

## THE DANISH SALMONELLA SURVEILLANCE PROGRAMME OF SLAUGHTER PIG HERDS

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*En Janvier 1995 un programme de surveillance sérologique de Salmonella obligatoire des cheptels de porcs de boucherie a été commencé par l'industrie porcine danoise et les autorités vétérinaires. Le principe du programme est de contrôler, à l'abattage, tous les cheptels livrant plus de 100 porcs de boucherie par an, comprenant 16.000 cheptels avec 800.000 échantillons. Le programme de surveillance est basé sur la recherche des anticorps de Salmonella dans le jus de viande par une technique sérologique basée sur une combinaison de LPS-antigènes O: 1, 4, 5, 6, 7 et 12. Des échantillons de viande de chaque cheptel sont recueillis continuellement et au hasard à l'abattoir. Les cheptels sont classés à un niveau 1, 2 ou 3 basé sur le résultat d'essai. Le niveau 3 représente les cheptels avec la plus haute prévalence de porcs séropositifs de Salmonella. Au Danemark tous les cheptels sont identifiés par des codes uniques qui donnent la possibilité d'identifier l'origine de chaque carcasse individuellement à l'abattoir. Les données de la surveillance des cheptels de porcs de boucherie sont assemblées dans une base de donnée établie et possédée par le ministère d'alimentation, d'agriculture et de pêche. Les cheptels placés au niveau 2 et 3 doivent demander conseil concernant la réduction de la prévalence de Salmonella. En plus, tous les porcs des cheptels au niveau 3 sont abattus sous des précautions d'hygiène renforcées. Pour contrôler l'effet des actions commencées pour réduire la prévalence de Salmonella, environ 1.400 échantillons de porc frais sont recueillis au hasard chaque mois et testés pour Salmonella par des méthodes microbiologique traditionnelles. Depuis 1996 le nombre de cheptels de niveau 3 a diminué considérablement. La prévalence de Salmonella dans le porc frais a augmenté considérablement de 0,8% en 1995 à 1,2% en 1996, mais l'augmentation a principalement eu lieu au début de 1996, depuis octobre 1996 la prévalence a été sous 1%.*

### INTRODUCTION

From the middle of the 1980's the number of diagnosed cases of human salmonellosis has increased in Denmark (2). Epidemiological typing methods have suggested that pork was associated with this increase. A preliminary Salmonella surveillance programme was initiated in 1993 with the existing programme being established in January 1995 (3). The aim of the compulsory programme is to reduce the prevalence of Salmonella in slaughter pig herds and pork, and the programme is administered by the Ministry of Food, Agriculture and Fisheries (1).

This comprehensive programme is made possible not only because of cooperation between the Danish pig industry and the veterinary authorities, but also due to a high degree of collaboration between pig producers and the slaughterhouses. About 95% of all pigs slaughtered in Denmark are slaughtered at the cooperative slaughterhouses owned by the pig producers, the last 5% are slaughtered at non-cooperative slaughterhouses.

### MATERIAL AND METHODS

The Ministry of Food, Agriculture and Fisheries has established a central database, the Zoonosis Register (ZOOR) in which herd surveillance data are received, stored and calculated. ZOOR is administered by the Danish Veterinary Service. An official herd ID-code, enables ZOOR to trace back the result of every sample to individual herds.

The programme consists of the following parts: (I) Serological monitoring of all herds producing more than 100 slaughter pigs per year. (II) Assignment of herds into one of three Levels (1, 2 or 3) based on the prevalence of seroreactors. (III) Mandatory advising and elaboration of a Salmonella intervention plan for all herds in Levels 2 and 3. (IV) Slaughter of Level 3 herds under increased hygiene precautions. (V) Monitoring of the prevalence of Salmonella in pork products.

Furthermore, the programme includes monitoring of breeding and multiplying herds and of Salmonella in animal feed (not described in this paper).

