

The serological Salmonella Monitoring in German pork production: the structure of the central database and preliminary results of a basic epidemiological report

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Abstract

Since 2002, the Qualität und Sicherheit GmbH (QS GmbH) has carried out a serological salmonella monitoring in German finishing pig herds. This monitoring aims at reducing the risk of introducing salmonella into the meat production chain caused by infected slaughter pigs and to identify and to remove infection sources. For this purpose the farms are differentiated into three risk categories (I = low, II = middle, III = high) by their chance to introduce salmonella into the pork production chain. All data generated within the monitoring are entered into the central database Qualiproof[®] (Qualitytype AG, Dresden).

The dataset investigated included 1 762 270 samples taken between April 1, 2003 and March 31, 2006 originating from 15 452 farms. Blood sera or meat juices are sampled at slaughterhouses following a scheme (up to 60 samples per year and farm, depending on farm size). The laboratories analyse the samples serologically using one of four ELISA-tests and report the results as OD% as well as the decision "positive"/"negative" (cut-off: 40 OD%). The categorisation is recalculated quarterly based on the percentage of positive samples during the last 12 months for each farm. A proportion of less than 20% positive samples yields in category I, 20-40% category II, $\geq 40\%$ category III.

The analysis showed that so far 12 545 farms could be categorized, and, that in quarter 1-2006, 80% of the farms were in category I, about 15% in category II, and only 5% in category III.

11.1% of all samples were serologically positive. The distributions of the OD%-values differed between the regions of Germany. The North-western parts for Germany showed higher values than other parts of Germany. Higher numbers of animals per area as well as per farm and a higher rate of participation in these intensive agricultural regions are reasons for the higher Salmonella prevalence. Apart from regions, single risk factor analyses showed an increase in prevalence by laboratory, testkit and the slaughterhouse. Due to strong interactions between these factors multivariate statistical models have to be used to describe the real influences on the OD%-values correctly.

The basic epidemiologic report can be used to optimise the salmonella monitoring by evaluating further useful information. Periodical updates of this analysis will help to control the evolution of the Salmonella prevalence in fattening pigs in Germany. Furthermore, these data can be used to define scientific hypotheses and to conduct specific studies.

Introduction

The Salmonella regulations establishment as well as the implementation of the European regulation on zoonoses requires to prepare objective and scientifically valid information about the situation of the Salmonella burden in the German pork production.

Regarding the prevalence of *Salmonella* in finishing pig herds, a variety of results is currently available in Germany. Some of them are presented in table 1.

Table 1: Published data of *Salmonella* prevalence in Germany

Source	Samples (n)	Group	Detection	<i>Salmonella</i> -Seroprevalence (%)
Vornahme et al. (2007)	13 611	Gilts	serological	9.9
Meyer (2004)	2 947	Fattened pigs	serological	7.3
Leyk et al. (2004)	unknown	Fattened pigs	serological	8.0
Ehlers (2003)	51 477 (1999)	Fattened pigs	serological	6.0
	68 761 (2002)	Fattened pigs	serological	11.0
	92 309 (2003)	Fattened pigs	serological	14.2
Protz et al. (1997)	11 942	Fattened pigs	serological	7.7

Since 2002, the QS Qualität und Sicherheit GmbH in Bonn/Germany (QS) has carried out a serological *Salmonella* monitoring in German finishing pig herds. This monitoring aims at reducing the risk of introducing *Salmonella* into meat production chain by infected slaughter pigs and to identify and remove infection sources.

To establish the *Salmonella* burden of the farms, blood serum or meat juice samples are analysed regarding the presence of antibodies against *Salmonella*. By this, the *Salmonella* burden of the farm can be estimated simply and cost-effectively. The farms are classified by their percentage of positive samples during the last year in the categories low, middle or high burdened (QS Qualität und Sicherheit GmbH 2006).

