrate.

Twelve water tanks were scrubbed and chemically disinfected (using cleaning method 3 of Trial 1). Cattle were removed from access to six of the water tanks when the tanks were cleaned; cattle continued to drink from the remaining six water tanks. The MPN of coliforms were calculated from cultures of the water and biofilm prior-to and immediately following cleaning and from cultures of water 24, 48, 72 and 96 hours after cleaning.

Results and Discussion

Trial 1

The MPN of coliforms in the water collected immediately after treatment from tanks cleaned with chemical disinfection (method 3) was reduced (p=.0003) on average more than 99% (mean 2.3 $\log_{10}$ reduction, std. dev.= 0.9 $\log_{10}$; Figure 2). Cleaning methods 1 and 2 did not reduce the MPN of coliforms in the water. The MPN of coliforms in the water collected from tanks at 24 hours post-treatment was not significantly different from the respective pre-treatment level regardless of the cleaning method (p=.12). Similarly, the MPN of coliforms in the biofilm of tanks cleaned with chemical disinfection was reduced (p<.0001) on average more than 99.9% (mean 3.6 $\log_{10}$ reduction, std. dev. = 1.3 $\log_{10}$; Figure 3). The MPN of coliforms in the biofilm in tanks physically cleaned (methods 1 and 2) was not significantly reduced (p>.05).

Trial 2

The MPN of coliforms in water and biofilm were reduced immediately after water tank disinfection by averages of more than 99% (Figure 4) and 99.999%, respectively (p<.0001). The MPN of coliforms in the water increased in both groups following disinfection (p<.0001); however, during the 4 days after cleaning, the MPN of coliforms in water from tanks that cattle were drinking was nearly 100-fold greater than water from tanks without cattle access (p=.0003; Figure 4).

The post-treatment rise in the MPN of coliforms we observed in Trial 1 may have been due to introduction of bacteria and/or substrate into the water by cattle drinking from the tanks, or from regrowth of bacteria remaining in the water and biofilm. Trial 2 was designed to test if bacterial regrowth was directly from the tank or from re-contamination by cattle. In Trial 2 coliform regrowth occurred within days of cleaning the

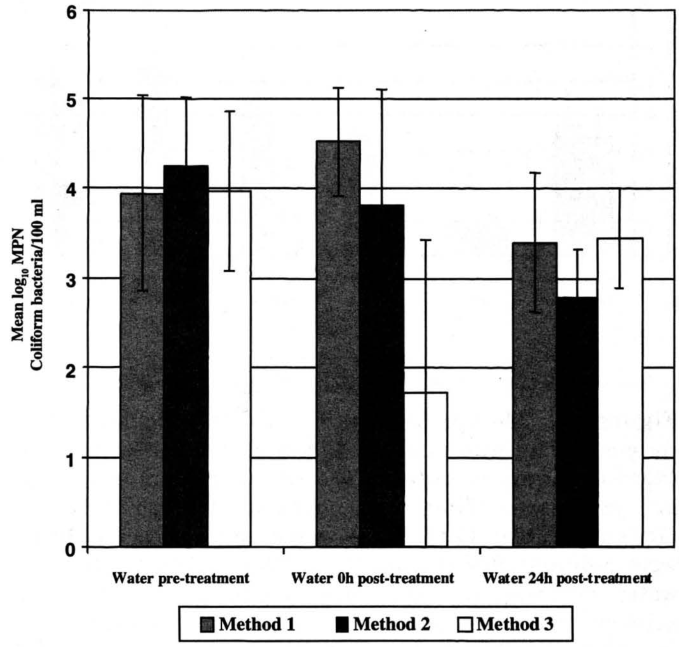

Figure 2. Most probable number (MPN) of coliform bacteria per 100 ml water from feedlot water tanks cleaned by draining and refilling (method 1, n=6); draining, scrubbing and re-filling (method 2, n=6); or draining, scrubbing, refilling and chemical disinfection for 15 minutes (method 3, n=6). Cleaning by method 3 significantly reduced the coliform bacteria in the water immediately after treatment (p=.0003). Error bars show 1 standard deviation.

