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

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## Summary

*A clinical trial was conducted in summer 2003 to evaluate effects of vaccinating feedlot cattle against Type III secretory proteins of enterohemorrhagic Escherichia coli on prevalence of E. coli O157:H7 in feces. Treatments included: 1) no vaccination; 2) vaccinated once at re-implant (day 42); 3) vaccinated upon arrival (day 0) and again at re-implant (day 42); and 4) vaccinated on arrival (day 0), at day 21, and again at re-implant (day 42). Vaccination effectively reduced the proportion of feedlot cattle shedding O157 in the feces, the effect was dose-responsive, and vaccination within a pen conferred protection to unvaccinated pen-mates (herd-immunity).*

## Introduction

*Escherichia coli* O157:H7 has been a pathogen of concern to the beef industry for two decades. Because cattle represent a significant reservoir of *E. coli* O157:H7, a great deal of research has been conducted at the University of Nebraska to deter-

mine the ecology of *E. coli* O157:H7 in Nebraska beef feedlots. Most recently, research has focused on identifying and scientifically testing easily implemented on-farm intervention strategies to control the carriage and shedding of *E. coli* O157:H7 in feces of feedlot cattle. Previous research at Nebraska (Potter et al., Vaccine 2004) found that vaccinating feedlot cattle against Type III secretory proteins of *Escherichia coli* O157:H7 reduced the probability of fecal shedding of the organism by 59%. In that study cattle were vaccinated three times at three-week intervals. Current feedlot practices make a three-vaccination treatment protocol challenging to implement. However, vaccinating cattle once at reimplant, or twice, once at initial processing and again at reimplant, would be much easier to implement into current feedlot practices. Therefore, an experiment was conducted to evaluate the effects of varying the number of doses of a commercially prepared vaccine on the probability that cattle shed *E. coli* O157:H7 in feces.

## Procedure

The clinical trial was conducted during summer (May - September) of 2003 at the University of Nebraska Beef Research Feedlot at Ithaca, Nebraska. Four-hundred-

eighty medium-weight steers were stratified by weight and assigned randomly to 60 pens (8 head/pen) and to one of four vaccination treatments (2 head/treatment) within a pen. Steers were blocked into four groups based on replication of dietary treatment. Dietary treatments are summarized in a separate report (2005 *Nebraska Beef Report*, pp. 28-30). Vaccine (2 ml/dose) was administered subcutaneously in the neck using an 18 ga x 5/8-inch needle. Vaccination treatments included: 1) no vaccination; 2) vaccinated once at re-implant (day 42); 3) vaccinated upon arrival (day 0) and again at re-implant (day 42); and 4) vaccinated on arrival (day 0), at day 21, and again at re-implant (day 42). An additional 128 steers were assigned to 12 pens and two study blocks within the same feedlot to serve as unvaccinated external controls. Blocking criteria for external controls was steers per pen (8 head in 8 pens; 16 head in 4 pens). Steers were fed for an average of 138 days and each steer was sampled by rectal fecal grab every three weeks of the feeding period, resulting in one pre-treatment period (day 0), two interim periods (day 21, day 42), and four test-period samplings (days 63, 84, 105, and 126). Feces from these cattle were collected for culture in two sample blocks within

(Continued on next page)

the same test period on consecutive days for vaccinated and external control pens.

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.

The odds of a treated animal shedding *E. coli* O157:H7 was compared to that of unvaccinated control cattle within the pen and control cattle in the external pens, accounting for repeated measures, block, and pen using the GENMOD procedure of SAS. Adjusted odds ratios (OR) were converted to relative risk (RR) using marginal probabilities for prevalence and vaccination. Vaccine efficacy was calculated as (1-RR). Feedlot performance was evaluated using the MIXED procedure of SAS accounting for block and pen. Because treatments were assigned to animals within a pen, only weights and average daily gain (ADG) can be reported for the direct effect of vaccination treatment.

