SPECIFIC CLEANING AND DISINFECTION PROCEDURES FOR *SALMONELLA* INFECTED PIG HERDS

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SUMMARY

The paper describes the in-depth analysis of the reasons for an extreme high Salmonella load of a high-health and well-managed pork production system and the specific cleaning and disinfection measures that were taken to reduce the prevalence of Salmonella antibody positive finisher pigs produced by the system. The results and experiences gained during the study are discussed.

Keywords: salmonella load, high-health pork production system, cleaning and disinfection

BACKGROUND AND OBJECTIVE

In September 2002, the first German nation-wide quality management and assurance system for food production was launched. This QS-System ("QS" stands for "Quality and Safety") started with the pork production chain in response to a series of scandals and a growing distrust of the consumers in meat, especially in pork. QS is a non-governmental voluntary quality management system developed and established solely by the following five sectors of the food production chain: the feed industry, farming, the slaughter industry, the meat processing industry and retail.

One of the major modules of the QS-System is a Salmonella monitoring programme. Due to the fact that slaughter plants and meat processors have already good hygiene procedures (GHP) and good manufacturing procedures (GMP) which include activities targeted at Salmonella reduction, the Salmonella monitoring within the QS-System focuses on the primary production, i.e. mainly on the finishing phase of the pig production. The QS Salmonella monitoring programme aims at categorising the participating herds according to the risk of introducing Salmonella into the pork chain via infected slaughter pigs. The following three categories are differentiated: Cat. I = low risk, Cat. II = medium risk, and Cat. III = high risk. The classification into the categories is calculated quarterly based on the percentage of salmonella antibody positive meat juice samples during the last 12 months for each farm (ANONYMOUS, 2007a).

The presented study is a contribution to a better understanding of Salmonella infection sources and reservoirs in pig production systems, especially in those with remarkably high hygiene levels, where producers and their farm veterinarians are often at a loss convinced of the idea that nothing can be improved. The objective of this study was to detect "hidden" Salmonella infection sources and reservoirs in a well-managed group of pig herds with a hygiene level far above average.

MATERIAL AND METHODS

Three very cooperative owners of well-managed herds with a high hygiene level, but continuously categorised into Cat. III, were chosen for this study. All of them did not see any of the traditionally accepted risk factors (e.g. frequent diarrhoea, rodent infestation, hygiene deficiencies, pets in the barn etc.) on their farms. Furthermore, they themselves and their veterinarians did not know where to start with intervention measures.

The study herds are:

- a breeding herd with 680 sows with an extremely well-run biosecurity system (only shower-in access to the barn, separate isolation barn for gilts, ectoparasite-free status),
- a well-managed, visually always clean separate nursery (1000 piglets with 6 to 18 kg on flat decks, 1000 grow-finishers with 18 to 30–40 kg on slatted floors), and
- three finisher herds that receive exclusively weaner pigs from this breeding herd through the described nursery.

In the first phase of the study, selected and earmarked sows, piglets, weaners and finishers were repeatedly tested serologically (SALMOTYPE® Pig Screen ELISA, Labor Diagnostik Leipzig, Leipzig) and bacteriologically (DIN ISO 6579) for identifying the time and location of the infection. 42 sows were included into the study representing animals of different litter numbers ranging from sows with one litter to sows with 12 litters. All 42 sows farrowed within three weeks. Per sow three piglets were chosen, earmarked with individual numbers and blood was drawn from each of these sentinel animals at various points in time until slaughter. All together, 694 blood samples, 41 colostrum samples and 66 meat juice samples were investigated.

Simultaneously, along the first phase of the study, diverse faeces samples, environmental samples (floors, walls, fans, troughs, drinkers, transport vehicles and cleaning tools) and slaughter samples (tonsils, Lnn. mandibulares and Lnn. iliaci) were cultivated for Salmonella, all together 538 samples.