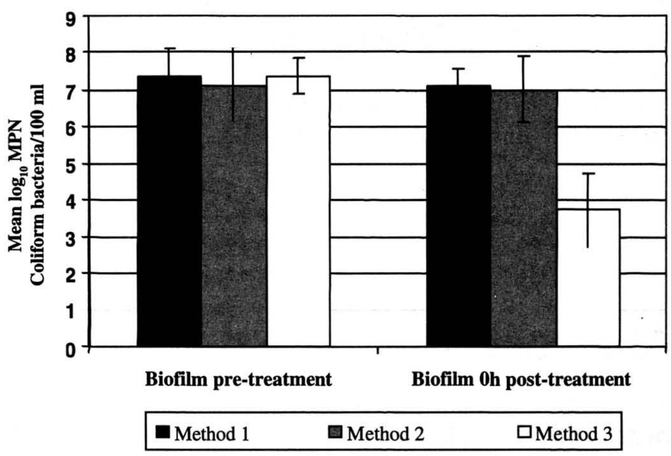

Figure 3. Most probable number (MPN) of coliform bacteria per 100 ml from swabs of the bottom surface (biofilm) of feedlot water tanks cleaned by draining and refilling (method 1, n=6); draining, scrubbing and re-filling (method 2, n=6); or draining, scrubbing, refilling and chemical disinfection for 15 minutes (method 3, n=6). Cleaning by method 3 significantly reduced the coliform bacteria in the biofilm immediately after treatment (p<.0001). Error bars show 1 standard deviation.

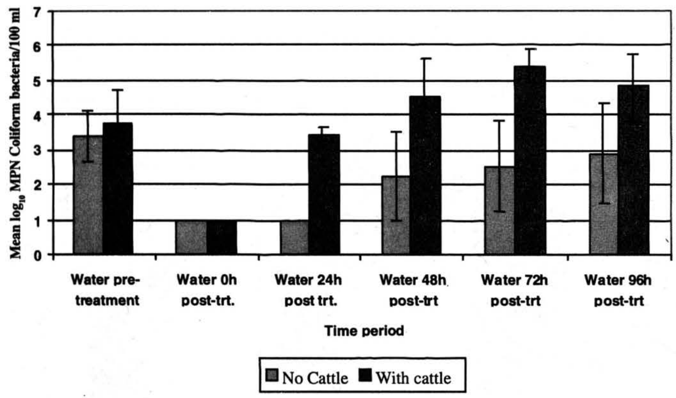

Figure 4. Most probable number (MPN) of coliform bacteria per 100 ml water collected from six feedlot water tanks exposed (and six not exposed) to cattle after cleaning by draining, scrubbing, refilling and chemical disinfection for 15 minutes and refilling. Coliforms in water (and biofilm, not shown) were reduced after treatment ($p<.0001$). Coliform levels in water increased with time after cleaning ($p<.0001$) and the coliform levels were higher in tanks with cattle access ($p=.0003$). Error bars show 1 standard deviation.

tanks regardless of cattle access, but the magnitude of coliform regrowth was 100-fold greater in water that cattle were drinking. These data indicate that coliform bacteria rapidly re-populate water tanks in the summer because cattle recontaminate them with coliform bacteria and/or substrate.

Conclusions

If the overall number of coliforms in a water tank reflects the likelihood of transmitting coliform bacteria from water tanks to cattle, then the benefits of cleaning and disinfecting water tanks to minimize the transmission of coliform bacteria to cattle are short-lived. The practice of cleaning feedlot water tanks is important for palatability and for other water quality reasons, but routine cleaning and disinfection may not, by itself, reduce the likelihood of transmission of coliform bacteria to cattle through water tanks.

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References

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Footnote

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Abstract

Serological, Colostral and Milk Responses of Cows Vaccinated with a Single Dose of a Combined Vaccine Against Rotavirus, Coronavirus and *Escherichia coli* F5 (K99)

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Twenty-five Ayrshire/Friesian cows were vaccinated once with a new combined vaccine against rotavirus, coronavirus and *Escherichia coli* F5 (K99) or given a saline placebo 31 days before the first expected calving date. Blood samples were taken from the cows at intervals from vaccination until seven days after calving and from their calves up to 28 days after birth, and colostrum and milk samples were collected from the cows at intervals for 28 days after calving. There was a significant increase in the mean specific antibody titre against all three antigens in the serum of the vaccinated animals (even in the presence of pre-existing antibody) which was accompanied by increased levels of protective antibodies to rotavirus, coronavirus and *E coli* F5 (K99) in their colostrum and milk for at least 28 days.