DEVELOPMENT OF A SANITARY RISK INDEX FOR SALMONELLA IN PIG HUSBANDRY

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Introduction

For reasons of food safety and economic pressure, risk factor studies are required to have a scientific basis to initiate a control program to avoid *Salmonella* in pig herds. The aim of the present study was to determine risk factors for the prevalence of *Salmonella* in Belgian slaughter pigs. These factors will be combined in a scientifically based sanitary risk index (SRI). This SRI can be defined as an objective measure of the *Salmonella* prevalence of a farm and/or the risk for introduction and/or the risk of spread of *Salmonella* from a farm. The SRI is a statistical model of a group of parameters and their weight factors.

Material and methods

60 Belgian farrow-to-finish herds belonging to one slaughterhouse co-operation were randomly selected. Herd data were collected using a questionnaire, consisting of 2 major parts, in order to identify potential risk factors. The general part of the questionnaire concerned all pigs in the herd; the specific part concerned the slaughter pigs to be sampled. Following topics were included: housing and ventilation, management, hygiene and biosecurity, and production parameters. The specific part additionally pertained to feeding, disease control and transport to slaughterhouse.

From each of the herds, 33 randomly selected pigs from an average delivery of 77 pigs were blood sampled at slaughter. Each herd was sampled two times i.e. in summer (July-October) and in winter (December-March) to account for seasonal variation in seroprevalence. In total, 3975 fattening pigs were sampled in the slaughterhouse. Serological examination for specific antibodies to *Salmonella* was performed by means of an indirect mix-ELISA (IDEXX® HerdChek).

For the determination of risk factors a Linear Mixed Model was applied (SAS®). This method was used with the continuous S/P-value[1] on the pig level as dependent variable so that a selection of a cut-off value was avoided and because analysis on pig level with a continuous dependent variable has more power then analysis with a dichotomised variable.

In a first step, the S/P-value has been transformed with a logarithmic function to get a normal distribution. Next, each of the factors obtained from the questionnaire were separately introduced in the model to assess whether any of these factors were univariate associated with the S/P-value. Variables significantly related to the S/P-value ($P<0.05$ and 85% of the observations included) were analysed jointly in a multivariate model with herd and herd*season as random effects.

Results

In 60 herds (100%) at least 1 sample was positive when using OD10%[2] as cut-off, for both seasons. 68% of the herds in summer and 78% in winter, were positive when using OD40%. The average within-herd seroprevalence was in summer: 70% (range: 15%-100%) and in winter 64% (range: 15%-100%) when using OD10%. When using OD40% as cut-off, the within-herd prevalence in summer and winter were respectively 27% (range: 0%-97%) and 16% (range: 0%-79%). Differences between winter and summer were significant for OD40% ($P<0.05$).

Categorical and continuous variables were studied by univariate analysis, of which 182 were significantly associated with *Salmonella* prevalence. The significant variables could be sorted into 5 classes: farm characteristics, hygiene, management, climate and feed. The most important variables have been selected for the multiple analyses based on the P-value, the estimate and the biological sense. The variables were introduced in the multivariate model. Factors still significantly ($P<0.05$) associated with the S/P-value in the multivariate analysis are enumerated in table 1 together with their estimates. Incorporating these 12 factors in the multivariate model could considerable reduce the variance between herds, 58% of the variance could be explained by these factors. The sanitary risk index for *Salmonella* can be defined as the multivariate model with intercept, risk factors (see table 1) and their weight factors (estimates).

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[1] Sample to Positive
[2] Optical Density Percentage, OD%=(S/P/2,5)*100

Discussion

The most important factor in the SRI seems the structure of feed. Feeding pigs meal instead of granulated or crumb feed is a protecting factor for *Salmonella*. Jorgenson *et al.* (1) found that pigs that received meal have the largest population of lactic acid bacteria in the stomach. Also adding organic acids in feed and drinking water gives a reduction effect on *Salmonella* prevalence. Beside the feed, hygienic measures such as number of days emptiness after cleaning, applying the strict all-in all-out system and controlling the rodent population seems to be important. These factors have been supported by previous research (2, 3, 4). Furthermore it could be deduced from the index that providing the right climate for the pigs (programmed temperature and ventilation, regulation of air inlet) is a factor to consider for reducing the S/P-values.

