Vaccination to control *Salmonella* shedding and improve growth in pigs

Farzan, A.*, Friendship, R.M.

(1) Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON Canada

*corresponding author: afarzan@uoguelph.ca

Abstract

A clinical field trial was performed to determine the effectiveness of an autogenous *Salmonella* Typhimurium bacterin compared to a commercial live *S. Choleraesuis* vaccine in pigs. The association between *Salmonella* shedding and weight gain was also investigated. Nine cohorts of weaned pigs were randomly assigned to one of three treatment groups (injection with *S. Typhimurium* bacterin, vaccination via water with *S. Choleraesuis* vaccine, or a control group receiving no vaccine). In each cohort, the average daily gain was calculated for a selected pen throughout the production stage. Fecal samples were collected bi-weekly and cultured. The pigs vaccinated for *S. Choleraesuis* were more likely to shed *Salmonella* compared to pigs vaccinated with *S. Typhimurium* bacterin and the chance of *Salmonella* shedding in the both vaccinated groups was higher than in the control group. The pigs from pens with a higher *Salmonella* recovery rate experienced slower growth compared to pigs from pens where *Salmonella* was not isolated. This latter finding indicates that there might be an economic incentive for producers to try to control endemic salmonellosis if effective programs could be developed.

Introduction

Immunization appears to be one of the most promising approaches for control of *Salmonella* on swine farms (Denagamage et al, 2007) and live attenuated vaccines has been suggested (Haesebrouck et al, 2004) as the oral immunization can stimulate local gut immunity (Letellier et al, 2001). *Salmonella* Choleraesuis vaccines are commercially available and may provide cross-protection against other *Salmonella* serovars as well (Maes et al, 2001; Kennedy et al, 1999; Roof et al, 1995; Kelly et al, 1992), however *S. Choleraesuis* does not appear to be a common pathogen in Ontario swine herds any longer (Farzan et al, 2008). On the other hand *Salmonella* Typhimurium var. Copenhagen has become the most frequent serovar recovered on Ontario swine farms (Farzan et al, 2008). The objectives of the present study were i) to determine if an autogenous *S. Typhimurium* vaccine or a commercial live *S. Choleraesuis* vaccine can reduce the prevalence of *Salmonella* shedding in pigs, ii) to determine if *Salmonella* shedding is associated with weight gain in pigs.

Materials and methods

The trial was conducted on one farrow-to-finish pig operation with the history of clinical and subclinical salmonellosis. Nine cohorts of weaned pigs, with approximately 350 pigs in each group, were randomly assigned to one of three treatment groups (S. Typhimurium bacterin, S. Choleraesuis vaccine, or as the control group). A *Salmonella* Typhimurium var Copenhagen DT104 strain which was isolated from the study farm was used and the autogenous vaccine was prepared at Gallant Custom Laboratories, Cambridge, Ontario. In each cohort, one pen was randomly selected in the nursery stage and 30 pigs were ear-tagged and weighed. The tagged pigs were weighed again when marketing. Pooled fecal samples were collected bi-weekly from manure found on the pen floor and cultured for *Salmonella*. A Generalized Linear Latent and Mixed Models was used to compare the presence of *Salmonella* in the pooled fecal samples collected from the pens in three groups. A mixed linear regression method with pen as random effect was applied to compare the average daily gain in the vaccinated and the control pigs.

*Safe pork 2009 - Québec city, Québec, Canada*
Results

The number of Salmonella-positive samples in each group is shown in Table 1. The chance of Salmonella shedding during finisher stage in S. Choleraesuis vaccinated pigs [OR=5.2 (1.8, 15.5)] and S. Typhimurium vaccinated pigs [OR=3.3 (1.1, 9.9)] was higher than in the control group. The S. Choleraesuis vaccinated pigs were more likely to shed Salmonella compared to pigs which were vaccinated with S. Typhimurium bacterin.

Table 1: Culture of Salmonella from pooled manure samples collected from pens housing pigs assigned to one of three treatments: S. Choleraesuis live oral vaccine, S. Typhimurium autogenous bacterin given intramuscularly and non vaccinated controls

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Nursery one</th>
<th>Nursery two</th>
<th>Finisher</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Choleraesuis vaccine</td>
<td>Not sampled</td>
<td>14/75 (18.7)</td>
<td>30/156</td>
<td>44/231 (19.0)</td>
</tr>
<tr>
<td>S. Typhimurium vaccine</td>
<td>4/20 (20.0)</td>
<td>8/78 (10.3)</td>
<td>19/156</td>
<td>31/254 (12.2)</td>
</tr>
<tr>
<td>Control</td>
<td>Not sampled</td>
<td>4/48 (8.3)</td>
<td>6/120 (5.0)</td>
<td>10/168 (5.9)</td>
</tr>
<tr>
<td>Total</td>
<td>4/20 (20.0)</td>
<td>26/201 (12.9)</td>
<td>55/432</td>
<td>85/653 (13.0)</td>
</tr>
</tbody>
</table>

The control pigs which had the lowest average of Salmonella shedding showed the best growth performance compared to the vaccinated groups (Table 2). In addition, the pigs from pens with a higher Salmonella recovery rate were deemed to have a lower average daily gain.