Meantime, this monitoring system is the greatest database concerning *Salmonella* in the German pork production. A basic epidemiological analysis has been carried out including all data from April 1, 2003 until March 31, 2006.

Material and methods

Depending on farm size, every farm has to take up to 60 blood serum or meat juice samples per year. The samples are taken on the farm by a veterinarian (blood serum samples) or at the slaughterhouse (meat juice samples) and sent to a laboratory, where they are analysed serologically. The number of samples per slaughter is given by the Qualiproof® database (Qualitype AG, Dresden/Germany) following a scheme which provides for consistent distribution over the whole year. Four ELISA-tests are registered within the *Salmonella* monitoring system (Enterisol, Herdcheck, Salmotype Pigscreen, Salmotype Fleischsaft). For each sample, the laboratories report the antibody activity in OD% (optical density relative to reference) as well as the decision "positive"/"negative" (cut-off: 40 OD%) to QS.

The classification of the farms into the categories I, II, or III is made by their percentage of positive samples per year: category I, if less than 20% of the samples are positive; category II, if 20-40% of the samples are positive; and category III, if more than 40% of the samples are positive. The first classification is given after the delivery of the first 60 samples. The classification is updated quarterly basing on the data of the last 12 months.

If for farms with few samples or if the last sampling is more than 6 months ago, the classification is not updated, but they are labelled "below quota" and "sampling gaps", respectively.

Up to March 31, 2006, 1 762 270 valid samples from 15 452 participating farms were entered into the QS database. 203 slaughterhouses as well as 37 laboratories all over Germany were involved in the QS *Salmonella* monitoring.

To perform regional analyses of the data, regions within Germany were defined regarding numbers of fattening pigs and numbers of farms per area as well as farm sizes within each district. By means of their location, every farm and every sample was assigned to one of the six regions (North-west, North-east, West, South, Cloppenburg/Vechta, the Alps).

The data transmitted were analysed statistically using SAS®, version 9.1 TS level 1M3 (SAS Institute, Inc., Cary, NC, USA). Absolute and relative frequencies of farms or samples with similar attributes were determined. The results of the laboratory examinations in OD% were converted into the logarithmic scale for the statistical analyses. To display the results in tables and figures, these

logarithmic values were reconverted and presented as geometric means. Several analyses of variance regarding one or more influence factors were used.

