

Herd-level risk factors influencing serological *Yersinia* prevalence in fattening pig herds

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Abstract

Yersiniosis is the third most frequent zoonosis reported in the European Union with pork as an important source. Identifying risk factors in swine production which may decrease the risk of pork production contamination during pre-harvest is an important step prior to controlling *Yersinia* spp.. Therefore, management strategies and production processes which might be associated with fattening pigs testing seropositive for pathogenic *Yersinia* spp. were investigated on 80 fattening pig farms. Although more than 70 farm characteristics were included in the risk assessment, there were only a few which seemed to be connected with serological prevalence: housing on a fully slatted floor and the use of municipal water were observed in herds with low serological *Yersinia* prevalence, whereas recurring health problems and a low daily weight gain compared to the mean of the herds included in the study were identified more often in herds with a high prevalence.

Introduction

In humans, yersiniosis is a gastrointestinal infection caused by *Yersinia* (*Y.*) *enterocolitica*, and to a lesser degree by *Y. pseudotuberculosis*. Infection with *Y. enterocolitica* is recognised as a high-risk food-borne zoonotic hazard with public health relevance, having the highest risk for pork consumers (2, 16). Pigs are asymptomatic carriers of pathogenic *Y. enterocolitica* and tonsillar tissue is the most reliable sample to detect *Y. enterocolitica* in slaughter pigs (19). Pigs were also identified as regular carriers of *Y. pseudotuberculosis*. But the agent has seldom been isolated from fattening pigs in European countries (14).

Serological testing is preferable to bacteriological methods on the basis of practicability, time-saving aspects, and costs. There is a strong association between *Y. enterocolitica* positive tonsil culture and seropositivity (11, 12), whereas serological results did not correlate to bacteriological findings in faeces (22). Investigations into antibodies based on YOPs (*Yersinia* outer membrane protein) present a broad diagnostic tool to detect pathogenic *Yersinia* infected pigs on the farm (6), because all pathogenic *Yersinia* spp. (*Y. pestis*, *Y. pseudotuberculosis*, and pathogenic *Y. enterocolitica*) carry the 70-kb virulence plasmid (1), which encodes the secretion of YOPs.

Antibodies against *Yersinia* spp. cannot be found in all pig herds (22). The objective of this study was to find those herd factors associated with the detection of antibodies against pathogenic *Yersinia* antigens in fattening pig herds.

Material and Methods

The serological within-herd *Yersinia* prevalence of 80 fattening pig herds from Lower Saxony, Germany, was taken for risk analysis. Prevalences were estimated based on serological results of 30 slaughtering pigs per herd.

Detecting antibodies against *Yersinia* was performed using a commercial ELISA (enzyme-linked immunosorbent assay) test based on recombinant *Yersinia* outer membrane proteins. The Pigtype® Yopscreen ELISA was applied according to the manufacturer's instructions (Labordiagnostik Leipzig, Germany). A basic cut-off of optical density (OD %) 20 was used.

A standardised risk-factor questionnaire was adopted from another study (SALINPORK (10)) and modified to include 74 questions on herd size and type, housing conditions, management practice, feeding practice, and production parameters. Since serological results originate from two studies, interaction effects were accounted in a multivariate logistic regression model. The Wald chi-square test was performed to calculate the relation between farm factors and serological prevalence. As the serological prevalence within the herds represented a bimodal distribution, the herds were divided in two categories: category I with low within-herd prevalence (< 20 % of the tested pigs were positive) and category II with high within-herd prevalence (> 20 % of the pigs were positive).

Results

The serological within-herd prevalence of *Yersinia* varied from 0 % to 100 %. 16.3 % (n=13) of the herds had no serological reactors. 25 % (n=20) of the investigated herds were merged into the category I and 75 % (n=60) of the herds belong to the category II. Most herds had a seroprevalence above 90 % (52.5 %, n =42) (Fig. 1).

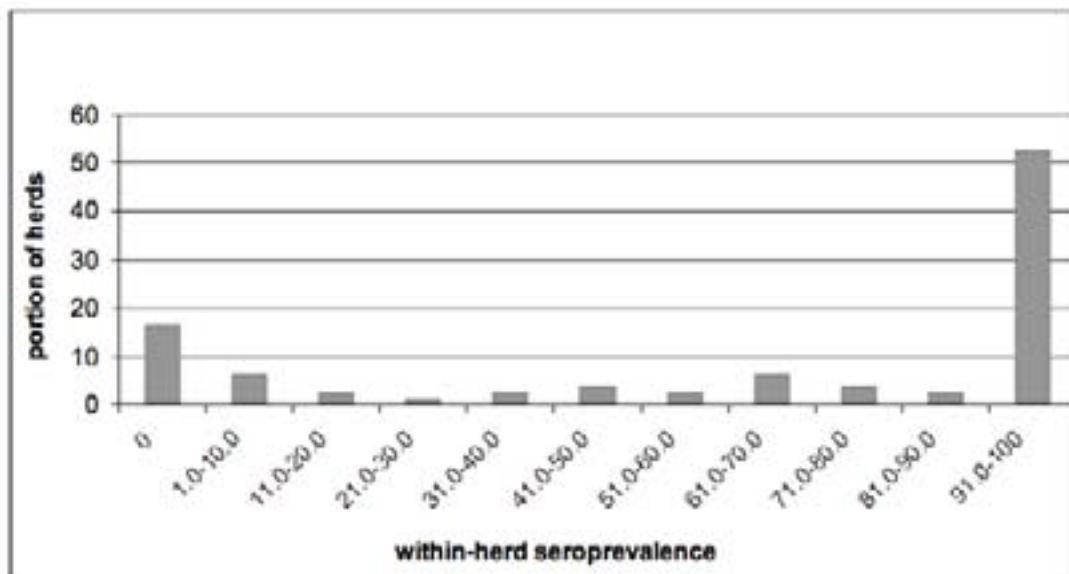


Figure 1: Frequency distribution of within-herd *Yersinia* seroprevalence of 80 fattening herds

Although over 70 parameters were gathered from each farm for risk analysis, only four farm factors were associated with the serological prevalence of *Yersinia* spp. (Tab. 1). Farms which housed the pigs on fully slatted floor and which offered municipal water mainly indicated low within-herd *Yersinia* prevalence (category I). In contrast, farms with high within-herd prevalence (category II) often recorded recurring health problems in the fattening herd and the daily weight gain was inferior to those herds with low *Yersinia* prevalence.

