January 2001

A Diagnostic Strategy to Classify Pens of Feedlot Cattle by the Prevalence of *Escherichia coli* O157:H7 Fecal Shedding

David R. Smith
University of Nebraska-Lincoln, dsmith@cvm.msstate.edu

Spring Younts
University of Nebraska-Lincoln

Mark Blackford
University of Nebraska-Lincoln

Todd Milton
University of Nebraska-Lincoln

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

See next page for additional authors

Authors

David R. Smith, Spring Younts, Mark Blackford, Todd Milton, Rodney A. Moxley, Jeff Gray, Laura Hungerford, and Terry J. Klopfenstein

A Diagnostic Strategy to Classify Pens of Feedlot Cattle by the Prevalence of *Escherichia coli* O157:H7 Fecal Shedding

David Smith
Spring Younts
Mark Blackford
Rodney Moxley
Jeff Gray
Laura Hungerford
Todd Milton
Terry Klopfenstein[1]

This diagnostic strategy can be used in food-safety research or as a monitoring tool in animal production food-safety programs to classify feedlot pens by the percentage of cattle shedding *Escherichia coli* O157:H7.

Summary

This study evaluated two pen testing strategies to predict the percentage of cattle in a pen shedding detectable E. coli O157:H7. Culture of a composite fecal sample most accurately detected pens with 37% or more cattle shedding E. coli O157:H7 in feces. A new pen test device most accurately detected pens with 16% or more individuals shedding. The likelihood of detecting E. coli O157:H7 with either method increased as pen prevalence increased. If both pen-level test methods were used together, pens could be classified as high, medium or low prevalence with less labor and expense than testing individual cattle.

Introduction

The principles of hazard-analysis-critical-control-points (HACCP) were developed to minimize the likelihood that food will be contaminated with potentially dangerous pathogens. Ideally food-safety would be maximized if HACCP principles were applied at all levels of food production and processing. Unfortunately, there is insufficient knowledge of the epidemiology and ecology of *E. coli* O157:H7 to design and implement HACCP-based food safety programs in cattle feedyards.

Research or development of on-farm HACCP programs to control *E. coli* O157:H7 in feedlot production systems have been hampered by difficulty in determining the infection status of cattle at any point in time. The difficulty in diagnosis results because infection with *E. coli* O157:H7 in cattle occurs without clinical signs, except in calves, and because there is a lack of field-validated methods to monitor livestock for food safety pathogens.

Determining if individual live cattle are shedding *E. coli* O157:H7 is expensive and impractical. For example, culture of the feces from most, if not all, animals in a feedlot pen requires considerable labor and supplies. Handling finished cattle prior to shipping is not desirable because of the loss in value to cattle due to shrink, dark cutters and bruising. It may be possible to control *E. coli* O157:H7 in feedlots without knowing the infection status of individual cattle because control points or interventions for reducing human foodborne pathogens in feedlot cattle would most likely be directed towards pens of cattle. Therefore, the *E. coli* O157:H7 status of pens of feedlot cattle is an important outcome for feedlot production food safety research and HACCP monitoring.

Research and development of HACCP-based feedlot food safety programs could advance if pens of cattle, rather than individuals, could be accurately and economically classified by

