Salmonella enterica prevalence and serotype distribution in swine at slaughter

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Abstract

The objective of this cross-sectional study was to analyze data available from multiple studies conducted by our research team estimating the prevalence of *S. enterica*, and the serotype distribution in swine at slaughter, based on different sample types. A total of 1,110 pigs from three large capacity abattoirs located in the Midwestern U.S. were individually sampled at slaughter. Individually paired samples collected included: cecal contents and ileocecal lymph nodes. Samples were collected on multiple occasions in all three abattoirs, transported to the laboratory, and processed for the isolation and identification of *S. enterica*. The overall prevalence of *S. enterica*, based on cecal contents, mesenteric lymph nodes, and any of the samples (i.e., cecal contents and/or mesenteric lymph nodes) was 54.7%, 27.9%, and 62.6%, respectively. There was a significant difference ($P<0.05$) between prevalence estimates based on cecal contents and mesenteric lymph node samples in all three abattoirs, and overall. A variety of *S. enterica* serotypes was isolated in all abattoirs. The average number of serotypes isolated per group was 3.48. This study confirms that the *S. enterica* prevalence at slaughter in swine is high, requiring attention due to the associated risk of contamination of the abattoir environment. Moreover, our results demonstrate the common occurrence of a high diversity of serotypes in swine at slaughter. This study also shows that both cecal contents and mesenteric lymph nodes should be considered for a better estimate of *S. enterica* prevalence at slaughter.

Introduction

Salmonella enterica is recognized as an important foodborne pathogen with multiple potential sources. Although *S. enterica* constitutes a very heterogeneous group of bacteria, including more than 2,400 serotypes, only a limited number of serotypes are responsible for most outbreaks. Subclinical *Salmonella* infections in pigs constitute an important food safety problem as carrier animals pose a risk for pork product contamination. A variety of *S. enterica* serotypes have been recovered from pigs on-farm and at slaughter, with a much higher diversity of serotypes being found at slaughter. However, the current knowledge on the ecology of *S. enterica* serotypes, as well as the effect of different sample types on their frequency distributions is very limited. Unfortunately, the required large scale studies to investigate serotype ecology are cost prohibitive, and therefore, rarely conducted. With this limitation in mind, we decided to analyze data available from two previous studies (Rostagno et al.,2003; Hurd et al.,2005) conducted by our research team to determine the prevalence and distribution of *S. enterica* serotypes in swine at slaughter, based on different sample types.

Materials and Methods

A total of 1,110 pigs from three large capacity abattoirs (A, B, and C) located in the Midwestern U.S. were included in this study. Individually paired samples (cecal contents and mesenteric lymph nodes) were collected in multiple occasions in all three abattoirs, transported to the laboratory, and processed for the isolation and identification of *S. enterica* (Rostagno et al.,2003; Hurd et al.,2005). In each of abattoirs A and B, 12 groups of pigs were sampled in 3 different occasions, whereas in abattoir C, 21 groups were sampled in 7 different occasions. Results were organized in an electronic spreadsheet, and proportions were compared by Chi-square ($P<0.05$).

Results

The overall prevalence of *S. enterica*, based on cecal contents (CC), mesenteric lymph node (MLN), and any of the samples (CC and/or MLN) was 54.7%, 27.9%, and 62.6%, respectively. There was a significant difference ($P<0.05$) between prevalence estimates based on CC and MLN samples in all three abattoirs, and overall. The prevalence of *S. enterica*, based on any of the samples collected was: 57.1% in abattoir A, 48.3% in abattoir B, and 70.2% in abattoir C. All 45 groups of pigs sampled were positive for *S. enterica*. A variety of *S. enterica* serotypes was isolated in all abattoirs (16 in abattoir A, 16 in abattoir B, 9 in abattoir C, and 21 overall). The number of serotypes isolated from each group varied with an average of 3.48 serotypes per group (minimum of 1 and maximum of 6 serotypes per group). Although *S. enterica* serotype Typhimurium was the most frequently isolated (numerically), there was no statistical difference in comparison to the isolation frequency of serotype Derby (27% versus 21.8%, $P>0.05$). Other serotypes were isolated at a significantly ($P<0.05$) lower rate (Table 1).