## Results

### *E. coli* Results

In total, *E. coli* O157:H7 was recovered from 845 of 4253 culture observations (20%) from cattle in treated and external control pens. During the pre-treatment sampling period, the proportion of cattle shedding *E. coli* O157:H7 within the 60 treated pens was 45% and was not different ( $P > 0.10$ ) for animals allocated to different vaccine treatments. The proportion of cattle shedding *E. coli* O157:H7 among the external control pens was 30.5% during the same test period and was significantly lower ( $P < 0.05$ ) than treated pens; however, the proportion of cattle shedding *E. coli* O157:H7 among the external control pens was higher ( $P < 0.05$ ) than treated pens throughout the remainder of the study (Figure 1).

**Table 1. Finishing performance and carcass merit for steers receiving 0,1, 2, or 3 doses of vaccine within vaccinated pens.**

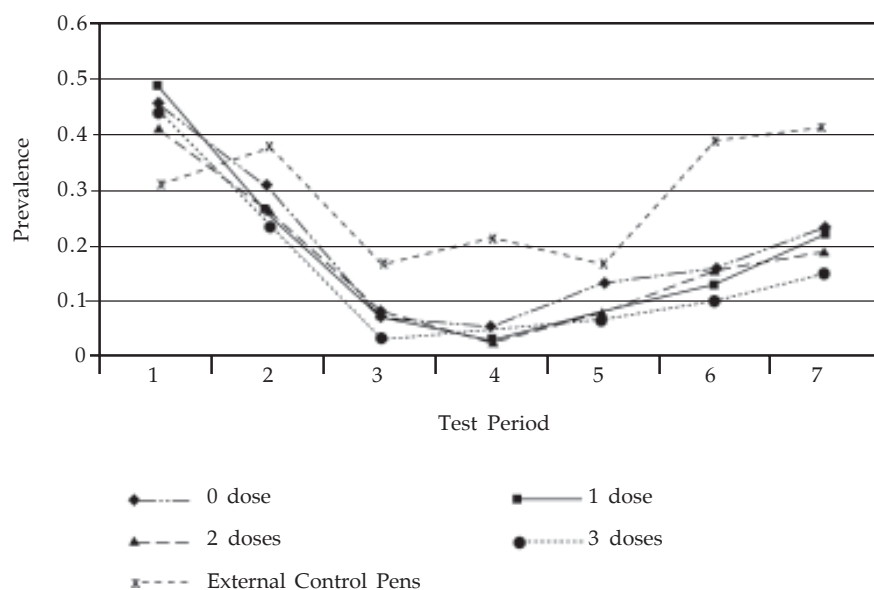
Item	Treatment <sup>a</sup>				SEM <sup>a</sup>	VAC <sup>b</sup>
	0	1	2	3		
Steers	120	120	120	120		
Initial BW, lb	745	742	742	745	2.32	0.59
Final BW, lb <sup>c</sup>	1242	1233	1229	1244	6.26	0.27
ADG, lb	3.60	3.56	3.53	3.62	0.41	0.45
HCW, lb	782	777	774	784	3.94	0.27
12 <sup>th</sup> rib fat, in.	0.37	0.32	0.36	0.34	0.04	0.67
Marbling <sup>d</sup>	489	503	485	487	5.51	0.09

