Productivity and *Salmonella* Incidence of Swine Reared in Differing Management Systems

J.N. Nielsen, J.A. Patterson, P. Boccazzi, J. Frank, A. Sutton, A. Schinckel, and B. Richert
Department of Animal Sciences

Food contamination due to *Salmonella* is the cause of large numbers of human food-borne illnesses worldwide. Reduction in fecal shedding and prevention of new *Salmonella* infections in livestock during the late finishing/marketing phase of production are critical control points associated with human food safety. In Scandinavian countries, swine producers who have large numbers of *Salmonella* positive swine entering the food chain are penalized if measures are not instituted to decrease the incidence. This is also likely to happen in the United States, as meat packing plants begin to implement new food inspection procedures based on Hazard Analysis Critical Control Points (HACCP).

The objective of this research was to compare multi-site segregated early weaning to continuous flow rearing on the shedding of Salmonella during the late finishing phase of swine production. Since it is common practice to feed growth promotant antibiotics, and to withhold feed from pigs for 12-24 hours prior to slaughter, these variables were also studied. Measurements of productivity, such as average daily gain (ADG, lb/day) and number of days to reach market weight of 240-260 lbs., were also examined.

Methods

Two hundred eighty-eight pigs from two different genetic sources were used in this study. Source A pigs had average lean growth and high feed intake, while Source B pigs had high lean growth and average feed intake. Littermate pigs were divided among 4 treatment groups: continuous flow (CF) medicated, CF nonmedicated, segregated early weaned (SEW) medicated, and SEW nonmedicated. Pigs were housed in pens of 6-7 animals, all penmates being from a single genetic source and treatment group. The SEW pigs (144) were placed in clean, off-site nursery facilities at approximately 13 days of age and moved at 8 weeks of age to a cleaned, disinfected, curtain-sided grower-finisher building at a third site, where they were reared until market weight. Littermate pigs (144) were weaned at approximately 26 days of age into an on-site all-in, all-out nursery. At 8 weeks of age, they were moved into a continuous flow finisher, interspersed with pens of varying age pigs, where they remained until reaching market weight. Pigs in the medicated treatment groups received feed supplemented with Carbadox (50 g/ton) in nursery rations and Bacitracin Methylene Disalicylate (BMD, 30 g/ton) in grower/finisher rations. Pigs with clinical signs of illness in any treatment group were treated with other short-term antibiotics as recommended by attending veterinarians.

Rectal fecal specimens were collected from all study pigs at approximately 4 1/2 months of age and at 3-4 week intervals thereafter until slaughter. Fecal specimens were cultured for the presence of *Salmonella* as detailed elsewhere (Nielsen et al., 1997). All pigs that tested positive for *Salmonella*,

as well as their penmates, were re-tested at weekly intervals. When any pigs in a *Salmonella* positive pen reached market weight, all penmates had feed withheld for approximately 24 hours on the day prior to shipping. Rectal fecal specimens were collected before and after the 24 hour fast. Subsequent to the fast, pigs being marketed were allowed access to feed for approximately 4 hours, then sorted, mixed, shipped to the slaughterhouse (approximately 1 hour transit time) and held without food for an additional 12-18 hours prior to slaughter. When possible, cecal contents, cecal wall and ileocecal lymph nodes were collected and cultured from *Salmonella* positive pigs and negative penmates at slaughter.

Results

Of the 288 pigs included in this study, a total of 9 pigs (3%) tested positive for *Salmonella* spp. on one or more occasions. Eight of the 9 positive pigs (89%) were reared in the SEW facilities. Seven of the 9 *Salmonella* positive pigs (78%) were in medicated treatment groups. Two serotypes of *Salmonella* were identified from pigs in this study. *Salmonella anatum* (3 pigs) was isolated only from Source A pigs, while *Salmonella derby* (6 pigs) was isolated from all positive Source B pigs, as well as one pig (deviant serotype) from Source A. The pig from which the deviant serotype was isolated was the only pig that tested positive for *Salmonella* in the continuous flow facilities, and this pig only tested positive in cecal contents at slaughter.

No pigs subjected to an 18-24 hour fast converted from fecal negative to positive status at the end of the 24 hour fast. A number of pigs underwent multiple 18-24 hour fasts on successive weeks without being mixed and transported (3 pigs fasted 2 successive weeks, 2 pigs fasted 3 successive weeks, and 2 pigs fasted 4 successive weeks); none of these pigs had detectable levels of *Salmonella* spp. in feces at 3-7 days post-fasting. Three pigs had *Salmonella* isolated from cecal contents only at slaughter. One was the pig from the continuous flow facility from which the deviant serotype was isolated; the remaining 2 pigs were penmates of pigs identified as *Salmonella* positive prior to slaughter.

