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Vaccination for *Escherichia coli* O157:H7 in Market Ready Feedlot Cattle

Robert Peterson
University of Nebraska-Lincoln

David R. Smith
University of Nebraska-Lincoln, dsmith8@unl.edu

Rodney A. Moxley
University of Nebraska-Lincoln, rmoxley1@unl.edu

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

Galen E. Erickson
University of Nebraska-Lincoln, gerickson4@unl.edu

See next page for additional authors

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Authors

Robert Peterson, David R. Smith, Rodney A. Moxley, Terry J. Klopfenstein, Galen E. Erickson, and Susan Hinkley

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Summary

A clinical trial was conducted during the summer of 2004 to evaluate the effects of vaccinating cattle against *Escherichia coli* on the probability of detecting *E. coli* O157:H7 in feces and colonization at the terminal rectum. The probability for vaccinated or nonvaccinated cattle to shed *E. coli* O157:H7 in feces was not significantly different. However, the probability for steers to be colonized by *E. coli* O157:H7 in the terminal rectum was greatly reduced for vaccinated (0.3%) compared with nonvaccinated (20.0%) steers. We concluded that the vaccine was effective at reducing colonization of *E. coli* O157:H7 at the terminal rectum of cattle.

Introduction

Beef cattle represent an important reservoir for *E. coli* O157:H7 and, in cattle, the mucosal cells 3-5 cm proximal to the terminal rectum are an important site of colonization. Previous research at Nebraska found that vaccinating feedlot cattle against Type III secretory proteins of *Escherichia coli* reduced the probability that cattle shed *E. coli* O157:H7 in their feces (2005 Nebraska Beef Report, pp. 61-63); however, no research documenting the effects of the vaccine on colonization of *E. coli* O157:H7 in the terminal rectum has been reported. Intervention strategies aimed at reducing colonization in the terminal rectum could aid beef industry efforts to reduce *E. coli* O157:H7 contamination of beef products. Therefore, a clinical trial was conducted to evaluate the effects of vaccination on the probability that cattle shed *E. coli* O157:H7 in the feces, and that of ani-

mals colonized by this organism in the terminal rectum when the treatment is applied at the pen level.

Procedure

The clinical trial was conducted during the summer months (May - September) of 2004 at the University of Nebraska Beef Research Feedlot at Ithaca, Neb. Two hundred eighty eight medium-weight steers were stratified by weight and assigned randomly to 36 pens (eight head/pen) and pens were assigned randomly to vaccination treatment. Cattle were stratified by weight so the heaviest 36 cattle could be systematically assigned to 1 of 36 pens using a random number generator. This process was repeated seven more times so that each pen would have a total of eight animals per pen.

Treatments included vaccinated and nonvaccinated pens of steers. Steers in vaccinated pens received three doses of the vaccine at 21-day intervals. Steers in nonvaccinated pens received 3 doses of the adjuvant (placebo) at the same 21-day intervals. Researchers and feedlot personnel were blinded to the actual vaccination treatments.

Each steer was sampled by rectal fecal grab on day 0 and every 14 days of the feeding period following administration of the treatment, resulting in 1 pre-treatment period (day 0), and 4 test-period samplings (14, 28, 42, and 56 days post treatment). Feces from all steers were collected for culture on the same day within the same test period. All fecal samples were taken immediately to the UNL *E. coli* lab and analyzed for presence of *E. coli* O157:H7 using procedures previously described (2004 Nebraska Beef Report, pp. 67-68) with modifications.

A terminal rectum mucosal (TRM) sample was collected from each steer by scraping mucosal cells 3-5 cm proximal to the rectoanal juncture at harvest. The TRM samples were cultured using standard methods involving selective enrichment, immunomagnetic

separation, agar plating, biochemical and immunological testing, and PCR confirmation as previously described (2004 Nebraska Beef Report, pp. 67-68) with modifications.