<sup>a</sup>Standard error of the mean

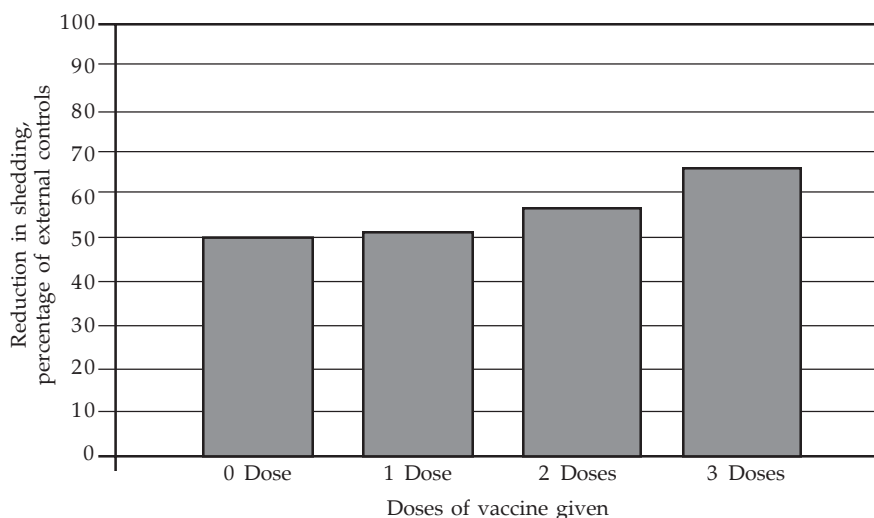
<sup>b</sup>Main effect of vaccination treatment.

<sup>c</sup>Calculated from carcass weight, adjusted to a 63% common dressing percentage.

<sup>d</sup>Marbling = Marbling score = 400 = Slight<sup>0</sup>, 450 = Slight<sup>50</sup>, 500 = Small<sup>0</sup>, etc.



**Figure 1. The proportion of steers shedding *E. coli* O157:H7 by test period and treatment (0, 1, 2, or 3 doses of vaccine) within treated pens compared to untreated pens.**



**Figure 2. Percentage reduction in *E. coli* O157:H7 shedding (vaccine efficacy) by steers receiving 1, 2, or 3 doses of vaccine within treated pens compared to pens receiving no vaccine (21-84 days post treatment).**

The proportion of cattle shedding *E. coli* O157:H7 in both treated and control pens during test periods four to seven differed significantly by test period ( $P < 0.05$ , Figure 1). There was no interaction between vaccination and test periods four to seven. During test periods four to seven cattle in pens receiving one, two, or three doses of vaccine were less likely to shed *E. coli* O157:H7 than cattle in pens not receiving vaccine (OR=0.33;  $P=0.0008$ ) — a vaccine efficacy of 59%. Vaccine efficacy of receiving one, two, or three doses of vaccine was 52%, 58%, and 68%, respectively ( $P < 0.01$  for each, Figure 2), compared with cattle in pens not receiving vaccine. Unvaccinated cattle in pens receiving vaccine treatments were also less likely to shed *E. coli* O157:H7 than cattle in pens not receiving vaccine (OR=0.42,  $P=0.02$ ). Compared to unvaccinated

cattle within the pens receiving vaccine treatments, the odds of shedding *E. coli* O157:H7 decreased as cattle received one, two, or three doses of vaccine (OR=0.94, 0.82, and 0.59 respectively). Cattle receiving three doses of vaccine were 35% less likely to shed *E. coli* O157:H7 than unvaccinated cattle in the same pen ( $P=0.06$ ) during the post-treatment period.

#### *Finishing Performance*

Least squares means for finishing performance measures are presented in Table 1. There were no differences ( $P > 0.10$ ) in finishing performance for steers receiving one, two, or three doses of vaccine compared with unvaccinated steers within the same pen. These data suggest vaccinating feedlot cattle against Type III secretory proteins of enterohemorrhagic *Escherichia*

*coli* will have no measurable impact on finishing performance.

In conclusion vaccine efficacy improved with the number of doses administered, and vaccinating a majority of cattle within a pen offered a significant protective effect (herd immunity) to non-vaccinated cattle within the same pen. Furthermore, vaccinating feedlot cattle against Type III secretory proteins of enterohemorrhagic *Escherichia coli* had no detrimental effects on finishing performance. Vaccination appears to be a promising pre-harvest intervention strategy for the control of *E. coli* O157:H7.

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