SALMONELLA SEROTYPES IN A MULTIPLE-SITE PRODUCTION SYSTEM

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Long-term trends in production agriculture in the USA are towards fewer and larger producers. The number of hog operations declined from 430,000 in 1984 to 209,000 in 1994. In 1991, although 84% of operations had less than 1000 head, these accounted for only 22% of hogs produced. Increased farm size means that emergence of a foodborne pathogen on a farm can affect a greater volume of product and potentially affect more consumers (Hueston and Fedorka-Cray 1995). Alternatively, some intensive production practices allow greater control of the environment and may lead to an overall safer food supply. "Improving production systems" is popularly promoted to reduce exposure of animals to Salmonella. However, apart from historically important measures such as banning swill feeding and general improvement of hygiene, recommendations on how to achieve this are often superficial. This is a consequence of lack of information about the epidemiology of sub-clinical Salmonella infection on swine farms.

The structure of the US swine industry is changing radically with the emergence of large integrated production systems. Features of these systems are the use of multiple-site (MS) production (different phases of production raised on separate sites) and all-in/all-out (AIAO) management of both nursery and finisher phases of production (all animals are removed from a location before introducing a new group). In the United States in 1995, AIAO management of finishing barns was practiced on 42.4% of operations, representing 51% of national hog production (Bush 1996). A further trend in the industry is the adoption of segregated early weaning (SEW) methods, and reduction of average weaning ages (now typically 17 to 19 days in North Carolina) may impact the epidemiology of Salmonella in MSAIAO systems.

Based on principles of hygiene as well as apparent benefits of MSAIAO production in controlling some infectious diseases of growing pigs, it has been postulated that AIAO management of the finishing phase may be useful for controlling Salmonella in growing pigs (Dahl et al., 1996). However, in a study of 29 herds in North Carolina, we found MSAIAO production appeared to have no benefit in reducing the prevalence of Salmonella of finishing pigs, compared with conventional farrow-to-finish systems (Davies et al., 1996). In fact, our data indicated that Salmonella may be more prevalent in finishing pigs produced in these systems. We felt that all-in/all-out management per se was unlikely to be detrimental to Salmonella control, and that 'system level' factors may be important. We are now conducting longitudinal studies to describe the epidemiology of Salmonella infections in MSAIAO systems in North Carolina. This paper presents results of a cross-sectional study, conducted as a prelude to a longitudinal study, of Salmonella prevalence in a multiple-site system.

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MATERIALS AND METHODS

Production system and sampling: Over a two month period in 1996, we sampled pig populations present on all sites of a 4-level production pyramid as follows:

1) Level 1 - Gilt development (Farm A - 10,000 head gilts): Two groups of gilts (total 207) destined for farm B were sampled. These animals are a cohort in a 2 year study.

2) Level 2 - Sow farms (Farms B and C - approximately 1000 sows): At the time of sampling, piglets weaned from these farms each week were transported to the nursery and commingled. At least 90 breeding females were sampled per farm, comprising 30 or more females in each of the breeding, gestation, and lactation phases of production. Approximately 10 boars were also sampled on each farm.

3) Level 3 - Nursery (Farm D - 4500 pigs): The nursery facility consists of 4 buildings of 2 rooms each, and is managed all in/all out by room. Rooms have 32 pens, each containing about 20 pigs. The accommodation has 100% woven wire floors. The pits under the floors are flushed with recycled lagoon water. Feed and water are supplied ad libitum. Water is supplied by drinking nipples. Samples were collected from 96 individual pigs, being 32 pigs in each of 3 randomly selected rooms, with the most recently introduced group not eligible. At approximately 10 weeks of age, pigs are transferred from the nursery to one of the 3 finishing herds.