In the second phase, targeted intervention measures were implemented according to the findings of phase 1. The major measures are:

Cleaning and disinfection (ANONYMOUS, 2007a)

- intensifying cleaning and disinfection of floors, walls, troughs, drinkers etc. and other pig contact areas in the pens
- adding disinfection to already existing cleaning of floors and walls of areas with no or rare pig contact (ante-rooms for changing clothes and boots, alleys for pig movements, tools for cleaning and devices for moving pigs, transport vehicles)
- cleaning and disinfection of areas that are not regularly included in cleaning and disinfection (fans and air ducts, upper parts of walls and ceilings, scales, loading and unloading ramps)

Implementing “black and white” principles (ANONYMOUS, 2007a)

- optimising animal and people movement targeting for salmonella transmission
- ante-rooms with a strict and obvious separation between normal and farm clothes and boots (e.g. installing solid separation between “black” and “white”)
- installing boots use in only one building
- increasing awareness of crossing walkways between stables and farmyard

Watering system
- chlorination of the drinking water, if taken from a well (ANONYMOUS, 2007b)
- switch to municipal water supply instead of well

Changing feed structure, composition, and feed acidification (VISSCHER, 2006)
- rough grinding of grain components (largest possible particle size)
- increase of barley in the ration (about 35%)
- adding of 0.6 to 1.2% K-diformate (Formi®)

Optimising rodent control (ANONYMOUS, 2007a)
- Improving cleanliness outside barns
- Engaging a professional pest control company

For controlling the efficacy of these measures, 357 serological samples (298 blood samples and 59 meat juice samples) were taken during phase 2. Twenty weaning pigs per finishing herd (n = 60) were randomly selected and earmarked as sentinel animals and five times serologically investigated.

Simultaneously, along the second phase of the study, diverse faeces samples, environmental samples and slaughter samples (similar as described for phase 1) were cultivated for Salmonella, all together 549 samples.

RESULTS

Bacteriology:
1. The isolated Salmonella strains in all herds and all age groups belonged to the serovar *Salmonella Typhimurium* [4, (5), 12: i: 1, 2] and the same phage type.
2. All gilts were Salmonella negative, 8.3% of the pooled faeces samples taken from the productive sows were Salmonella positive.
3. None of the faeces samples taken from the weaned piglets in the flat deck were Salmonella positive (see Figure 1).
4. Whereas 4.5% of the grow-finisher samples in phase 1 were Salmonella positive, none of these faeces samples were Salmonella positive in phase 2 (see Figure 1).
5. The drastic increase of Salmonella positive faeces samples from grow-finishers to the finishers in phase 1 from 4.5% to 27.8% was remarkably reduced in phase 2 to 10.2% in the finishers (see Figure 1).
6. The bacteriological results of samples (faeces and environmental) taken from the finisher herds 1, 2 and 3 show only in herds 1 and 2 significant reductions between phase 1 and phase 2, whereas in herd 3 an increase occurred (see Figure 2):
   - herd 1, phase 1: faeces 56.3%, environmental 31.1%
   - herd 1, phase 2: faeces 6.3%, environmental 10.0%
   - herd 2, phase 1: faeces 25.0%, environmental 7.5%
   - herd 2, phase 2: faeces 6.3%, environmental 0%
   - herd 3, phase 1: faeces 15.6%, environmental 5.0%
   - herd 3, phase 2: faeces 21.9%, environmental 26.1%

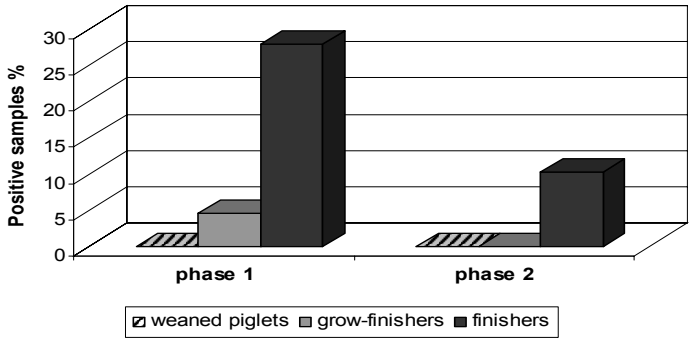

Figure 1. Bacteriological results of faeces samples of all three finisher herds in phase 1 and 2