With the identification of the risk factors, adequate intervention strategies could be designed to reduce *Salmonella* prevalence and contamination in finishing pigs. The SRI could be used at different levels of the pig production column, e.g. on national level, on individual farm level and also for integral quality control (IQC).

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References

(1) *Jorgensen, J., Dahl, J., Wingstrand, A. The effect of feeding pellets, meal and heat treatment on the Salmonella prevalence of finishing pigs. "In: Proceedings of the 3rd International Symposium on Epidemiology and Control of Salmonella in Pork". Washington, 5-7 August 1999. 308-312.*

(2) *Letellier, A., Messier, S., Paré, J., Ménard, J., Quessy, S. Distribution of Salmonella in swine herds in Quebec. Vet. Microbiol. 1999; 67: 299–306.*

(3) *Lo Fo Wong, D.M.A., Dahl, J., Stege, H., Van der Wolf, P.J., Leontides, L., von Altrock, A., Thorberg, B.M. Herd level risk factors for subclinical Salmonella infection in European finishing herds. Epidemiology and control options of Salmonella in European pig herds. Ph.D. Thesis. Royal Veterinary and Agricultural University, Denmark. 2001.*

(4) *Van der Wolf, P.J., Wolbers, W.B., Elbers, A.R.W., van der Heijden, H.M.J.F., Koppen, J.M.C.C., Hunneman, W.A., van Schie, F.W., Tielen, M.J.M. Herd level husbandry factors associated with a serological Salmonella prevalence in finishing pig herds in the Netherlands. Vet. Micorbiol. 1999; 78: 205-219.*

Table 1. Risk factors for *Salmonella* in pig husbandry.

	Variable	Class		Estimate
B0	intercept			-2.31
B1	seizoen	1	summer	0.19
		2	winter	0.00
B2	vta1n	0	granulated feed	0.39
		2	crumbed feed	0.81
		3	meal	0.00
B3	aanpvbb	-1	no computer	-0.71
		0	no adjustment of climate	0.14
		1	adjustment of climate	0.00
B4	tempiamk	-1	no temperature programmed	0.27
		1	temperature less then 22 °C	0.03
		3	temperature more then 22°C	0.00
B5	venminak	-1	no ventilation programmed	0.14
		1	minimum ventilation less then 15%	0.12
		2	minimum ventilation more then 15%	0.00
B6	rli2amn	1	natural ventilation, manual or automatic adjustment	-0.22
		2	no adjustment of air inlet possible	0.00
B7	dstandam	continuous	number of days emptiness after cleaning	-0.05
B8	spijlam	continuous	width of slats	0.09
B9	twatern	0	drink trough or drink nipple	0.53
		2	drink nipple in feed trough	0.03
		3	no extra water supply (pulp feed)	0.00
B10	aiaoam	0	continuous system	0.14
		1	all-in all-out	-0.22
		2	no clear system or both systems	0.00
B11	zuur	0	no acidification	0.21
		1	acidification of drinking water	0.19
		2	acidification of feed	0.00
B12	hoestwan	-1	no coughing	0.24
		2	coughing when pigs weight less then 40 kg	0.19
		4	coughing when pigs weight between 40 and 80 kg	-0.18
		6	coughing when pigs weight more then 80 kg	0.00
B13	resknaan	-1	no rodent control	-0.15
		0	no results of rodent control	-0.40
		1	results of rodent control	0.00

Explanation of variables from table 1: Season (seizoen), food structure (vta1n), adjusting climate in nursery (aanpvbb), programmed temperature (tempiamk), programmed ventilation (venminak), regulation of air inlet (rli2amn), number of days emptiness after cleaning (dstandam), width of slats (spijlam), type of water supply (twatern), all-in all-out (aiaoam), acidification (zuur), incidence of coughing (hoestwan) and rodent control (resknaan).