THE PREVALENCE OF SALMONELLA SPP. IN PIGS DURING THE FATTENING PERIOD AND DURING THE SLAUGHTER

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Abstract
Salmonellosis is one of the most reported zoonotic diseases, constituting a major problem worldwide. In the interests of sound management of this zoonosis, attributed to the consumption of meat and pork products, control measures must be taken simultaneously at all levels of production from farm to consumer. The purpose of this study was to identify the carrier status of Salmonella spp. starting with analyzing the fat pigs before slaughter, and analyzing each stage of the process flow within the slaughterhouse.

In order to identify the Salmonella carrier status 50 samples were collected from faeces in the pig farm and 50 samples from the different technological processes within the slaughterhouse, starting from pigs reception to chilling. Samples were analyzed by classical method SR EN ISO 6579: 2003 / AC: 2007.

The following results were obtained: the Salmonella spp. load of the faecal samples collected from pigs before slaughter was 67% (33/50, while after transportion of pigs to the slaughterhouse, at reception the load was 73%. In the slaughterhouse, it was found that the load varied at each checkpoint of the process flow.

Interpreting the results obtained in each checkpoint in the slaughterhouse and making comparisons between them, differences of Salmonella spp. load that ranged from 100% before slaughtering to 12.5% after carcass refrigeration were found.

It was concluded that carriers pigs are a carcass contamination source, because they cannot be identified at the time of their reception in the slaughterhouse, and to be able to control the level of contamination of carcasses, control measures should be applied at farm level and compliance with the HACCP principles during the technological flow in the slaughterhouse should be followed.

Keywords: Carcasses, identification, faecal, pigs, Salmonella spp.

INTRODUCTION
Salmonella spp. is a factor of concern for the pork industry worldwide, due to its impact on public health and high costs. Annually 80.3 million cases of food poisoning are caused by Salmonella spp. (Majowicz et al., 2010).

In the US, Salmonella spp. is the second leading cause of poisoning and the leading cause of death and hospitalization (Scallan et al., 2011). Although it was reported that the number of cases of human salmonellosis can be directly attributed to the consumption of pork, they are difficult to determine, estimates varying between 1% and 25% (Guo et al., 2011).

Although Salmonella spp. has been identified in all links of the pork production chain, there has been increasing focus on the pre-harvest phase (i.e., on-farm). However, in order to be able to develop effective intervention measures, it is essential that risk factors for the occurrence of Salmonella infections in swine herds be identified. By identifying and quantifying the effects of risk factors, interventions can be developed and applied to reduce Salmonella infection and carriage in the pigs at the herd level, which will reduce the contamination pressure at the abattoir (Rostagno et al., 2012).

Salmonella infections in swine herds are much more common than the clinical disease (i.e., salmonellosis). Asymptomatic intestinal carriage and intermittent shedding of Salmonella characterize most subclinically infected pigs, which represents a very common scenario in swine herds around the world. Pigs can potentially remain a risk to food safety for Salmonella long after they have been infected, excreting the bacteria in faeces and/or harbouring it in several tissues, particularly the intestinal tract, and associated lymph nodes (Boyen et al., 2008).

In addition, surveillance programs aim to improve the understanding of the sources and the prevalence of Salmonella starting from the primary production. Although the eradication of the pathogen is rarely achievable, a
reduction of the pathogen load by identifying which factors influence the animal carriage status could help in reducing the risk to human health in an integrated food chain plan (Milnes et al., 2009).

The aim of this study was to determine the carrier status at farm level and the carrier pigs' influence on the carcass contamination during slaughtering.

MATERIALS AND METHODS

The study was conducted in a production farm, where 50 pigs were monitored during the finishing stage, where faecal samples were collected before delivering the pigs to the slaughterhouse.

In order to highlight the importance of transportation for transmission of the *Salmonella* spp., the same number of samples was collected from vehicles after unloading pigs at the slaughterhouse.

Subsequently, in order to make an analysis of the impact of each stage of the process flow within the slaughterhouse with reference to the presence of *Salmonella* spp. the same number of samples were collected in each stage of the processing flow, from the waiting area to the carcass chilling.

Samples were analyzed in the hygiene laboratory using the method SR EN ISO 6579: 2003/AC: 2007.

RESULTS AND DISCUSSIONS

After analyzing the faecal samples collected from fat pigs collected a week before delivery a prevalence of 67% with *Salmonella* spp. was found.

After analyzing the faecal samples collected from the transportation vehicles, at receiving the pigs to the slaughterhouse, a 5% increase in *Salmonella* spp. load was observed.

