A Retrospective Study of Salmonella in Swedish Pig Herds

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Introduction

Sweden has achieved efficient control of salmonella in the food production sector. Due to this control, red and white meat produced in Sweden can today be claimed to be virtually free from salmonella (1). The different parts of the control programmes have been described in detail elsewhere (2,3). When joining the European Union in 1995, Sweden acquired additional guarantees regarding salmonella when importing live animals and fresh meat, based on the control programme (5).

Ever since 1961, when effective legislation was put in place, salmonella findings in animals reared for food production have been the cause for authorities to take action, including restrictions put on the farm, and measures implemented to ensure that infection is controlled. Hence, there exist official records of all noticed salmonella findings in pig herds. However, there has been no systematic study of cases published. In many countries, salmonella originating from pork and pork products, accounts for a considerable part of salmonella cases in humans (6) and it has been estimated that annual costs due to salmonella in pigs in EU-countries alone, account for more than 600 million Euro. There is also a growing interest in trying to control salmonella contamination in pork and pork products by pre- and post harvest measures, including control measures at the herd level. A retrospective study of cases in a country which has achieved effective salmonella control may give new insights into important control mechanisms.

The aims of the present study were to review salmonella cases in Swedish pig herds, detected in the years 1971-1991 and to present data regarding herds, control measures and sampling.

Material and Methods

Records from all notified cases of salmonella in pigs during the years 1971-1991 compiled at the Swedish Board of Agriculture, were checked for completeness of data and accuracy. In addition, contacts were taken with veterinarians that had been involved. For the purpose of this study, a case of salmonella in a pig herd was defined as an isolation of salmonella from a pig, leading to notification and restriction put on the herd from which the pig originated. If salmonella was found more than once in a herd, each new finding was defined as a case, if herd restrictions had been released in between.

The following data were recorded for each case, as defined above: geographical location, date of restrictions put on farm and restrictions released, how salmonella was detected, sero and phage type of salmonella species isolated, type and size of herd and results of salmonella sampling schemes of pigs.

Six herds where salmonella had been found were excluded, as it was not possible to verify if they were put under restrictions. Sixteen herds were excluded for various reasons, mainly due to lack of accuracy in files regarding the salmonella status of herds. A few herds consisting of cattle or poultry and pigs were excluded, as salmonella was found primarily in the former species, even though at one time or another, an identical serotype was found in the pigs. Statistics regarding Swedish swine production, during the years 1971-1991 were gathered from conventional statistical sources (7).

Results

In total 180 findings of salmonella encompassing 158 herds fulfilled the case definition used. Eight herds were put under restrictions twice, and one herd each, three times, four times and ten times respectively. In eight of the eleven herds with more than one case, the same serotype was isolated in consecutive cases. The herd with ten cases of salmonella was put under restriction for a total of 2219 days during the period 1971-1991. All cases were due to Salmonella Derby.

In four cases clinical suspicions of salmonellosis led to sampling of herds, in 51 cases salmonella was detected by post mortem investigations, in 110 cases salmonella was detected by investigations at normal or sanitary slaughter and in 15 cases reasons for investigations were unknown. There were no major differences between serotypes as regards reasons for sampling. In Figure 1, annual distribution of all cases according to major serotypes is shown.

In 60 of the cases, salmonella could be reisolated in the herds, after the initial finding (R-pos). In the other cases, salmonella was not found (R-neg), in spite of rather intensive
sampling. R-neg cases were distributed on fattening herds
29; integrated herds 17; piglet production herds 29; and
unknown, 45. Corresponding figures for R-pos were 30, 6, 3
and 21. In Table 1 is shown distribution of herd sizes. R-pos
herds generally were larger than R-neg.

In Table 2 is shown distribution of serotypes. Salmonella
Derby. Typhimurium and Choleraus were accounted for 68 and
80% respectively of cases in R-pos and R-neg. In total 21
serotypes were found. The last cases of Salmonella
Choleraus were seen in 1979. In Table 3, distribution of
phagetypcs (8) of Salmonella Typhimurium isolates is
shown. Phagetype 8 dominated, making up 32% of all
isolates.

In Figure 2, the geographical distribution of cases and
total number of pigs produced, can be seen. With few
exceptions, number of cases were closely correlated to
number of pigs per county.

In Figure 3, restriction periods, according to serotypes
are compared. Periods varied considerably but Salmonella
Derby seemed to have a tendency for longer restriction
periods.

