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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 transportation 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 χ^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 (Sörqvist 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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REFERENCES

Argüello H. R., Carvajal Ana, Nistal, P. R., 2012. Importance of the abattoir on the control of salmonellosis (1/2).

Beloeil P.A., Chauvin C., Proux K., Madec F., Fravalo P., Alioum A., 2004. Impact of the *Salmonella* status of market-age pigs and the pre-slaughter

process on Salmonella caecal contamination at slaughter. Veterinary Research, 35: 513-530.

Berends B.R., Van Knapen F., Snijders J.M.A., Mossel D.A.A., 1997. Identification and quantification of risk factors regarding *Salmonella spp*. on pork carcasses. International Journal of Food Microbiology, 36: 199-206.

Borch E., Nesbakken T., Christensen H., 1996. *Hazard identification in swine slaughter with respect to food-borne bacteria. International Journal of Food Microbiology,* 30: 9-25.

Borch E., Nesbakken T., ChristensenH., 1996. Hazard identification in swine slaughter with respect to food-borne bacteria. International Journal of Food Microbiology, 30: 9-25.

Boyen F., Haesebrouck F., Maes D., Van Immerseel F., Ducatelle R., Pasmans F., 2008. Non-typhoidal *Salmonella* infections in pigs: A closer look at epidemiology, pathogenesis and control. Veterinary Microbiology, 130, 1–19.

De Sadeleer L., Dewulf J., De Zutter L., Van der Stede Y., Ribbens S., De Busser E., Quoilin S., Houf K., Delhalle L., Grijspeerdt K., Maes D., 2008. A qualitative risk assessment for human salmonellosis due to the consumption of fresh pork in Belgium. Flem. Vet. J., 78, 34-41

Gill C.O., Bryant J., 1992. The contamination of pork with spoilage bacteria during commercial dressing, chilling and cutting of pig carcasses. International Journal of Food Microbiology, 16(1):51-62.

Guo C., Hoekstra R.M., Schroeder C.M., Pires S.M., Ong K.L., Hartnett E., 2011. Application of Bayesian techniques to model the burden of human salmonellosis attributable to U.S. food commodities at the point of processing: Adaptation of a Danish model. Foodborne Pathogens and Disease, 8(4), 509–516.

Hald T., Wingstrand A., Swanenburg M., Altrock A., von Thorberg B.M., 2003. The occurrence and epidemiology of *Salmonella* in European pig slaughterhouses. Epidemiology and Infection, 131: 1187-1203.

Lettellier A., Beauchamp G., Gue'Vremont E., D'Allaire S., Hurnik D., Quessy S., 2009. Risk factors at slaughter associated with presence of *Salmonella* on hog carcasses in Canada. Journal of Food Protection, 72: 2326-2331.

Majowicz S.E., Musto J., Scallan E., Angulo F.J., Kirk M., O'Brien S. J., 2010. The global burden of nontyphoidal *Salmonella* gastroenteritis. Clinical Infectious Diseases, 50(6), 882–889.

Milnes A.S., Sayers A.R., Stewart I., Clifton-Hadley F.A., Davies R.H., Newell D.G., Cook A.J.C., Evans S.J., Smith R.P., Paiba G.A., 2009. Factors related to the carriage of Verocytotoxigenic E. coli, Salmonella, thermophilic Campylobacter and Yersinia enterocolitica in cattle, sheep and pigs at slaughter. Epidemiol Infect 137:1135-48.

Pearce R.A., Bolton D.J., Sheridan J.J., McDowell D.A., Blair I.S., Harrington D., 2004. Studies to determine the critical control points in pork slaughter hazard analysis and critical control point systems. International Journal of Food Microbiology, 90: 331-339.

Rivas T., Vizcaino J.A., Herrera F.J., 2000. Microbial contamination of carcasses and equipment from an Iberian pig slaughterhouse. Journal of Food Protection, 63(12):1670-1675.

Rostagno M.H., Callaway T.R., 2012. Review, Pre-harvest risk factors for *Salmonella* enterica in pork production, Food Research International 45 (2012) 634–640.

Scallan E., Hoekstra R.M., Angulo F.J., Tauxe R.V., Widdowson M.A., Roy S.L., 2011. Foodborne illness acquired in the United States—Major pathogens. Emerging Infectious Diseases, 17(1), 7–15.

Silva L. E., 2003. Safe pork.(5): 250-252.

Vangroenweghe F., Heylen P., Arijs D., F. C., 2009. Hygienograms for evaluation of cleaning anddisinfection protocols in pig facilities. 8th International Symposium on Epidemiology and controlof foodborne pathogens in pork – Safepork. Quebec, Canada, 220-23.

Vieira-Pinto M., Temudo P., Martins C., 2005. Occurrence of *Salmonella* in the ileum, ileocolic lymph nodes, tonsils, mandibular lymph nodes and carcasses of pigs slaughtered for consumption. J. of Vet. Med. B 52, 476-481.

Yu S.L., Bolton D., Laubach C., Kline P., Oser A., Palumbo S.A., 1999. Effect of dehairing operations on microbiological quality of swine carcasses. Journal of Food Protection 1, 62(12):1478-1481.

SR EN ISO 17604:2003-Microbiology of food and animal feeding stuffs — Carcass sampling for microbiological analysis

SR EN ISO 6579: 2002 - General guidance on methods for the detection of *Salmonella.* International Organization for Standardization, Geneve, Switzerland

EFSA (2010) - Scientific Report : Quantitative Microbiological Risk Assessment on *Salmonella* in Slaughter and Breeder pigs: Final Report Prepared by VLA in consortium with DTU and RIVM (Grant number: CFP/EFSA/BIOHAZ/2007/01).

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