1. The herd monitoring scheme makes use of an indirect enzyme linked immunosorbent assay based on a combination of the LPS-antigens O:1,4,5,6,7 and 12 (the so-called mix-ELISA). The assay was developed by the Danish Veterinary Laboratory for the use on serum, but has been modified to be used also on meat juice (5). Meat juice is obtained, when frozen meat samples from slaughter pigs are thawed. The mix-ELISA detects about 95% of all Salmonella serotypes occurring in Danish pigs (3,4).

The slaughterhouses collect meat samples continuously from about 16,000 herds with samples being taken at random from each herd. In Denmark, pig producers are paid based on the weight and the classification of the dressed carcass (3,4). The herd of origin is known for each individual carcass due to the official herd ID-

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code. At the end of the slaughter line, where the weight of the carcase and the herd ID-code are recorded, a computer, updated from ZOOR, will automatically determine whether a carcase is to be sampled and tested for Salmonella antibodies. Labels for identification of the meat samples are printed automatically (3,4). However, at small slaughterhouses, the carcasses to be sampled are selected manually.

Each quarter, between 4 and 60 meat samples are collected from each herd, with the number of samples being determined by the number of pigs delivered for slaughter. Around 800,000 meat juice samples are examined annually for Salmonella antibodies at the Danish Veterinary Laboratory with data of the sample ID and test result being transferred electronically to ZOOR (3,4).

2. The result of the examination of the meat samples is summarized monthly for the individual herd. Based on the proportions of seroreactors during the previous three months, the herds are assigned to one of three levels. Level 1 herds have no or very few seroreactors, Level 2 herds have a relatively high proportion of seroreactors whereas Level 3 herds have an unacceptable high proportion of seroreactors (3). Both the herd owners and the slaughterhouses are informed monthly by ZOOR about the current Salmonella level of the herds. When a herd is placed in Levels 2 or 3, the herd owner must start a Salmonella intervention plan (3,4). To prevent carcase contamination with Salmonella during slaughter, the Danish Veterinary Service requires that pigs from Level 3 herds are slaughtered under special hygiene precautions, see (IV).
3. Since January 1995, herds assigned to Level 2 and 3 are requested by the slaughterhouse to seek advice on how to reduce the prevalence of Salmonella. The herd owner, a veterinary surgeon and a pig consultant must work out a herd specific intervention plan, otherwise the slaughterhouse will collect a penalty per slaughter pig delivered until the plan has been elaborated and received by the slaughterhouse. Three months after the assignment to Level 2 and 3, the veterinary surgeon and the pig consultant must certify that the programme agreed upon is being followed (4). If not, the slaughterhouse will again collect a penalty per slaughtered pig. If the herd remains in Level 2 or 3, or the herd is reassigned to Level 2 or 3 six months after the first assignment, it is required that the owner again seeks advice on how to reduce the Salmonella prevalence in the herd as described above.  
From August 1996, the requirements of the intervention in the Level 2 and 3 herds were increased. Ordered by the Danish Veterinary Service, these requirements include that a sufficient number of pen fecal samples must be collected and analysed in order to clarify the distribution of Salmonella in the herd. Based on these results an appropriate intervention plan must be prepared. Additionally, the slaughterhouses announced in July 1996 that from January 1997, a slaughtering fee would be charged from all herds assigned constantly to Level 3 for more than 6 months. The fee will be collected until the herd is assigned to a lower level.
4. All pigs from Level 3 herds are slaughtered under special hygiene precautions, which include that the pigs are delivered to the slaughterhouse as late in the day as possible and they are slaughtered as the last pigs on that day (3). The speed of the slaughterline is reduced, or manpower is increased. Heads of carcasses are not split during slaughter. Plucks and abdominal viscera are either rejected or heat treated. Potential contamination of the carcase with Salmonella during evisceration is monitored by swabbing a total of 1,400 cm<sup>2</sup>. Swabs are analysed for Salmonella by traditional microbiological methods (6). If more than 25% of the samples are positive that particular group of pigs will be heat treated or brine cured (3,6).
5. To monitor the effects of the actions initiated to reduce the Salmonella prevalence in the slaughter pig herds, approximately 2,200 samples, 1,400 from fresh pork and 800 from offal, are collected randomly every month, and analysed by traditional microbiological methods (6). The number of samples collected are determined by the number of pigs slaughtered (3). The results from the surveillance of pork and offal are not registered in ZOOR but in a special Salmonella database.

