SALMONELLA INFECTION LEVEL IN DANISH INDOOR AND OUTDOOR PIG PRODUCTION SYSTEMS MEASURED BY ANTIBODIES IN MEAT JUICE AND FAECAL SHEDDING ON-FARM AND AT SLAUGHTER

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SUMMARY

The prevalence of Salmonella shedding was compared in 34 organic, conventional outdoor and indoor pig herds. Individual faecal and meat juice samples from 30–50 pigs per herd were analysed for presence of Salmonella, and Salmonella antibodies, respectively. We found low levels of Salmonella shedding on farm and at slaughter in organic and conventional outdoor herds compared to indoor pigs. Overall 5,5% of the pigs were seropositive. The serological test result was associated with Salmonella shedding at slaughter in pigs from conventional systems, but not in organic pigs. The duration of transport did not affect the risk of Salmonella shedding.

Keywords: fattening pig, production systems, Salmonella, faecal shedding, organic pigs

INTRODUCTION

Pork and pork products are recognised as one of the major sources of human salmonellosis (Lo Fo Wong et al. 2002, Wegener and Baggesen 1996). Pigs in outdoor production systems benefit from a low animal density, and access to outdoor area, and organic pig production furthermore differs from conventional production in terms of feeding, weaning age, and use of preventive medication (Bonde and Sørensen 2004). It is therefore likely that the risk of Salmonella is different in organic, outdoor, and indoor pig production. The level of Salmonella shedding at slaughter might differ between the production systems, caused by differences in the level of resistance to the pathogen, which may be due to the immune system based disease resistance and/or components of the husbandry systems affecting disease development and pathogen shedding (Zheng et al, 2007).

Stege et al. (2000) found a herd level association between high seroprevalence and presence of Salmonella in faecal samples. Jensen et al. (2004) observed a higher prevalence of Salmonella antibodies in outdoor than indoor pig production systems, and Hald et al. (1999) also reported that the proportion of seropositive pigs tended to be higher in conventional outdoor production systems compared to pigs from either organic or indoor production systems. On the other hand Meyer et al. (2005) reported that conventional slaughter pigs were more likely to be seropositive than organic pigs. The presence of antibodies indicates that the pig has been exposed to challenge by the enteric pathogen at some stage of its development.

A number of stress factors related to the routine management in a pig herd may increase the risk of infection, as stress can induce carriers to shed Salmonella at a higher rate and increase the susceptibility of Salmonella-free pigs to infection (Mulder, 1995). Transport of pigs to the abattoir causes significant stress to the animals, which can trigger an increase in shedding (Lo Fo Wong et

al. 2002), and duration of transport and lairage may also affect the level of Salmonella shedding at slaughter (Morgan et al., 1987). It is therefore essential to compare the faecal shedding before and after transport to the abattoir, when assessing the risk of pathogen transfer into the food chain.

The objective of this survey was to investigate the effect of different pig production systems with indoor or outdoor rearing, and the effect of transport duration, on the potential pathogen transfer risk into the food chain from Salmonella in pig faeces. Further we evaluated the predictive value of the serological test result in relation to Salmonella shedding at pig level.

MATERIALS AND METHODS

Eleven organic, 12 conventional outdoor and 11 indoor fattening pig herds were included in the survey. The median yearly production of slaughter pigs in the herds amounted to 1300 pigs in the organic herds, 2750 pigs in the conventional outdoor herds and 1935 pigs in the indoor herds. Sows and suckling piglets were kept outdoors on pasture in organic as well as conventional outdoor herds. The organic fattening pigs from weaning at seven to eight weeks of age to slaughter were housed in deep litter pens with access to an outdoor area with concrete floor, with a total space allowance (indoor and outdoor) of min. 2,30 m^2 per 100-kg pig. Eight of the organic herds fattened their own piglets, while three herds bought 30-kg pigs from other organic herds. Two of the organic herds kept the growing pigs on pasture until they weighed 60–80 kg. The organic pigs were fed organic feed and were provided with roughage. Preventative medication with antibiotics was not applied in the herds. Conventional outdoor pigs from weaning at four to five weeks of age to slaughter were housed in deep litter pens with access to an outdoor area with concrete floor, with a total space allowance (indoor and outdoor) of min. 1,20 m^2 per 100-kg pig. Six conventional outdoor herds fattened their own piglets, while the remaining six herds bought 30-kg pigs from other outdoor herds. The conventional outdoor pigs got conventional feed without roughage supply. Preventative medication with antibiotics was not applied in the herds. The indoor pigs were housed in indoor pens without access to outdoor areas and roughage. The indoor pigs were typically weaned at three to four weeks of age, kept in two-climate pens in the sow herd until 30 kg live weight, and then moved to pens with either solid concrete or slatted floor, and mostly with a space allowance of less than 0,75 m^2 per slaughter pig. Three indoor herds fattened their own piglets, while the remaining eight herds bought 30-kg pigs from indoor sow herds.

