CONTROL OF SALMONELLA ENVIRONMENTAL CONTAMINATION DURING PIG TRANSPORT AND LAIRAGE: A REALISTIC PROJECT?

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Abstract

This study aims at investigating Salmonella environmental contamination of trucks and lairage pens and evaluating the efficiency of an improved cleaning and disinfection protocol to reduce Salmonella environmental contamination.

During four days, the lairage of two French pig slaughterhouses were sampled twice a day when pigs were present and once at the end of the week after the cleaning protocol. In parallel, six trucks per day were randomly selected and sampled at their arrival and after the cleaning procedure. The samples consisted of floor surface swabbing. Salmonella occurrence, level of contamination and serotypes were determined. The efficiency of different cleaning and disinfection procedures on the presence of Salmonella was also estimated.

Salmonella was isolated in 97.7% of the lairage samples when pigs were present (contamination levels >10⁴ UFC/m²) and in 65% of the truck samples (contamination levels from <10 to >10⁴ UFC/m²). An improved cleaning and disinfection procedure reduced efficiently the occurrence and the level of contamination in the trucks (almost 100%) compared to a simple wash with cold water (no effect), more partially in the lairage.

This study showed the importance of a good cleaning and disinfection protocol to decrease the level of contamination or eliminate the bacteria in the trucks used for the transport of pigs.

Introduction

Salmonella is a leading cause of foodborne illness worldwide and the consumption of pork meat is a major source for human infection (EFSA 2014). Salmonella is commonly carried in the intestinal tracts of a wide range of animals, including livestock animals. The organism may also be transmitted through direct contact with infected animals or humans or faecally contaminated environments.

In a recent survey in UK, Salmonella was isolated from 30.5% of individual pig caecal contents at slaughter (Powell et al., 2016). Pigs get infected through oral intake of Salmonella and they can carry this bacterium asymptotically in their tonsils, gut and gut-associated lymphoid tissue for months resulting in so called Salmonella carriers. During periods of stress, re-excretion may occur. In this way, carriers are a permanent potential source of infection for other animals, including humans. Stress
factors can occur during the fattening period, but also prior to slaughter, for instance during transport to the slaughterhouse or during the stay in the lairage. Evidence supporting non negligible transmission rates during transport may be found in the literature (Ferrer Savall et al., 2016). Up to 20% of uninfected pigs within a batch may become infected during transport and lairage (Hurd et al., 2002). After 2 or 6 hours of combined transport and lairage, the number of animals excreting *Salmonella* has more than doubled (Hurd et al., 2001). *Salmonella* can be isolated from initially healthy pig faeces after 2 hours exposure of the pigs to a contaminated environment (Boughton et al., 2007).

Cleaning and disinfection of pig pens at lairage is important and considered as an essential part of any successful on-farm *Salmonella* control (Andres and Davies, 2015). What about the protocols used for trucks and lairage? Are they sufficient to eliminate or to reduce *Salmonella* environmental contamination (De Busser et al., 2013)?

This study aims at investigating *Salmonella* environmental contamination of trucks and pens of lairage in two French pig slaughterhouses. In parallel, we evaluate the efficiency of an improved cleaning and disinfection protocol to reduce *Salmonella* environmental contamination.

**Material and methods**

**Sampling and experimental design**

During four successive worked days, the floor of the pens of lairage of two pig slaughterhouses (coded S1 and S2) were sampled twice when pigs were present and once at the end of the week after the cleaning protocols. In parallel, in each slaughterhouse, six trucks per day were randomly selected and floor environmental samples were collected at their arrival at the slaughterhouse (transport duration between 30 and 180 min) and after the cleaning procedures. All samples were analyzed within four hours after collection.

**Standardization of the swab sampling method**

Each sample consisted in a total swabbing of 2 m² of floor surface. A swab was used on 4 sites of 50 cm² using an iron frame to standardize the method.

Two samples per pen or per truck has been done each time, and one sample after the cleaning and disinfection procedures.