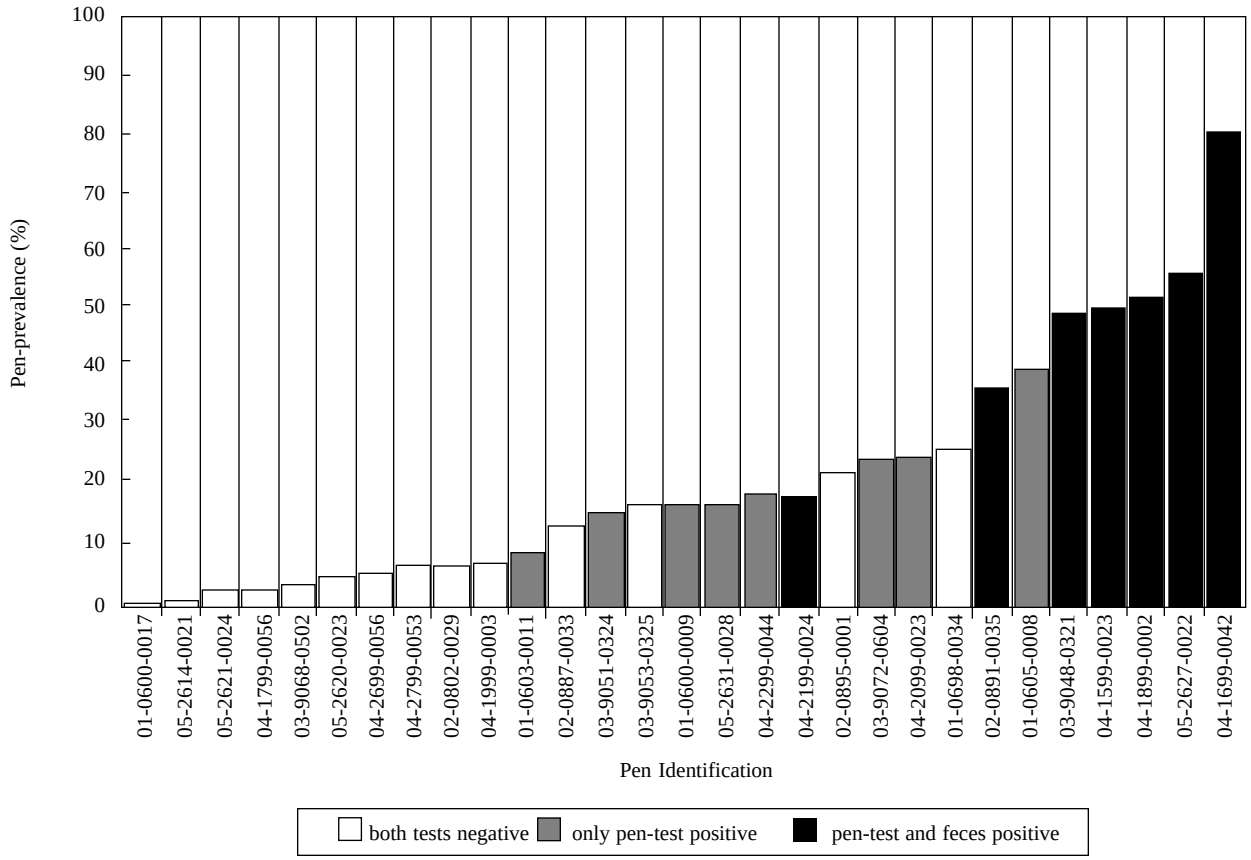

Figure 1. The relationship between the *Escherichia coli* O157:H7 culture results of the pen-test device, a composite fecal sample collected from the pen and the percent of cattle in the pen shedding detectable levels of the organism in rectal feces.

the level of fecal shedding of *E. coli* O157:H7. Such a "pen-test" could serve as a monitoring tool in feedlot production food-safety programs, and would allow researchers to test potential interventions, or look for feedlot production methods related to the presence or absence of food-borne pathogens. The objective of this study was to evaluate diagnostic strategies to efficiently identify pens of feedlot cattle with a high prevalence of cattle shedding *E. coli* O157:H7.

Procedure

Twenty-nine feedlot pens from five Midwestern feedlots, ranging in size from 36 to 231 (median 107) cattle, were each studied once between June and September, 1999 (Smith et al. 2001 Beef Report). Seven pen-test devices that cattle could rub, lick or chew were placed in the pens the evening prior to sample collection. The morning of sampling, feces were collected from the rectums of all cattle in each pen and concurrent samples were collected of pen-test devices and a single composite sample of 20 fresh fecal pats from the pen surface. Culture methods were specific to the type of sample but included selective enrichment and immunomagnetic separation. Isolates were confirmed by standard methods including PCR. Non-parametric statistical methods were used to test either rank differences or rank correlations between pen-level classifications and the results of individual animal testing.

Results

Escherichia coli O157:H7 was isolated from at least one animal in each of the 29 pens. The percentage of cattle shedding detectable levels of the organism within a pen ranged from 0.7% to 79.8% (median 17.1%).*E. coli* O157:H7 was recovered from at least one pen-test device from 15 pens and from the composite fecal samples of eight pens (Figure 1). Recovery of*E. coli* O157:H7 from at least one pen test device or from the composite fecal sample was most likely to occur from the pens with higher prevalence (Wilcoxon rank sums P=0.001).

The pen-test devices and composite feces were evaluated singly as diagnostic tools to differentiate high prevalence pens from low prevalence pens. The new pen-test device most accurately detected as positive (greatest percentage of pens classified correctly) pens with 16% or greater prevalence (pen-level sensitivity = 82%, pen-level specificity = 92%). Culture of composite feces most accurately detected as positive pens with a 37% percent or higher prevalence (pen-level sensitivity = 86%, pen-level specificity = 91%).

Information from culture of the pen-test devices and the composite feces was combined to classify pens by three levels of fecal shedding prevalence. Pens were classified as high prevalence if *E. coli*

(Continued on next page)

O157:H7 was recovered from the composite fecal sample; pens were classified as medium prevalence if the organism was recovered from the device, but not from the composite feces; pens were classified as low prevalence if the organism was not recovered from the device or the composite feces. This classification scheme correlated well (Spearman's $r = 0.76$, $P<0.0001$) with the pen-prevalence determined by culturing the feces from individual cattle. Pens classified as high prevalence had significantly higher rankings in pen-prevalence than pens classified as medium prevalence ($P=0.05$) or low prevalence ($P=0.0006$), and pens classified as medium prevalence had significantly higher rankings in pen-prevalence than pens classified as low prevalence ($P=0.005$).

The premise of the pen-test was to culture a few devices from which many cattle in a pen could have contributed organisms. Culture of the pen-test devices alone or in parallel with culture of a composite fecal sample may be a diagnostically efficient strategy to characterize *E. coli* O157:H7 fecal shedding in feedlot pens. This diagnostic strategy may be useful as a research tool or as a monitoring tool in the development of animal production food safety programs.

[1]David Smith, assistant professor, Veterinary and Biomedical Sciences, Lincoln; Spring Younts, graduate student, Veterinary and Biomedical Sciences, Lincoln; Mark Blackford, graduate student, Animal Science, Lincoln; Todd Milton, assistant professor, Animal Science, Lincoln; Rodney Moxley, professor, Veterinary and Biomedical Sciences, Lincoln; Jeff Gray, assistant professor, Veterinary and Biomedical Sciences, Lincoln; Laura Hungerford, associate professor, Great Plains Veterinary Educational Center, Clay Center; Terry Klopfenstein, professor, Animal Science, Lincoln.