During a one-year period faecal samples were collected in each herd from 3–5 batches of 10 randomly chosen and individually marked pigs 1–7 days before slaughter, and the animals were clinically examined. The examination assessed the animals visually in accordance with a clinical protocol focusing on body condition, general appearance, lesions, skin and haircoat, locomotive disorders, diarrhoea, constipation, and respiratory symptoms. Meat juice samples and samples of caecal content from the individual pigs were further collected at the abattoir. Faecal and caecal samples were cooled and sent to the laboratory to be analysed qualitatively for density of enteric Salmonella using the modified NMKL method. Positive samples were further analysed semi-quantitatively, and the cultures were serotyped. A meat sample from each pig was frozen, and meat juice (harvested after thawing) was examined for specific antibodies against Salmonella enterica using an indirect enzyme-linked immunosorbent assay (ELISA) (Nielsen et al., 1998). The ELISA combined several S. enterica O-antigens, and allowed detection of antibody response after a variety of different S. enterica serovar infections. Samples with an OD%>10 were considered seropositive.

Information about duration of transport to slaughter was collected from 155 batches of pigs (50 organic, 58 conventional outdoor, and 47 indoor batches).

Qualitative bacteriological and serological data at pig level were analysed by log-linear models (Using the SAS Proc GENMOD), taking herd and batch into account. Serological test response, Salmonella shedding on-farm and Salmonella shedding at the abattoir were all assumed binomial distributed with logit as the link function. The models were:

1. Serological test response (positive/negative) = system (organic, conventional outdoor, indoor) + any clinical symptoms (yes/no)
2. Salmonella shedding on-farm (positive/negative) = system (organic, conventional outdoor, indoor) + serological test response (positive/negative) + any clinical symptoms (yes/no)
3. Salmonella shedding at slaughter (positive/negative) = system (organic, conventional outdoor, indoor) + serological test response (positive/negative) + Salmonella shedding on-farm (positive/negative) + duration of transport (<1 hour, 1–3 hours, > 3 hours) + system* serological test response

Differences in transport duration between systems were analysed in SAS by Proc GLM, and differences in clinical symptoms between systems were analysed in SAS by Proc GENMOD.

RESULTS

The prevalence of Salmonella in the different production systems is illustrated in Table 1. Overall 5,5% of the pigs were seropositive with no significant differences between systems (P=0,11). The overall prevalence of Salmonella in faecal samples from pigs on-farm was 0,87%; the systems were significantly different (P<0,0001). Neither of the clinical parameters, e.g. diarrhoea, constipation or poor body condition, was associated with Salmonella shedding on farm. The prevalence of Salmonella shedding at slaughter was 2,2% of the sampled pigs, with a significant difference between systems (P<0,05). We obtained paired samples from 1556 pigs.

Table 1. The prevalence of Salmonella in pigs from 34 Danish herds with different production systems

	Serology meat juice		Salmonella shedding on-farm		Salmonella shedding at the abattoir	
System	N	% positive animals	N	% positive animals	N	% positive animals
Organic	539	7,2	593	0,17	537	1,9
Conventional outdoor	561	4,6	616	0,16	555	1,1
Indoor	465	4,5	600	2,7	474	4,0

Shedding of Salmonella on-farm was significantly predicting shedding at slaughter (P<0,0001), but differences in transport had no effect on Salmonella shedding at slaughter. Seropositive organic pigs were less likely to be shedding Salmonella at slaughter (0%) than seropositive pigs from the conventional indoor and outdoor production systems (10–12%) (P<0,01) (Figure 1). Late Salmonella infections occurred in all production systems with 0,5–4% of the seronegative pigs shedding Salmonella at slaughter. In the conventional systems an antibody positive test result was a significant predictor of Salmonella shedding at slaughter.

The duration of transport is illustrated in Figure 2. The mean durations of transport to slaughter were 175,3 min (organic pigs), 128,6 min (conventional outdoor pigs) and 96,8 min (indoor pigs) (P<0,0001).