In parallel, general information concerning the transport and the lairage conditions were recorded (duration or waiting time, origin of the herds or process of the batches, characteristics of the trucks: type, presence of sawdust… or identification of the pens, cleanliness level, localization of the animals, time of sampling).

**Salmonella** detection and semi-quantification

Swab samples were diluted in 150 mL of peptone buffered water and homogenized 1 min in a stomacher. The detection of *Salmonella* in the sample was done according the ISO 6579 reference method and the semi-quantification by using the Miniaturized Most Probable Number technique as described in part 2 of the ISO 6579 reference method. Two isolates per positive samples were serotyped according the Kaufmann-White classification (Popoff, 2001).
Results and discussion

Salmonella environmental contamination

Salmonella was isolated in 65% of all the truck samples, with respectively 50% and 81% for the trucks of slaughterhouses S1 and S2. For the different sampling days, the contamination of positive trucks varied from 25% to 83%; with respectively from 25% to 67% for S1 trucks and from 80 to 83% for S2 trucks. Previous French study showed that 47% of the trucks were positive (Rossel et al., 2002).

In our survey, 97.7% of all the pen lairage samples were positive in Salmonella. Previous French study showed that 41% of the pens were positive (Rossel et al., 2002). This high prevalence is close to those found in the literature (Hurd et al., 2002; De Busser et al., 2007; Ferrer Savall et al., 2016). The high levels of contamination of the holding pens point out that it is a major source of contamination of healthy pigs arriving at the slaughterhouse.

The amount of Salmonella in the environment was highly variable (from 0 to >10⁴ CFU/m²) and varied between two different samples for a given pen or truck or between pens or trucks at the same sampling time (Figure 1). This variation is probably due to the transport and lairage conditions that were heterogeneous. In this study, we had different herds, different duration of transport and different waiting times in the lairage. Moreover, some trucks drivers used or not sawdust and we noticed less occurrence of positive samples in the trucks with sawdust.

![Figure 1](image)

**Figure 1.** Level of Salmonella contamination for trucks’ and lairage pens’ samples (S1 and S2) during the four successive days of sampling.

When the animals were in the pens, environmental samples were positive with a high variability of the contamination level (from less than 10 to more than 10⁴ CFU/m²). Nevertheless, there was no difference between the four days of sampling. This variability could be due to differences in the excretion of the pigs; some with intermittent excretion of Salmonella and/or re excretion due to stress. A study exploring the level of Salmonella excretion of the pigs in the trucks or in the pens would allow to see if there is a correlation between the level of Salmonella excreted by pigs and the contamination level of the environment.
Evaluation of the cleaning and disinfection procedures

An improved cleaning and disinfection procedure reduced efficiently the occurrence and the level of contamination in the trucks compared to a simple wash with cold water: 97.5% of trucks were negative after the cleaning and disinfection protocol and none with a simple wash with cold water. We observed a reduction of more than $10^4$ log UFC/m$^2$ of the contamination level with the cleaning and disinfection procedure.

The improved cleaning and disinfection procedure reduced also Salmonella contamination in the lairage; 73% of the holding pens were negative after the cleaning and disinfection protocol with still a reduction of the contamination level of more than $10^4$ log UFC/m$^2$.

Conclusion

No Salmonella have been detected after the cleaning and disinfection protocol in 97.5% of the trucks showing that good measures of hygiene (cleaning with hot water and disinfection) between two transports of animals allow the elimination of Salmonella in the trucks used for the transport. The high levels of contamination of the holding pens point out that it is a major source of contamination of healthy pigs arriving at slaughterhouse. The waiting period in the lairage of at least two hours contains a substantial risk for slaughter pigs to become infected with Salmonella as the cleaning and disinfection procedures are still not satisfactory in the field. Moreover, in lairage, a good protocol is not always sufficient to eliminate the bacteria. It could be interesting to go further in this investigation by looking for each data at the general information, the type of floor (concrete, partial, presence of cracks and crevices), the type of disinfectant chosen and its concentration, the presence of organic matter…to understand why an apparent good cleaning and disinfection protocol is not always sufficient to eliminate the substantial risk for slaughter pigs in the lairage and find different solutions.

References