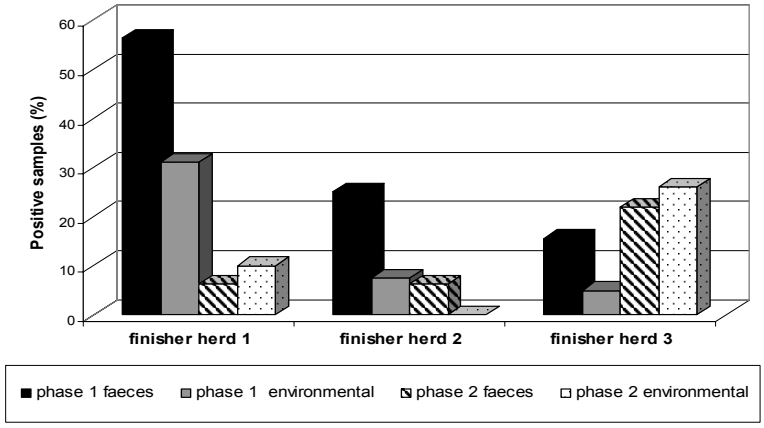

Figure 2. Bacteriological results of faeces and environmental samples in finisher herds 1, 2 and 3 in phase 1 and 2

Serology:

1. The serological results of the blood samples of the sows, of their colostrum, and the blood samples of the corresponding 7-day piglets correlated highly significantly.
2. The colostral antibodies in piglets decreased drastically during the suckling period; even piglets with the highest antibody level were negative after weaning.
3. The percentage of Salmonella antibody positive samples of all three herds in phase 1 increased over time and exceeded the 40%-threshold (category III) in the end of the finishing period, whereas the overall percentage of the positive samples in the end of the finishing period of phase 2 remained below 40% (see Figure 3).
4. The reduction of the overall percentage of the Salmonella antibody positive samples in phase 2 is exclusively due to the remarkable decrease of positive samples in herd 1 and 2 (see Figure 4).
5. The reduction (herds 1 and 2) and non-reduction (herd 3) of the serological results correlated strongly with the reduction (herds 1 and 2) and non-reduction (herd 3) of the bacteriological results in faeces samples (see Figure 2 and 4).

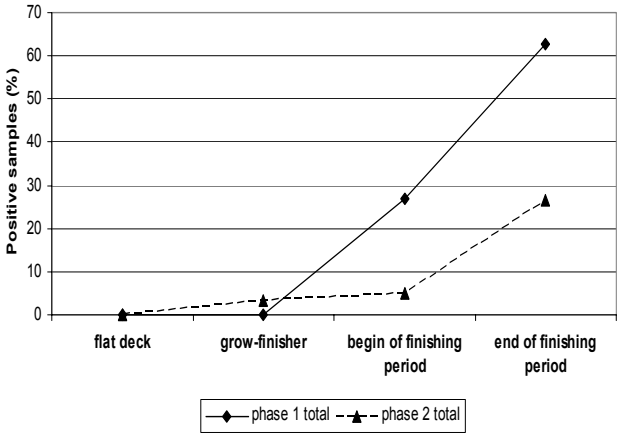

Figure 3. Serological results of blood samples of all three herds in phase 1 and 2