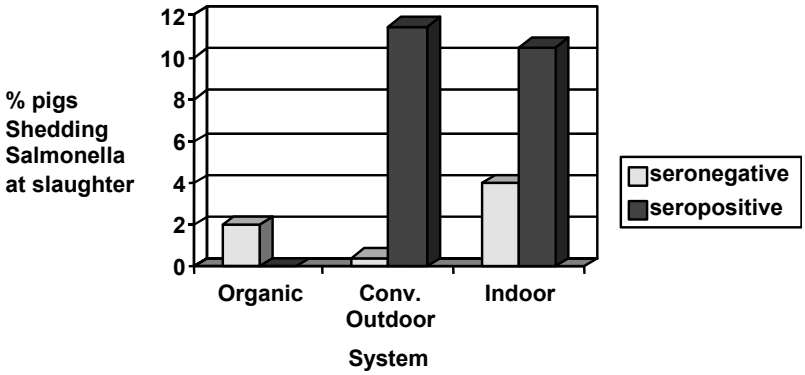

Figure 1. Prevalence of Salmonella shedding at slaughter in antibody positive and antibody negative pigs from 34 pig herds with different production systems

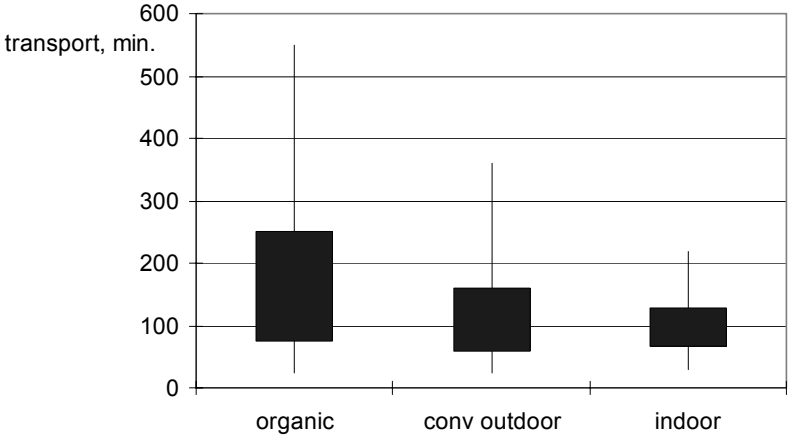

Figure 2. Duration of transport to the abattoir: min, max, 25% and 75% quartiles of the transport duration in minutes for the three pig production systems.

DISCUSSION AND CONCLUSION

In the survey we found similar Salmonella seroprevalences in outdoor and indoor systems. The result is consistent with Ledergerber et al. (2003), who compared the level of Salmonella infections in conventional and animal-friendly farms in Switzerland. In contrast to this, Jensen et al. (2004) found a higher seroprevalence of Salmonella in outdoor than indoor pig production system, and in a survey by Hald et al. (1999) the proportion of pigs from organic production

systems testing positive for antibodies against Salmonella was not different from pigs reared in indoor production systems, while the proportion of antibody positive pigs tended to be higher in conventional outdoor production systems. On the other hand, Meyer et al. (2005) reported that conventional slaughter pigs were significantly more likely to be seropositive than organic pigs.

The prevalence of Salmonella shedding in pigs from outdoor systems was significantly less than in indoor herds. Baggesen et al. (1996) found an overall prevalence of Salmonella shedding at slaughter of 6,2%, which is higher than the overall prevalence of 2,2% in this survey, and also of the prevalence for indoor pigs: 4,0% in this survey. There is a ten-year difference between the two surveys, so the apparent difference probably is the effect of the current Salmonella control programme in Denmark aiming to minimise the risk of Salmonella in slaughter pigs (Mousing et al., 1997). The lack of association between Salmonella shedding and clinical symptoms is in agreement with Stege et al. (2000) reporting predominantly subclinical salmonellosis in Danish finishing pigs. The low levels of Salmonella shedding in organic and outdoor pigs suggest that pigs from low input systems may be more resistant to the pathogen, or may encounter the infection earlier in life so they have cleaned themselves from infection at time of slaughter. The poor association between seropositivity and shedding of Salmonella in organic pigs at slaughter indicates that a serological test might be better suited to conventional than organic herds as a means to identify individual pigs more likely to shed Salmonella.

The differences in transport duration recognised in this survey did not affect the risk of Salmonella shedding at slaughter. The transport distances in general were rather small, and it is likely that a notable effect of transport relies on more substantial differences in transport time.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge from the European Community financial participation under the Sixth Framework Programme for Research, Technological Development and Demonstration Activities, for the Integrated Project QUALITYLOWINPUTFOOD, FP6-FOOD-CT-2003-506358. We are grateful to the participating farmers and the research technicians Orla Nielsen, Henrik Krogh Andersen, Kristine Riis Hansen and Michael Hansen for their assistance collecting faecal samples on-farm. Danish Crown gathered the transport data, collected the samples at the abattoirs, and analysed all bacteriological samples; the meat juice samples were analysed at the Danish Institute of Food and Veterinary Research. Furthermore, serotyping of Salmonella isolates from faecal and caecal samples were carried out at the Danish Institute of Food and Veterinary Research.

DISCLAIMER

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