4) Level 4: Finishing (farms having either 3 (farm E) or 6 (farms F and G) buildings managed AIAO). On all 3 farms, barns have 32 pens containing about 20 pigs each. The pigs are housed on fully slotted concrete floors. The pits under the floors are flushed with recycled lagoon water. Feed and water are supplied ad libitum. Water is supplied by drinking nipples. The buildings are equipped with curtain-sided tunnel ventilation (large fans at rear end of the building). On each farm, 3 barns were randomly chosen, in which 4 animals were sampled from every 4th pen, for a total of 96 pigs per site.

Bacteriology: To detect Salmonella organisms, 10g from each fecal sample was diluted 1:9 with 2% buffered peptone water and incubated at 37°C overnight. A 100 μl aliquot was transferred to 9.9 ml of Rappaport-Vassiliadis R10 broth and incubated 42°C for 24 hours. A loopful of broth was streaked on XLT4 and modified Brilliant Green agars and incubated at 37°C overnight. Suspect Salmonella were transferred to triple-sugar-iron and urea agar slopes, and isolates identified as Salmonella were forwarded to the National Veterinary Services Laboratories, Ames IA, for serotyping.

RESULTS AND DISCUSSION

Salmonella were isolated from pigs on all farms sampled, with multiple serotypes isolated from all but one site. Prevalence ranged from 3.4% at the gilt developer to 18% and 22% at the breeding farms (Table 1). No serotype was isolated from all levels of the pyramid, although S. derby was isolated from farms B, C, D, E and F. At all 3 finishing sites, the most prevalent serotype was either S. typhimurium or S. typhimurium (copenhagen), neither of which were isolated from either breeding farm or the nursery. Salmonella infection was widespread in this system, which continues to maintain high levels of health and productivity. The finding of multiple serotypes on most farms is consistent with earlier observations in North Carolina when large numbers of individual fecal samples have been cultured.

The most significant finding is the difference in serotype profile observed among all levels of the pyramid. This observation has potentially important implications for control of Salmonella in these systems, as it suggests that Salmonella transmission from sows to piglets in the breeding herd may be a relatively unimportant source of infection of finishing pigs, relative to the finishing environment itself. A recent review of epidemiologic studies in Holland, in primarily
2-site production systems, concluded that 'contamination by endemic flora in finishing sites was the predominant source of infection of finished pigs, rather than infection originating from breeding farms or other sources' (Berends et al., 1996). This conclusion is supported by recent data from Denmark (Dahl et al., 1996). Although our cross-sectional data also support this view, the possibility of cohort effects must be considered. It is feasible that the serotype profile of the sow farms had changed during the 4 to 6 months from when the market-age hogs were born and the time when both sows and market hogs were sampled. We have observed considerable variability in serotype profile in initial longitudinal studies in sow farms. However, the serotype profile at Farm E was essentially unchanged from that observed in another sampling one year previously. We are currently studying Salmonella shedding in cohorts of growing pigs to address this question.

Table 1: Salmonella prevalence in a multiple-site production system

<table>
<thead>
<tr>
<th>Farm type (farm)</th>
<th>Prevalence</th>
<th># serotypes</th>
<th>Predominant serotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gilt developer</td>
<td>3.4</td>
<td>3</td>
<td>tennessee</td>
</tr>
<tr>
<td>Breeding farms</td>
<td>18</td>
<td>3</td>
<td>derby</td>
</tr>
<tr>
<td>(C)</td>
<td>22</td>
<td>4</td>
<td>heidelberg</td>
</tr>
<tr>
<td>Nursery</td>
<td>6</td>
<td>2</td>
<td>derby</td>
</tr>
<tr>
<td>Finishing</td>
<td>(E) 16</td>
<td>1</td>
<td>typhimurium copenhagen</td>
</tr>
<tr>
<td>(F)</td>
<td>12.5</td>
<td>4</td>
<td>typhimurium</td>
</tr>
<tr>
<td>(G)</td>
<td>12</td>
<td>4</td>
<td>typhimurium copenhagen</td>
</tr>
</tbody>
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REFERENCES


