THE EFFECT OF TRANSPORTATION STRESS AND FEED WITHDRAWAL ON THE SHEDDING OF SALMONELLA TYPHIMURIUM BY SWINE

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Of the food borne pathogens, the United States Department of Agriculture has identified Salmonella to receive its highest priority (Davies, P., 1997). The consumption of pork products contaminated with Salmonella is a frequent cause of disease. Bryan (Bryan, 1988), for example, demonstrated, for example, that 11% of Salmonella outbreaks were associated with the consumption of pork, while Bean and Griffin (1990) have described numerous outbreaks where pork was identified as the source of contamination. S. typhimurium is one of the leading causes of salmonellosis in man and is the second most commonly isolated serotype from swine (Hargrett-Bean, Pavia, and Tauxe, 1988). Animals exposed to Salmonella generally become persistently colonized for the remainder of their lives and can serve as reservoirs to contaminate other animals and food products. In a study by Wood, et al (1989), it was shown that animals challenged with S. typhimurium continued to shed S. typhimurium until they reached market weight 28 weeks later. In that study, carrier animals were identified because they persistently shed low levels of the challenge organism.

Current data is consistent with the hypothesis that pigs are infected early in life and become persistently infected. Stresses, particularly those associated with shipping, are believed to increase the shedding of Salmonella by carrier animals. While most of this belief stems from anecdotal evidence, in 1970 Williams and Newell 1970 showed that shipment of pigs led to altered (increased) shedding patterns of Salmonella. Thus, as a result of shipping, carrier animals begin to shed higher levels of Salmonella that may be spread within the herd during shipment, at packing plants, and during the processing to finished products. We hypothesize that the number of Salmonella shed by carrier animals on the farm remains low because the immune system suppresses bacterial proliferation. The stress associated with shipment of pigs leads to suppression of the immune system and this in turn leads to uncontrolled growth of Salmonella. In addition, our preliminary data suggests that feed withdrawal prior to shipment to slaughter plants also may be an important factor leading to shedding of Salmonella (Isaacson, unpublished). The work described in this manuscript was designed to test these hypotheses.

MATERIALS AND METHODS

Fifty-six pigs were obtained and after weaning (4-5 weeks of age) each was challenged orally with 1 ml of S. typhimurium strain 798 containing 2 x 10⁸ viable cells. The strain used was resistant to nalidixic acid. Four weeks post challenge the pigs were re-challenged with the same number of organisms. For the first month fecal samples were obtained from each pig on a weekly basis and after the first month, on a monthly basis. When the pigs reached an average weight of 240 pounds, they were divided into four groups. Pigs in groups 1 and 2 were allowed access to feed for the 24 hour period prior to slaughter while pigs in groups 3 and 4 were taken off feed. Pigs in groups 2 and 4 were transported by truck-trailer for 167 miles (approximately four hours in duration) and slaughtered, while the pigs in groups 1 and 3 were slaughtered without transporting. Contents from the intestinal tract at the ileocecal junction were collected from each

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One gram samples of feces or ileocecal contents were added to 10 ml tetrathionate broth, mixed, and four serial 1:10 dilutions were prepared into four additional tubes containing 10 ml tetrathionate broth. All tubes were incubated 24 hours at 37° C. One ml from each tube was added to 10 ml of Rappaport medium, incubated 24 hours at 37° C, and then plated on brilliant green plates. After another 24 hour incubation period (37° C) red colonies from the brilliant green plates were picked and plated on LB agar containing nalidixic acid (50 µg/ml) to confirm that the colonies were the nalidixic acid resistant challenge organism. The relative concentration of challenge S. typhimurium per sample was defined as the highest log₁₀ dilution yielding growth.

RESULTS

All 56 pigs in this experiment were challenged with the nalidixic acid resistant S. typhimurium strain 798 to ensure that all pigs had been exposed to Salmonella. As expected, all animals were shedding the challenge organism one week after being challenged. The mean log₁₀ concentration was 3.35 per gram of feces one week post challenge. There was a steady decrease in the concentration of challenge organism in feces from the subsequent samples. After the re-challenge, the concentration of challenge organism in feces increased and then subsequently fell. One week prior to slaughter only one pig was shedding the challenge organism in feces and the log₁₀ concentration for that pig was 1.

To determine whether any of the treatments affected the presence of challenge organism in the intestinal tract, contents from the ileocecal junction were collected and cultured. Ileocecal contents were used instead of feces because after feed withdrawal and transporting, fecal samples could not be collected from a large number of the pigs. The culture results are shown in Table 1. Only 3 of 14 pigs in group 1 (on feed and no transport) were positive for S. typhimurium while 11/14 pigs in group 2 (on feed and transported) were positive. The difference between these groups was statistically significant (p=0.023). The mean concentration of challenge organism in samples from each group did not differ ranging from log₁₀ 2.3-2.6.

DISCUSSION

The objective of this study initially was to determine whether transportation related stress increased the risk that a pig would shed Salmonella in feces (or intestinal contents). In our preliminary experiments, there was evidence that suggested that feed withdrawal also might be a stressor that increased shedding of Salmonella. To test these two possibilities, a two by two matrix study was designed. Four groups of pigs were employed: feed, no transport; feed,
transport; no feed, transport; and no feed, no transport. To insure that all pigs had an equal opportunity to be persistent carriers, all were challenged with a nalidixic acid resistant strain of *S. typhimurium* that is known to persistently colonize pigs. Twenty-four hours before slaughter, the pigs were randomized into four equal groups of 14 and treated as described. As expected, pigs that remained on feed and not transported had the lowest incidence of *S. typhimurium* in ileocecal contents (3/14). The highest incidence (11/14) was in pigs that were transported and remained on feed. The two other groups had an intermediate incidence. We had expected that the pigs that were subjected to feed withdrawal and transported would have experienced the greatest degree of stress and would have had the highest number of *S. typhimurium* positive samples. However, this was not the case. Our interpretation of these results is that transportation related stress does contribute to increased shedding of *Salmonella*. This is consistent with the study of Williams and Newell (1970). It is interesting that when assessed as a single variable, feed withdrawal also appeared to increase the incidence of *S. typhimurium* shedding. However, when feed withdrawal was combined with transportation, the effects were not additive and shedding did not increase further. This suggests that feed withdrawal may actually reduce the incidence of *Salmonella* shedding when combined with transportation (5/14 pigs compared to 11/14 pigs). Thus, the practice of feed withdrawal prior to shipment of pigs to market, which was developed to reduce the amount of feces in the gut at slaughter, also may actually reduce the incidence of pigs that are actively shedding *Salmonella*.

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REFERENCES