Results

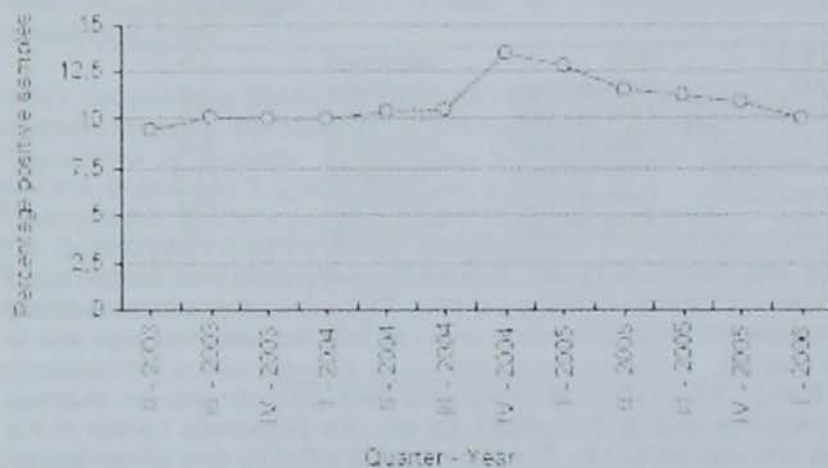


Figure 1: Percentage of positive samples per quarter

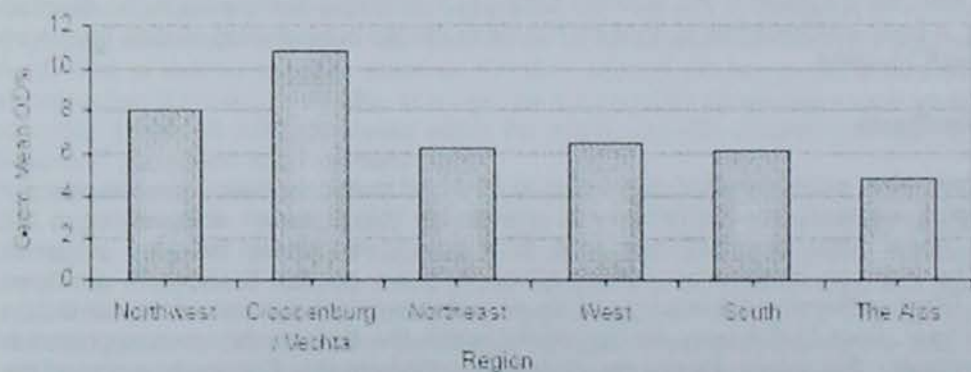


Figure 2: Antibody activity in OD% per region

Table 2: Categorisation of the farms in the quarter I/2006

	Categorisation					Overall
	I	II	III	Below quota	Gaps	
No.	5 875	1 087	407	4 458	538	12 365
%	47.5	8.7	3.2	36.0	4.3	100.0

During the first year, the number of participating farms increased strongly, and it is still increasing. The percentage of positive samples per quarter has small variation (Figure 1), but it peaked in quarter IV-2004. In quarter I-2006, the number of samples investigated was 206 327, the percentage of positive samples was 10.0%. In table 2, the categorisation of the farms in the quarter I-2006 is shown. Most of the farms were category I (47.5%), and only a small fraction (407 farms) belonged to category III. But more than 40% of the farms could not be classified because of missing samples or sampling gaps. 3 090 farms have never been classified, because they did not send the first 60 samples which are necessary for the first classification yet (e.g. participation < 12 months). The results differed between the regions, eminently the Northwest had the highest mean OD%-values of all regions (figure 2). Similar patterns of association are found due to the factors laboratory, testkit, and slaughterhouse (not presented here).

Discussion

The percentage of positive samples evaluated by the QS Salmonella monitoring was slightly higher than prevalence estimates from other studies in Germany (Pretz et al. 1997; Ehlers 1999; Leyk et al. 2004; Meyer 2004; Vonnahme et al. 2007).

The high proportion of farms with few samples reflects that the participation at this monitoring programme still is voluntarily and that participating farms are decorated with the QS certificate. To decrease this percentage of not categorised farms, control measures should be integrated into the monitoring system.

The analysis of the regions showed that mainly the North-western regions including Cloppenburg / Vechta (the districts with the highest density of animals in Germany) had the highest OD%-values as well as the highest percentage of category-III-farms in Germany. To interpret these results, it is necessary to consider that higher numbers of animals per area as well as per farm enhance the spread of pathogens within the animal population, because the transmission pathways are shorter. Furthermore, the rate of participation was higher in these regions than in the other German regions. Possibly, in the North-West of Germany, it is more necessary to participate at quality management measures to stand up to the competition. This might cause that farms participated at the QS Salmonella monitoring which participated not in the other regions.

As many laboratories analyse samples originating from only one or two regions, and as most of the laboratories use only one or two of the registered testkits, the factors testkit, laboratory, and region showed various interactions between each other. Therefore, identifying one of these factors as an initial risk factor is invalid, and additional analyses have to be performed. Specific sub-analyses are necessary to affirm the real influences of these factors on the results of the samples. Scientific studies concerning this problem are in preparation.

The epidemiological report of the QS Salmonella monitoring showed that these data are adequate to improve the quality of the German pork production. Furthermore, they fulfil the criteria of public surveillance, because changes in the Salmonella prevalence can be observed in detail basing on the continuous evaluation of data. The basic analysis of the data can be used to identify gaps of information within the database, to generate recommendations regarding the performance of the monitoring system, and to initiate scientific studies.

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