In Table 4 results of culturing samples for the presence
of salmonella, is presented. Faecal samples from R-pos
showed a recovery rate of 3.3%, and corresponding figures
for samples taken at slaughter were 3.1%. There were
differences between serotypes, Salmonella Choleraus
was found less frequently in faecal samples compared to
Salmonella Derby and Salmonella Typhimurium. In R-neg a
mean per case of 46 faecal samples and 93 samples at
slaughter were taken without finding salmonella.

Discussion

The most interesting finding is the very low rates of
reisolating. In only 33% of the cases, salmonella was
reisolated. Actual number of herds in this group was even
lower as in 11 herds more than one case occurred. There may
be several reasons for this. False positive results due to
cross contamination at post mortem or at the laboratory is
one probable cause.

A major part of the cases though, is thought to be true
cases, but it has not been possible to find salmonella in the
herd of origin. This is in line with present Swedish experi-
ences, where findings at slaughter of salmonella in intestinal
lymph nodes, seldom are confirmed when tracing back to the
herd. In 1997 and 1998, none of six and ten findings respect-
ively, were traceable (9). The probable cause is that infec-
tion is transient, or that the prevalence is too low, to be
detected by faecal sampling. It is also probable that intesti-
nal lymph nodes may harbour salmonella, without the pig
excreting salmonella or excreting intermittently. Size of herds
may also have influenced the outcome of an initial infection.
Herd sizes were on average larger in R-pos cases.

Three serotypes dominated. Salmonella Derby and
Salmonella Choleraus were more often reisolated in herds
and Salmonella Typhimurium and Salmonella Dublin were
less frequently so.

Of totally 56 Salmonella Typhimurium cases, only nine
(16%) were R-pos cases. The particular strain of Salmonella
Typhimurium involved may be of importance. Distribution of
phage- types showed a wide range, including types more
often seen in cattle (8), and types typically found in birds (1,
9) (10). Unfortunately, the phage-typing system used can not
be compared with present systems. Restriction periods often
were shorter for Salmonella Typhimurium cases than for
other common serotypes and Salmonella Typhimurium was
more often found in piglet producing herds (data not
shown).

Salmonella Derby was more often found in R-pos than in
R-neg cases. Salmonella Derby also had a tendency for
longer restriction periods. This could indicate that Salmo-
rella Derby has an ability to chronically infect herds,
something that is in line with present Swedish experiences.

Number of cases has been consistently low since around
1980 and figures have not changed significantly after 1995
when active surveillance at slaughter- houses and in herds
was introduced. This indicates that the situation is stable in
spite of extensive changes taken place as regards herd size
and management systems.

Isolation rates of salmonella from different materials
differed slightly. Samples taken at slaughter, consisted
mostly of swabs or cuts from the liver and/or carcass swabs.
Faecal samples were taken by different techniques, e.g. from
the box floor, as pooled samples, rectal swabs or rectal
content. Culture techniques may also have differed slightly
between laboratories.

Faecal sampling may have a low sensitivity to detect
salmonella in pigs (11, 12). It is likely that in both R-pos (after
restrictions were released) and R-neg cases, some herds still
were infected with salmonella. Results from other parts of
the Swedish salmonella control programme, such as routine
sampling of pigs in herds and at slaughter, strongly indicate,
that most such infections if they occur are cleared out of
herds rapidly, and do not pose a significant threat either from
the point of view of spread between herds or as a human
health problem (13, 14, 9, 15). The control, even though not
guaranteeing complete eradication of salmonella in all
infected herds, still reached the goal, i.e. to produce pork
and pork products, virtually free from salmonella.
References


Table 1. Distribution of cases according to herd size

<table>
<thead>
<tr>
<th>Herd size</th>
<th>Not reisolated in herd</th>
<th>Reisolated in herd</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1000 pigs</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>500-999</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>100-499</td>
<td>28</td>
<td>9</td>
</tr>
<tr>
<td>50-99</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>20-49</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>1-19</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>n.i.</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