Table 1. *Salmonella enterica* serotype distribution in swine at slaughter

Serotype	Cecal contents (CC)	Mesenteric lymph node (MLN)	Any sample (CC and/or MLN)
Typhimurium	19.8%	13.8%	27%
Derby	17.1%	7.8%	21.8%
Anatum	5.9%	1.5%	7.2%
Heidelberg	4.7%	2.5%	5.7%
Saint Paul	2.7%	1.6%	2.9%
Infantis	1.7%	0.2%	1.9%
Senftenberg	0.7%	0%	0.7%
Agona	0.4%	0.1%	0.5%
Newport	0.2%	0.3%	0.5%
Schwarzengrund	0.4%	0%	0.4%
Choleraesuis	0%	0.3%	0.3%
Ohio	0.2%	0%	0.2%
Mbandaka	0.2%	0%	0.2%
Hartford	0.1%	0.2%	0.2%
Worthington	0.1%	0.1%	0.2%
Muenchen	0%	0.2%	0.2%
Montivideo	0.1%	0%	0.1%
Babelsberg	0.1%	0%	0.1%
Molade	0%	0.1%	0.1%
Bovis-morbificans	0.1%	0%	0.1%
Cerro	0.1%	0%	0.1%
Untypable	0.5%	0.3%	0.7%

Discussion

This study shows that both cecal contents and mesenteric lymph node samples should be considered for a better estimate of *S. enterica* prevalence at slaughter. Our results corroborate a previous study conducted by our research team (Hurd et al.,2004) demonstrating that different sample types generate different prevalence estimates on-farm and at slaughter. Similarly, Swanenburg et al.(2001), studying *Salmonella* in slaughter pigs, also reported significant difference in the prevalence estimates based on different sample types. Davies et al.(2005) also reported similar results when analyzing the differential translocation of *S. enterica* serotypes Derby and Typhimurium to mesenteric lymph nodes in swine. This study shows that results of *S. enterica* isolation from pigs should always be carefully interpreted, with careful attention to the type of sample that has been collected. However, a critical question arises: Why are the results affected by the different sample types? We hypothesize that the combination of the invasiveness of the serotype(s) infecting the pigs prior to slaughter, and the period of time elapsed between infection

and sampling will determine the prevalence estimate based on mesenteric lymph nodes. Probably, mesenteric lymph node samples reflect on-farm infections (as suggested by Bahnson et al.,2005) and, in the case of more invasive serotypes, rapid infections acquired from pre-slaughter contaminated environments (transport trailers and abattoir holding pens). In the other hand, cecal content samples reflect (mostly) rapid infections or contaminations of the gastrointestinal tract (i.e., passage of bacteria with no colonization or infection) after pigs leave the farm. However, further knowledge on the pathogenesis of *S. enterica* serotypes infection will allow refinement of this hypothesis.

Our results regarding serotype distribution are in agreement with a report from the USDA (Schlosser et al.,2000) on the *S. enterica* serotypes isolated from carcasses and ground pork. According to the report, a variety of serotypes was also commonly found, and *S. enterica* serotype Typhimurium was not the most common serotype isolated. Curiously, our results contrast with the reported distribution of *S. enterica* serotypes in pigs from Denmark (Nielsen et al.,2005) and the Netherlands (Van Duijkeren et al.,2002), where *S. enterica* serotype Typhimurium has been by far the most common serotype isolated with very low serotype diversity. However, it is difficult to compare results as the number of variables to be considered is overwhelming.

Conclusions

This study confirms that the *S. enterica* prevalence at slaughter in swine is frequently high requiring attention due to the associated risk of contamination of the abattoir environment, and consequently, of pork products. Moreover, our results demonstrate the common occurrence of a high diversity of serotypes in swine at slaughter. This study also shows that both cecal contents and mesenteric lymph nodes should be considered for a better estimate of *S. enterica* prevalence at slaughter.

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