Table 2: The impact of vaccination against Salmonella on average daily gain in pigs

<table>
<thead>
<tr>
<th>Group</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>95% Confidence interval</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Choleraesuis vaccine</td>
<td>-26.6</td>
<td>13.5</td>
<td>-53.0, 0.27</td>
<td>0.048</td>
</tr>
<tr>
<td>S. Typhimurium vaccine</td>
<td>-90.8</td>
<td>16.2</td>
<td>-122.5, -59.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Control</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight at weaning (kg)</td>
<td>4.7</td>
<td>2.1</td>
<td>0.7, 8.7</td>
<td>0.022</td>
</tr>
<tr>
<td>Intercept</td>
<td>694.5</td>
<td>31.2</td>
<td>633.3, 755.8</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Discussion

The primary goal of the present study was to investigate the effectiveness of two vaccines to control Salmonella shedding in the market weight pigs. This was a field trial and the prevalence of Salmonella shedding was initially different among the treatment groups with the lowest prevalence of shedding in the control group. Previously we have shown that younger pigs are more likely to shed Salmonella than finisher pigs (Rosendal, 2007) and therefore our estimate of vaccine effectiveness may be biased because the decrease in shedding might be due to age. It is possible that vaccination was performed after pigs had been exposed and that efficacy might have been improved had the pigs been vaccinated sooner. At least one study suggests that it might be prudent to establish a vaccination strategy for pregnant sows to control Salmonella in their piglets (Roesler et al, 2006). Another significant finding of this study is that pigs that appeared clinically healthy but were found to be shedding Salmonella grew slower than pigs not shedding Salmonella. This suggests that there is an economic cost to subclinical Salmonella infection and provides an economic incentive for producers to implement Salmonella control measures.
Acknowledgments

We would like to acknowledge the Ontario Ministry of Agriculture, Food and Rural Affairs - Food Safety Research Program and Ontario Pork for funding the project, as well as Gallant Laboratory Inc. for preparing the autogenous vaccine, Laboratory Service Division at University of Guelph and Laboratory for Foodborne Zoonoses for *Salmonella* culturing and serotyping. The authors would appreciate the pig producer who participated in the project.

References


Investigating the epidemiology of Salmonella in pork. A systematic review approach from slaughter to cooler

O’Connor AM (1*), McKeen JD.(1), Dickson J ,(1),

1) Department of Veterinary Diagnostic and Production Animal Medicine, College of Veterinary Medicine, Iowa State University, USA

*1715 Vet Med, Iowa State University, Ames, IA, USA 50011-1250
E-mail: oconnor@iastate.edu; Fax: 001-515-2941072

The purpose of the review was to describe, based on all available studies that could be identified, the points of introduction and amplification of Salmonella in the harvest process to the cooler. These results were obtained from 15 publications which described 40 studies that evaluated the presence of Salmonella on pork carcasses during primary processing. The review concluded that there is little evidence that Salmonella is introduced into the pork product as it moves along the processing chain to the cooler.

The change in Salmonella prevalence as the carcass moved toward the cooler was evaluated at multiple points during processing. The carcass sampling points evaluated in the review were after bleeding, after stunning, after scalding, after dehairing, after singeing, after polishing, after evisceration, after washing and after chilling. The studies evaluated Salmonella prevalence as the carcass moved from sampling points along the processing line. There were 48 unique comparisons of Salmonella prevalence between points on the processing line in the 40 studies i.e. a comparison of Salmonella prevalence of the carcass after scalding compared to Salmonella prevalence after singeing represents on single comparison. 48 such comparisons were found and of these 40 were associated with either no change or a decrease in Salmonella prevalence on the carcass. Of the 8 times that Salmonella prevalence increased as the carcasses moved closer to the cooler, the observed increase in Salmonella was more than 10% only 4 times.

The median prevalence of Salmonella positive carcasses evaluated in the cooler was 0%, and the mean was 4%. This compares favorably to the median prevalence of Salmonella evaluated at bleeding of 37% and mean of 58%. This suggests that generally the processing procedures in place resulted in decreased carcass contamination as the carcass moved toward the cooler.