The effect of vaccine treatment on the probability to detect *E. coli* O157:H7 from feces was tested by modeling the probability of detecting *E. coli* O157:H7 from feces using the logit link function in a multivariable generalized estimation equation (GEE) model (Proc GENMOD, SAS Institute, Cary, N.C.). Least squared means of the parameter estimates from the multivariable logistic models were used to estimate adjusted probabilities for class variables (vaccine treatment). Relative risk (RR) values for levels of vaccine treatment were calculated from the adjusted probabilities and vaccine efficacy was calculated as (1-RR).

Results

E. coli

In total, *E. coli* O157:H7 was recovered from 86 of 1,419 culture observations (6.1%) from feces collected from steers in vaccinated and nonvaccinated pens. During the pre-treatment sampling period, the average proportion of steers shedding *E. coli* O157:H7 within the treated pens was 6.3% and was 1.4% in nonvaccinated pens ($P = 0.07$).

In this study an association between test period and the probability for cattle to shed *E. coli* O157:H7 approached statistical significance ($P = 0.07$; Figure 1). Other studies suggest test period was significantly associated with fecal shedding of *E. coli* O157:H7 (Potter et al., Vaccine 2004; 2005 Nebraska Beef Report, pp. 61-63, Khaitsa et al, 2003), The odds of detecting *E. coli* O157:H7 in the feces increased as the time between the last vaccination and sampling occurred. After adjusting for dietary and vaccination treatment, and using day 56 posttreatment as the referent,

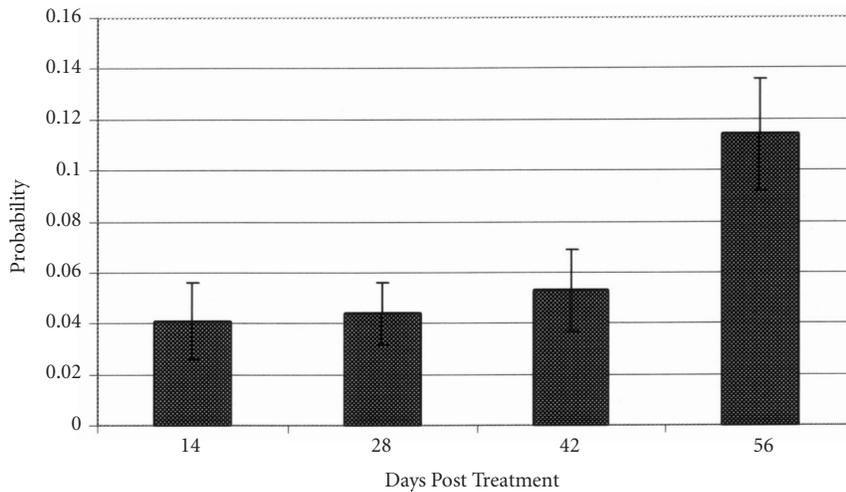


Figure 1. Probability of steers shedding *E. coli* O157:H7 in the feces 14, 28, 42, and 56 days post treatment adjusted for dietary and vaccination treatment.

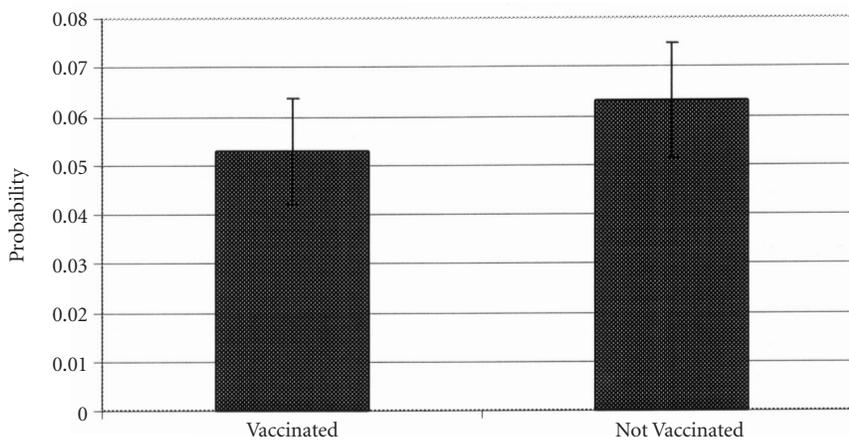


Figure 2. Probability of steers shedding *E. coli* O157:H7 in the feces by vaccination treatment adjusted for sample and dietary treatment.