1) No information available

1999 ISECSP. Control Programs 345
Table 2. Distribution of serotypes of salmonella found in pig herds

<table>
<thead>
<tr>
<th>Serotypes</th>
<th>All cases</th>
<th>Not reisolated in herd</th>
<th>Reisolated in herd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhimurium</td>
<td>56 30.8%</td>
<td>47 38.5%</td>
<td>9 15.0%</td>
</tr>
<tr>
<td>Derby</td>
<td>42 23.1%</td>
<td>18 14.8%</td>
<td>24 40.0%</td>
</tr>
<tr>
<td>Cholerasuis</td>
<td>33 18.1%</td>
<td>18 14.8%</td>
<td>15 25.0%</td>
</tr>
<tr>
<td>Dublin</td>
<td>16 8.8%</td>
<td>14 11.5%</td>
<td>2 3.3%</td>
</tr>
<tr>
<td>Anatum</td>
<td>5 2.7%</td>
<td>3 2.5%</td>
<td>2 3.3%</td>
</tr>
<tr>
<td>Livingstone</td>
<td>4 2.2%</td>
<td>2 1.6%</td>
<td>2 3.3%</td>
</tr>
<tr>
<td>Montevideo</td>
<td>4 2.2%</td>
<td>4 2.5%</td>
<td>0</td>
</tr>
<tr>
<td>Agona</td>
<td>2 1.1%</td>
<td>2 1.6%</td>
<td>0</td>
</tr>
<tr>
<td>Infantis</td>
<td>2 1.1%</td>
<td>2 1.6%</td>
<td>0</td>
</tr>
<tr>
<td>Sinstorf</td>
<td>2 1.1%</td>
<td>2 1.6%</td>
<td>0</td>
</tr>
<tr>
<td>Mbandaba</td>
<td>2^1 1.1%</td>
<td>2 1.6%</td>
<td>0</td>
</tr>
<tr>
<td>Bredeney</td>
<td>1 0.5%</td>
<td>0</td>
<td>1 1.7%</td>
</tr>
<tr>
<td>California</td>
<td>1 0.5%</td>
<td>1 0.8%</td>
<td>0</td>
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<tr>
<td>Flint</td>
<td>1 0.5%</td>
<td>1 0.8%</td>
<td>0</td>
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<tr>
<td>Fresno</td>
<td>1 0.5%</td>
<td>1 0.8%</td>
<td>0</td>
</tr>
<tr>
<td>Hato</td>
<td>1 0.5%</td>
<td>1 0.8%</td>
<td>0</td>
</tr>
<tr>
<td>Liverpool</td>
<td>1 0.5%</td>
<td>0</td>
<td>1 1.7%</td>
</tr>
<tr>
<td>Münster</td>
<td>1 0.5%</td>
<td>1 0.8%</td>
<td>0</td>
</tr>
<tr>
<td>Newington</td>
<td>1 0.5%</td>
<td>0</td>
<td>1 1.7%</td>
</tr>
<tr>
<td>Stanleyville</td>
<td>1 0.5%</td>
<td>0</td>
<td>1 1.7%</td>
</tr>
<tr>
<td>Thomson</td>
<td>1^2 0.5%</td>
<td>1 0.8%</td>
<td>0</td>
</tr>
<tr>
<td>Serotype not available</td>
<td>4 2.2%</td>
<td>2 1.6%</td>
<td>2 3.3%</td>
</tr>
</tbody>
</table>

1) one case; double infection with *Salmonella* Newington
2) double infection with *Salmonella* Typhimurium
Table 3. Distribution of *Salmonella* Typhimurium cases according to phage types

<table>
<thead>
<tr>
<th>Phage type</th>
<th>All cases</th>
<th>Not reisolated in herd</th>
<th>Reisolated in herd</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>18</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Not typeable</td>
<td>9</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>var cop</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>var cop 1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>var cop 9</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>No information</td>
<td>11</td>
<td>8</td>
<td>3</td>
</tr>
</tbody>
</table>

|              | 56        | 47                      | 9                  |

Table 4. Isolation of *Salmonella* from samples taken in cases where salmonella was reisolated

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Faecal sampling</th>
<th>Sampling at slaughter</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Samples</td>
<td>Positive</td>
<td>Samples</td>
</tr>
<tr>
<td>S. Derby</td>
<td>2503</td>
<td>76</td>
<td>37569</td>
</tr>
<tr>
<td>S. Cholerasuis</td>
<td>781</td>
<td>4</td>
<td>9242</td>
</tr>
<tr>
<td>S. Typhimurium</td>
<td>1170</td>
<td>26</td>
<td>1479</td>
</tr>
<tr>
<td>Other serotypes</td>
<td>1158</td>
<td>80</td>
<td>517</td>
</tr>
<tr>
<td>Total</td>
<td>5612</td>
<td>186</td>
<td>48807</td>
</tr>
<tr>
<td></td>
<td>3.3%</td>
<td>3.3%</td>
<td>3.1%</td>
</tr>
</tbody>
</table>
Figure 1. Distribution of cases according to year and serotype

Figure 2. Distribution of pigs produced in Sweden and cases of salmonella according to county 1971, 1981, 1991
Figure 3. Restriction periods for cases where salmonella was reisolated