Figure 1: Frequency distribution of within-herd *Yersinia* seroprevalence of 80 fattening herds

Variable	Category I (portion of herds in %)	Category II (portion of herds in %)	p-value	odds ratio	CI*
Exclusive housing on fully slatted floor	65.0 % (N=20)	36.7 % (N=60)	0.0336	0.316	0.11 – 0.92
Exclusive use of municipal water	75.0 % (N=20)	44.1 % (N=59)	0.0342	0.284	0.09 – 0.91
Recurring health problems in the herd	15.8 % (N=19)	49.1 % (N=55)	0.0219	4.902	1.27 – 20.00
Daily weight gain below the mean of 708 g	27.8 % (N=18)	71.7% (N=53)	0.0072	6.610	1.67 – 26.21

*CI = confidence interval

Discussion

Bacteriological findings in faeces of finishing pigs showed that 80 % of 20 farms had at least one animal infected with *Y. enterocolitica* (15), which is in accordance with the serological results in the presented study. Relating to the number of infected pigs, there were 64.2 % serological positive animals. Thibodeau et al. (2001) found that 66 % of pigs at a slaughterhouse showed serological evidence of previous infection (20). Bacteriological findings of pathogenic *Y. enterocolitica* in tonsils of slaughtered pigs in Germany confirm these data (3).

The applied ELISA cannot distinguish between infections with different pathogenic *Yersinia* spp.. *Y. pestis*, the etiological agent of plague, is not found in Europe *Y. pseudotuberculosis* is especially found in production systems where pigs have contact with the outside environment, e. g. organic production (7). Against, pathogenic *Y. enterocolitica* was found more

frequently in pigs from conventional housing (13), like the herds included in this study. It is assumed that the presented serological results were mainly caused by infection with *Y. enterocolitica*, although an infection with *Y. pseudotuberculosis* cannot be completely ruled out.

Y. enterocolitica is transmitted from infected faeces or picked up from the floor of a contaminated pen (5). Fully slatted floor do not enable the oral intake to such an extent like partially slatted and solid floor. The risk factors "recurring health problems in the herd" and "low daily weight gain" might be associated. A low daily weight gain might be the consequence of recurring health problems, because illness causes inadequate feed intake and weight loss e.g. diarrhoea. Diarrhoea might lead to an increased shedding of the agent, causing a spread of the infection on the farm. Unfortunately, the information concerning the cause of health problems was invalid for analytical purposes. Virtanen et al. (2011) detected a relation between higher carriage and shedding prevalence of *Y. enterocolitica* to the use of tetracycline. They speculated that the need for tetracycline on farms reflected also the lower health status of pigs on these farms, which in consequence would be associated with the *Y. enterocolitica* prevalence (21).

A low serological within-herd prevalence was detected in farms exclusively using municipal water. Using this water was also discovered to be a protective factor for carriage and faecal shedding of *Y. enterocolitica* in pigs (21). Case-controlled studies in humans have identified drinking untreated water as a risk factor for *Y. enterocolitica* infection, but strains mainly belong to biotype A (17), which do not carry the virulence plasmid. A coherence between drinking untreated water from wells and streams and a infection with *Y. pseudotuberculosis* infections was described in Japan (4).

The findings of Laukkanen et al. (2009) might also be connected with drinking water. They found "drinking from a nipple" and "wet feeding" to be risk factors associated with a high bacteriological prevalence of *Y. enterocolitica* in slaughtered pigs (8). Although "wet feeding" was also included in the presented analysis, it could not be demonstrated as a risk factor. Fattening pig herds were found to have higher prevalence of antibodies to *Yersinia* than conventional farrow-to finish herds (18). The suggested beneficial effect of integrated or closed herds might have been included in the question relating to the number of suppliers, but there was no association with seropositivity. Skjerve et al. (1998) also demonstrated under-pressure ventilation and manual feeding of slaughter pigs to be protective factors, whereas using own vehicles for transporting animals to the abattoir, keeping clean and unclean sections in herds separate, using straw and daily observations of a cat with kittens increased the risk. Not all of these factors were requested in the presented study, but use of own transport for slaughter pigs and contact with other farm animals or pets on the farm were not apparent risk factors.

Further farm factors which were associated with high bacteriological prevalence of *Y. enterocolitica* were presented by Laukkanen et al. (2009). High prevalence was associated with the absence of coarse feed or bedding, which in turn seemed to represent typical factors for organic and small conventional farms (8). In the presented study, no association between herd size and seropositivity could be detected. Other described risk factors, such as production capacity (8), no access of pest animals to pigsty (8) and medicated feed (9) could not be supported by our findings.

Conclusion

The epidemiology of *Yersinia* spp. on swine farms is complex. Further investigations should necessarily include testing the presumed risk factors to evaluate their potency to affect the prevalence in fattening pig herds.

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