

## RISK FACTORS FOR SALMONELLA INFECTION IN RANCH TO RAIL CALVES

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*Le premier objectif de cette étude était de déterminer la prévalence de l'infection salmonellique des veaux entrant dans le processus d'engraissement et si l'infection était associée avec les pratiques d'alimentation et d'abreuvement dans les fermes d'origine. Le deuxième objectif était de déterminer l'effet de la présence de Salmonella dans les fèces sur les performances d'engraissement. Un échantillon aléatoire de 4 fèces provenant de chaque ferme a été soumis à la recherche de Salmonella par PCR, et les pratiques d'abreuvement et d'alimentation ont été précisées par une enquête. La prévalence totale était de 5,1 p. cent. Elle n'était pas liée au type de source de l'eau, ni à la fourniture de grain ou de nourriture mélangée, mais était significativement plus faible quand un supplément de foin était fourni (odd ratio : 41 ; intervalle de confiance à 95 p. cent : 18 à 91). Quand de la nourriture ou du fourrage était fourni, il n'y avait pas de différence significative de le fournir dans des mangeoires ou sur le sol. Les programmes de réduction des salmonelles dans les fermes du Texas peuvent impliquer une modification des pratiques de l'alimentation et de l'abreuvement, mais d'autres études sont nécessaires. Il n'y avait pas de risque supplémentaire pour la mortalité et la morbidité chez les veaux porteurs de salmonelles.*

### INTRODUCTION

The United States Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS) is currently introducing a pathogen reduction program to reduce the numbers of pathogenic organisms on meat (1). The guidelines call for monitoring of *Salmonella* as a marker organism and have used a baseline performance study to set the initial target for contaminated heifer and steer products at less than 1% prevalence. The guidelines call for further surveillance and eventual lowering of the threshold (1). *Salmonella* was targeted because it is the most common bacterial cause of food borne illness associated with meat and poultry products and also because it is believed that programs that reduce the prevalence of *Salmonella* contamination also will reduce contamination by other enteric pathogens (1).

Although the regulations explicitly target standard operating procedures at slaughter plants, they implicitly target all stages of the farm-to-table production continuum. For pre-harvest pathogen reduction programs, the identification of so-called critical control points in feedyards, sales barns and cow-calf production units will require considerable study. Thus far, there has been little attention to the reduction of intestinal colonization of *Salmonella* and whether intestinal colonization is associated with farm management practices. In addition to the public health importance of intestinal colonization, studies may well identify important veterinary health issues. For example, the impact of being a carrier of *Salmonella* at entry into a feedyard has never been documented.

The Texas A&M Ranch to Rail program is an information feedback system that allows producers to learn more about their calf crop and the factors that influence value beyond the weaned calf phase of beef production. To these producers, the value of their calves will be affected by both the public health and veterinary problems attributed to *Salmonella* infection. The objectives of this study were twofold. The first objective was to determine the prevalence of *Salmonella* infection in calves entering the feedyard testing in Ranch to Rail and to determine if prevalence is associated with watering and feeding practices on the participating ranches. The second objective was to determine the effect on feedyard performance of calves found to be positive for *Salmonella* in feces at entry into the feedyard.

### MATERIALS AND METHODS

Fecal samples were collected from all calves participating in feedyard testing in Ranch to Rail, North in Amarillo Texas. Bovine calf fecal samples were collected per rectum, from individuals using a disposable rectal examination glove. Following sample collection, each glove was inverted and tied to prevent cross-contamination. The samples were kept refrigerated and shipped to the laboratory daily. All samples were aseptically transferred into individual sterile vials. The vials were stored frozen at -20 C until being thawed in a refrigerator immediately prior to testing. A random selection of 4 fecal samples from each ranch was tested for the presence of *Salmonella* by polymerase chain reaction (PCR)(2).

Feeding practices were determined by mail survey of the participating ranches. Ranchers were asked if they provided hay or grain/mixed feed to the cow herd during the calving to weaning period. If additional feed was provided, it was determined if it was ever fed on the ground or always in a feeder. The crude odds of exposure for both cases and controls were computed ignoring possible clustering within herd. The odds ratios and their confidence intervals were adjusted for possible over dispersion by the method of Williams (7). Chi-square

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analysis was used to compare the proportion of positive and negative calves that received treatment and also for the proportion that died. Analysis of variance was used to compare the average daily gain of the 2 groups.

## RESULTS

Overall prevalence (with equal weighting by herd) was 5.1 % (28/544). Response rate to the mail survey was 96/137 (70%). Of the 96 herds, 79% (76/96) had dirt stock ponds; 50% (48/96) steel tanks; and 30% (29/96) streams or rivers for water sources. Seventy percent (67/96) fed supplemental hay, of which 22% (21/96) of herds were fed hay on the ground and 82% (79/96) provided supplemental grain or feed including 53% (51/96) on the ground.