Analysis of samples of faeces collected from the lairage area or after stunning showed only positive samples due to the presence of *Salmonella* spp. carrier pigs, which became a source of contamination for the pigs free of *Salmonella* spp.

Non-significant differences (p > 0.05) were found between the lairage area and stunning, as well as before carcass chilling (test $\chi^2$) were found, but there were significant differences (p < 0.001) between the lairage area, depilation, polishing, and after chilling.

Distinct significant differences (p < 0.01) were found between refrigeration and scalding, while the differences were highly significant (p < 0.001) between stunning and scalding.

After depilation and polishing an increase to 24% in the presence of *Salmonella* was found, possibly due to contact with depilatory machine which causes the elimination of faeces in the rectal ampulla of the pigs. Statistically, the differences were not significant (p > 0.05) between depilation and polishing stages, as well as between evisceration and after chilling.

After evisceration an up to 72% increase of *Salmonella* spp. load was observed and at the final stage, before the carcass delivery, only 12% positive samples were found, the difference being statistically significant (p<0.05).

*Salmonella* carrier pigs during the fattening stage constitutes the main source of contamination of the carcass and pork (Beloeil et al., 2004).

In the USA the prevalence of *Salmonella* spp. in fattening pigs was between 3.4% and 48% (Rostagno et al., 2012).

Following the completion of a study in a Portuguese slaughterhouse, Viera-Pinto et al., 2006 concluded that there are three ways in which *Salmonella* spp. could be transmitted among pigs: farm that the pig come from, during transportation and lairage time to be slaughtered.

Before referring to what happens in the slaughterhouse, a brief description of the role that fattening farms and transportation has on the pig contamination have to be described.

According to the data available at present, it is certified that 70% of carcass contamination is due to the swine origin, while other studies have shown that 100% contaminated carcasses could be reached due to cross-contamination in the slaughterhouse (Argüello et al., 2012).
In countries with a low prevalence, such as Denmark, where *Salmonella spp. cases* arriving at the slaughterhouse are limited, the significance of farms is consistent. In other areas (Spain), where about one third of the farms are infected with *Salmonella spp.*, the other two stages have a special significance because during the lairage period the risk is very high that *Salmonella*-free pigs to be contaminated by coming into contact with pigs coming from farms with this disease (Argüello et al., 2012).

A study conducted in 2005 monitoring the transportation of pigs from farm to slaughterhouse, an increase in the final contamination of carcasses was observed by 7 times higher than the one determined on live animals. In the same study, it was shown that 50% of carcasses were contaminated because of the process flow (cross-contamination) (Argüello et al., 2012).

As a conclusion, hygiene measures compliance is mandatory for maintaining an environment conducive to achieving *Salmonella*-free carcasses (Vangroenweghe et al., 2009).

In the slaughterhouse, after receiving the pigs, the lairage area is a source of *Salmonella spp.* contamination, because with increasing lairage time the risk of contamination of the *Salmonella*-free pigs increases (EFSA 2010).

Survival of *Salmonella spp.* during the scalding phase occurs when the water temperature falls below 62°C (Hald et al., 2003) and/or if the amount of organic material is high enough to determine *Salmonella* to protect against heat (Sörgqvist et al., 1990).

Depilation is a source of carcass contamination with faeces (Borch et al., 1996). Silva et al., 2012 found an increased number of *Salmonella*-positive carcasses after depilation stage compared with evisceration stage.

The high degree of carcass contamination before singeing was associated with failure of washing stage before cutting pigs, scalding water contamination or depilation process itself (Letellier et al., 2009; Hald colab., 2003; Pearce et al., 2004).

Polishing step determines carcasses recontamination (Rivas et al., 2000; Yu et al., 1999), while Gill and Bryant 1993 found a reduction of the contamination level of during this phase. Carcass contamination during the next stages of the slaughterhouse technological flow may occur due to non-compliance with sanitation stages of work equipment, of which the sterilization water temperature is crucial (Borch et al., 1996; De Sadeleer at al., 2008).

During the gutting process a contamination of carcasses by 55-90% occurs compared to the initial contamination (Berends et al., 1997). Compliance to animal dietary requirements before slaughter, correlated with evisceration operations compliance determines the reduction of the carcass contamination risk in this stage.

**CONCLUSIONS**

Comparing the last values before transport, with those from the reception at the slaughterhouse, there was an increase in the degree of contamination (transport stress).

During slaughtering process, analyzing the samples from the surface of carcasses, significant differences between the control points from the dirty area and the clean area were found, so it was found a high degree of contamination in the clean area, in the evisceration stage, decreasing significantly in the chilling stage of the carcass, which inhibits the growth of microorganisms of the genus *Salmonella*.

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