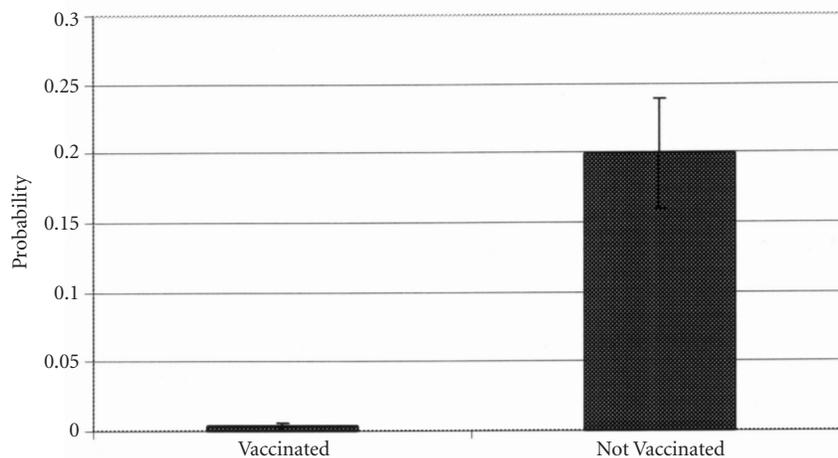


Figure 3. Probability of steers to be colonized by *E. coli* O157:H7 in TRM at harvest by vaccination treatment adjusted for dietary treatment.

the odds of detecting *E. coli* O157:H7 in the feces on d 14, 28, and 42 were 0.33, 0.60 and 0.44, respectively. In contrast to previous reports (2004 Nebraska Beef Report, pp. 67-68; 2005

Nebraska Beef Report, pp. 61-63), vaccination was not associated ($P = 0.51$) with the probability for cattle to shed *E. coli* O157:H7 in the feces (Figure 2). However, the relatively low probability

to detect *E. coli* O157:H7 in feces during this study compared with studies conducted in previous years may explain the lack of association between vaccination and test period and the probability to detect *E. coli* O157:H7 in feces. The probability to detect *E. coli* O157:H7 in feces during the summers of 2002 and 2003 was 0.15 and 0.20, respectively (2004 Nebraska Beef Report, pp. 67-68; 2005 Nebraska Beef Report, pp. 61-63). The probability to detect *E. coli* O157:H7 in feces over the course of this study was 0.06. After adjusting for sample and dietary treatment, the odds for vaccinated cattle to test positive for *E. coli* O157:H7 in the feces were 0.83 times the odds for nonvaccinated cattle to test positive for *E. coli* O157:H7 in the feces.

Terminal Rectum Mucosa

The factors explaining the probability for steers to test positive for *E. coli* O157:H7 in TRM samples in the multivariable logistic regression model were diet and vaccination treatment. Dietary treatment did not interact with vaccination. Vaccination was significantly ($P < 0.001$) associated with the probability for cattle to be colonized by *E. coli* O157:H7 1-2 inches proximal to the rectoanal juncture (Figure 3). After adjusting for dietary treatment, the odds of vaccinated steers to be colonized by *E. coli* O157:H7 1-2 inches proximal to the rectoanal juncture was 0.01 times the odds of nonvaccinated steers to be colonized by *E. coli* O157:H7 at the same location, a vaccine efficacy of 98.5%.

Although we were unable to detect a significant difference in the probability to detect *E. coli* O157:H7 in feces due to vaccination treatment, results from this study suggest vaccination effectively reduced the probability for cattle to become colonized by *E. coli* O157:H7 3-5 cm proximal to the rectoanal juncture.

¹Robert Peterson, research technician; Dave Smith, Rod Moxley, professors, Veterinary and Biomedical Sciences; Terry Klopfenstein, Galen Erickson, professors, Animal Science; Susan Hinkley, assistant professor, Veterinary and Biomedical Sciences.