Of the three pigs positive only at slaughter, two had *Salmonella* isolated only from the cecal contents. The third pig from the SEW facility was culture positive for *Salmonella* in the cecal contents, the cecal wall and ileocecal lymph node. This pig had two penmates that also cultured *Salmonella* positive; one penmate was positive once 3 weeks prior to slaughter, and the second penmate was fecal culture positive 3 weeks prior to slaughter and only cecal contents were positive at slaughter. Carcasses of 2 additional animals that tested positive prior to slaughter were unavailable for testing at the time of slaughter.

The production data were complicated by an outbreak of porcine respiratory disease complex in the SEW facilities during the mid-finishing phase of production. This compromised comparison of production data between SEW and CF facilities; however, there are notable trends when comparing the production data of *Salmonella* positive pigs with the overall production data for their treatment group within each facility. The one CF barrow receiving medicated feed that tested positive for *Salmonella* had an ADG of 1.22 as compared to the overall ADG of 1.29 for medicated CF Source A barrows. This pig took 212 days to reach market weight compared to 194 days for the overall average for that group. Three different treatment groups contained *Salmonella* positive pigs in the SEW facilities. One Source B group that did not receive medicated feed had an ADG of 0.92 compared to 1.26 for the

group overall, and weighed only 196 lb at 212 days of age, while the remainder of the group took an average of 197 days to reach market weight. The remaining two groups of *Salmonella* positive pigs in the SEW unit all received medicated feed throughout the study. One Source B group of barrows had an ADG of 1.19 compared to 1.34 for the group overall; these pigs took an average of 198 days to reach market weight compared to 187 days for the group overall. The last group of Source A *Salmonella* positive gilts had an ADG of 1.16 compared to 1.25 for the group overall, and took an average of 207 days to reach market weight compared to 197 days for the group overall.

Discussion

The combination of fasting followed by mixing with other pigs, shipping and holding in a strange environment prior to slaughter resulted in either resurgence and fecal shedding in pigs carrying undetected *Salmonella*, or initiation of *Salmonella* infection in the three animals found positive only at slaughter. A fourth pig was positive at an earlier sampling in the late finishing phase as well as at slaughter. This could be indicative of either a prolonged carrier state in this pig with intermittent shedding, or continued cycling of the organism and re-infection within a pen of pigs. Three animals that tested positive at sampling periods in the late finishing phase were negative for *Salmonella* at slaughter.

Salmonella was isolated from tissues (cecal wall and ileocecal lymph node) of only one of 16 pigs tested at slaughter. The presence of *Salmonella* in these tissues would support the hypothesis that this was a carrier pig capable of intermittent fecal shedding of *Salmonella*. However, this pig never had *Salmonella* isolated from feces in the finishing phase, although 2 of its penmates were positive. One of these penmates also had *Salmonella* isolated from cecal contents at slaughter. These results support the hypothesis that the combined stress of fasting, transport to unfamiliar surroundings, and commingling with a few carrier pigs may cause shedding and spread of *Salmonella* among pigs.

Production data demonstrated a definite decrease in productivity in *Salmonella* positive swine as compared with their *Salmonella* negative counterparts. *Salmonella* positive pigs took 10-15 days longer to reach market weight, and had an average daily gain of 0.07-0.34 lb/day less than their treatment groups overall. This raises the question of whether pigs that exhibit poor growth rate are simply more susceptible to infection with *Salmonella*, or whether *Salmonella* infection is the cause of the observed poor growth rate. Segregrated early weaning management systems produce animals with a higher overall health status and productivity than continuous flow systems; consequently, one might expect these pigs to have a lower incidence of infection with *Salmonella*. Although the numbers of pigs examined in this study are too low to be statistically significant, more *Salmonella* positive pigs were identified in the SEW management system than in the CF system. This observation also agrees with that of a previous study (Nielsen and Patterson, 1996).

Further studies utilizing serologic tests of pigs for antibodies to *Salmonella* combined with fecal culture would help determine whether pigs positive only in cecal contents at slaughter were indeed non-shedding carriers prior to stressing, or were naive pigs that became infected during commingling and holding prior to slaughter. In addition, sequential serologic tests, coupled with sequential production data throughout the lifetime of swine, could be used to address whether productivity is decreased for other reasons and leads to infection with *Salmonella*, or whether infection with *Salmonella* is the

inciting cause of decreased productivity in the *Salmonella* positive swine. Further studies on *Salmonella* incidence rates in swine reared under high health management systems, as well as studies of intervention methods to decrease *Salmonella* incidence, are warranted.

References

Nielsen, J.N., and J.A. Patterson. 1996. Presence and Prevalence of *Salmonella*, *Campylobacter* spp. and O-serotypes of *E. coli* in Swine Raised Under Differing Management Schemes. In: First International Symposium on Ecology of Salmonella in Pork Production. Ames, Iowa, USA, 11-13 March, 1996. p. 48.

Nielsen, J.N., J.A. Patterson, A. Sutton, A. Schinckel, B. Richert, and P. Boccazzi. 1997. The influence of growth promotant antibiotics and management system on the presence and prevalence of *Salmonella* in swine. In: Second International Symposium on Epidemiology and Control of *Salmonella* in Pork. Copenhagen, Denmark, 20-22 August, 1997.