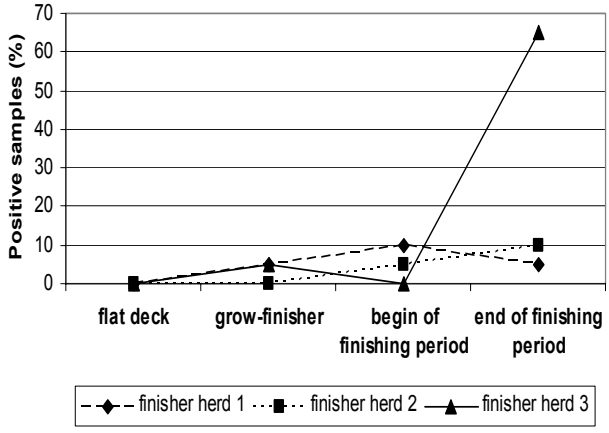

Figure 4. Serological results of blood samples of herd 1, 2 and 3 in phase 2

DISCUSSION AND CONCLUSIONS

As for its Salmonella infection pattern before any intervention measures, the investigated three-site pork production system (one sow herd, one flat deck with grow-finishers, and three finisher herds) can be characterised as follows:

- The "Salmonella problem" of the production system is obviously not a constant introduction of Salmonella into the system at various points of entry, but rather the circulation of one "quasi" hospitalised Salmonella serovar.
- This serovar is already found in the sow herd, but the Salmonella prevalence of the weaned piglets in the flat deck and in grow-finishers on the same site as the flat deck is relatively low.

– This low prevalence in the flat deck and grow-finisher period, however, leads to a varying increase of the Salmonella infection rate in the three finisher herds, with remarkable differences in the resulting prevalence in the end of the finishing period.

The intervention measures taken on flat deck and grow-finisher site as well as in the three finisher herds (specific measures on each site according to the results of the in-depth analysis of phase 1 as described in material and methods) are capable of drastically reducing the infection pressure and environmental contamination in Salmonella infected pork production systems (herds 1 and 2). However, it is unrealistic to expect a complete "sanitation" during one production cycle – only the stringent repetition of the specific measures necessary to be defined for every herd can lead to a sustainable success. Any failure in reducing the Salmonella load (as in finisher herd 3) must result in another in-depth analysis of the hygiene, biosecurity and the daily working procedures on the farm in question. Such analysis will identify the reasons for the failure, if "everything that happens" on the farm is taken into consideration; in case of herd 3 a non-planned construction in the barn without biosecurity measures, and a transfer of liquid manure from a cattle shed and a pig barn to the deep pit of the study pig barn led to severe hygiene and biosecurity break-downs.

Although the study design (applying all possible measures for reducing the salmonella load at once for demonstrating the feasibility of the reduction) did not allow an exact calculation of the contribution of the cleaning and disinfection procedures to the success in herd 1 and 2, it can be said that:

– visually clean and disinfected areas need to be tested for their freedom from Salmonella, and the cleaning and disinfection procedure must be improved, if Salmonella is still found,
– most important for the Salmonella reduction (in contrast to animal-adapted, pig-specific pathogens) is the inclusion of areas and rooms, to which the animals have no direct contacts:
  - floors of hallways inside and outside the barns (hallways for moving pigs need additional cleaning and disinfection of the walls as well!),
  - ante-rooms for changing boots and clothes (regular clothes and shoes must be clearly separated from coveralls and boots that are only used inside the barn),
  - rooms for feed storage, especially around the silo outlets,
  - offices and any other rooms that are walked into with the "inside-the-barn-boots",
– devices such as fans and areas such as under the trough and feeder outlets that are not regularly cleaned and disinfected, need to be included in the thorough cleaning and disinfection procedure in case of a high Salmonella load,
– any tools such as brooms, tools for scratching faeces, boards for moving pigs and transport vehicles need also be cleaned and disinfected.

These cleaning and disinfection procedures need to be applied (at least at the beginning of the sanitation attempt) after every movement of any pig group. In herds with a very high Salmonella load, these thorough and "more-than-usual" cleaning and disinfection measures need to be carried out and tested for their efficacy in several consecutive production cycles. The very basic precondition for the success of any sanitation, however, is that the farmer together with his veterinarian does not only follow a check list of measures, but analyses any routine activity on the farm and in the barn that might support the introduction and spread of Salmonella into the pork production system.

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