## RESULTS AND DISCUSSION

The results of the Danish Salmonella surveillance programme comprising approximately 16,000 slaughter pig herds from June 1995 to March 1997 are presented. Through out the surveillance periode the percentage of Level 1 herds ranged from 93.7 to 95.7% indicating an acceptable level of Salmonella infections in the majority of Danish slaughter pig herds. The percentages of herds in Levels 2 and 3 ranged from 2.9 to 4.3% and 1.3 to 2.3%, respectively (Fig. 1). The percentage of herds assigned to Level 2 showed some degree of variation, however, the percentage did not decrease. For herds assigned to Level 3 two logistic regression models using proc genmod SAS (7) was used to analyse the proportion of Level 3 herds per month (the number of Level 3 herds per month over the number of herds assigned to one of the three levels per month) in relation to time periods (in months) from June 1995 to July 1996 and from August 1996 to March 1997, respectively. From August 1996 to March 1997 a significant decrease was found in the proportion of Level 3 herds ( $\beta = -0.032$ ,  $P = 0.011$ ). This decrease might be associated with both the obligatory requirements to collect and analyse pen fecal samples for Salmonella, which were introduced in August 1996 and the announcement in July 1996 that a slaughtering fee would be effective from January 1997. Further analysis are necessary to identify the causes of the decrease in the number of Level 3 herds.

The Salmonella percentages in fresh pork are shown in Fig. 2 and ranged from 0.3 to 1.2% (mean 0.8%) in 1995 and from 0.6 to 2.1% (mean 1.2%) in 1996. A Chi-square test comparing the data from 1995 with the data from 1996 was significant ( $P = 0.001$ ). The increase in the percentage of Salmonella was mainly seen from February to September 1996 (Fig. 2). However, from October 1996 the percentage decreased to below 1%. The increase in Salmonella positive fresh pork samples in early 1996 appears to be associated with the concurrent increase in

the frequency of especially Level 2 herds, but also in Level 3 herds registered in the beginning of 1996 (Fig. 1). Although about 95% of the herds in Denmark are assigned to Level 1, it is still important to further reduce the number of herds assigned to Levels 2 and 3, thereby, reducing the risk of contamination of pork with *Salmonella*.

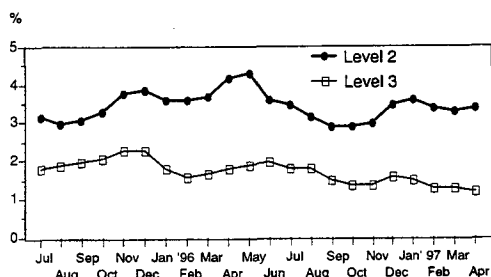


Figure 1. Distribution of Level 2 and 3 herds from June 1995 to March 1997.

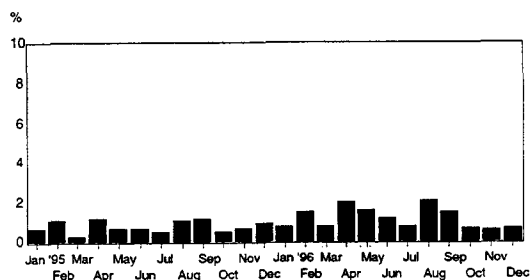


Figure 2. Prevalence of *Salmonella* in fresh pork samples collected from January 1995 to December 1996.

## REFERENCES

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