Prevalence of *Salmonella* infection was not significantly associated with the type of water sources available ( $P > .15$ ). Providing supplemental hay was associated with reduced odds of *Salmonella*-infection (odds ratio = .41; 95% confidence interval = .18 to .91). Feeding of supplemental grain or mixed feed was not significantly associated with prevalence of *Salmonella* ( $P > .15$ ) and the practice of providing feed or hay in a feeder versus feeding on the ground did not significantly ( $P > .15$ ) modify the effects of providing additional feed (table I). When no hay was provided the odds of being PCR-positive for *Salmonella* was .106 (11/104), .051 (9/175) for hay on the ground and .024 (2/82) for hay in feeders. When no grain/mixed feed was provided the odds for calves to be PCR-positive for *Salmonella* were .079 (5/63), .068 (13/191) for grain/mixed feed on the ground and .037 (4/107) for grain/mixed feed provided in feeders.

*Salmonella* infection did not alter the average daily gain, the likelihood of treatments or mortality (table II)

**Table I**  
Exposure odds and odds ratios for management factors

Management Practices	Odds of Exposure		
	Cases	Controls	Odds Ratio (95% CI)
<b>Watering Facilities</b>			
Dirt pond	.059	.068	.88 (.33 to 2.36)
Steel tank	.067	.055	1.21 (.53 to 2.78)
Streams or rivers	.093	.047	1.98 (.87 to 4.49)
<b>Feeding Practices</b>			
Feed hay	.043	.106	.41 (.18 to .91)
Feed hay x feeder interaction	.024	.051	.49 (.12 to 2.04)
Feed grain or mixed feed	.057	.079	.72 (.27 to 1.95)
Feed grain x feeder interaction	.068	.037	.55 (.18 to 1.67)

**Table II**  
Feedyard Performance

Performance	<i>Salmonella</i> pos	<i>Salmonella</i> neg
Average daily gain $\pm$ SE (kg)	1.38 $\pm$ .05	1.34 $\pm$ .01
Morbidity	.32 (9/28)	.29 (152/516)
Mortality	0 (0/28)	.016 (8/516)

## DISCUSSION

A previous study showed a prevalence of 1.5% of fecal samples positive for *Salmonella* by microbiological culture in a population of calves arriving at a Texas feedyard. These calves had been moved from Tennessee, then held at an auction market for 5 days. In that study, prevalence increased to 8% after 30 days in the feedyard and the authors hypothesized that the increase in positive samples was a result of recrudescence rather than new cases because serotypes from the environment were different than those of fecal isolates (3). *Salmonella* shedding can be intermittent when determined by culture (6) but we initially believed that the

increased sensitivity of PCR for bacterial detection would show an 8% or higher prevalence at entry into the feedyard. One explanation for observing a prevalence lower than expected is that the calves in the current study were not transported through markets (10,11) and were not stressed by a long stay at an auction barn (3). The Ranch to Rail program calls for weaning and pre-conditioning several weeks prior to transport to the feedyard and the calves were gathered at central gathering areas for immediate transport to the feedyard. It also is possible that shedding is intermittent even when organisms are detected by PCR.

We hypothesized that concentrated feeds would be a more common source of infection than hay (4). Our findings that feed type was not related to *Salmonella* infection provided evidence to dispute this hypothesis. Our finding that providing hay to the cow herd was associated with a reduced prevalence of *Salmonella* infection was contrary to our hypothesis, so we will not argue its importance as a cause of *Salmonella* spread, but rather suggest that the finding may well be a marker for some other herd management practice. Ranches that do not provide additional hay may be different in pasture management as well as climatic variables. The study involved ranches from a wide range of climatic regions in central and west Texas. It is also possible that closer grazing of pasture could be a source of fecal-oral spread of *Salmonella* or that supplemental hay stabilizes intestinal flora.

We hypothesized that feeding of the cow herd on the ground would increase the prevalence of *Salmonella* in calves because adult carrier cows and the fecal-oral route is the usual source and route of infection for *Salmonella* (5,6,8,9). Providing feed in a feeder reduced the odds of infection by approximately half for both grain and hay but the odds ratio was not statistically significant. Feeding the cow herd on the ground may be a significant disease factor but because of the low prevalence of disease in the population, we were unable to adequately evaluate the hypothesized odds ratio of 0.5 and further study is warranted.

Exposure of the cow herd to running water such as streams and rivers was associated with a doubling of risk, but this difference in risk was not statistically significant. It is possible that water sources are contaminated by cattle that wade into the water to drink or by wildlife (6). Our sample did not contain enough *Salmonella*-positive animals to adequately test the hypothesized odds ratio of 2.0, and further study is warranted.

There was no difference in morbidity or mortality among *Salmonella*-positive calves. We conclude that detection of *Salmonella* by PCR does not identify calves with a chronic disease that reduces growth, increases treatment costs or causes mortality to the infected calf. In order to be a significant veterinary problem these calves would have to be a source of infection for other calves. It is not clear how the rate of new infections in the feedyard is related to the proportion of infected calves at the start of the feeding period.

The study showed a low prevalence of *Salmonella*-infection in the study population. Pathogen reduction programs for *Salmonella* on Texas ranches may involve altering feeding and watering practices but further study is required. There was no additional risk for morbidity or mortality to *Salmonella*-positive calves.

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