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SALMONELLA CONTROL PROGRAMMES IN DENMARK

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by

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ABSTRACT

Since the late 1980's Denmark has implemented 3 separate pre-harvest programmes to control salmonella in broilers, pigs and layers of table eggs, respectively. The programmes differ in the methods employed and to a minor extent in their goals. However, in many important aspects they are very similar. First, they are all based on the credo that if at all possible, food borne zoonoses should be controlled at source, i.e. on farm. Their successful implementation has relied to a large extent on co-operation between the authorities and the industry and on the ability to make use of the industry infrastructure, including the ability to unequivocally identify farms of origin. The authorities have delegated responsibility for technical co-ordination of the programmes to committees with representatives from science, government bodies and industry. Second, there has been a close involvement of microbiologists and epidemiologists in the planning and implementation of programmes. The parties involved in the undertaking have shown willingness to accept recommendations to use of novel techniques in routine monitoring, for example, the serological examination of meat juice or egg yolk for salmonella antibodies. Finally, the hallmark of the Danish salmonella programmes has been a very close collaboration between medical and veterinary epidemiologists and microbiologists in monitoring the effect of the programmes on the incidence of human infection.

RECOMMENDATIONS

1. Where possible, the implementation and running of control programmes must be in close co-operation between authorities and industry and should make use of industry infrastructure for collection of samples and implementation of control measures.
2. Control programmes should be designed in close collaboration with epidemiologists and microbiologists to ensure that they are efficiently designed and that they are fine-tuned as required.
3. There should be close collaboration between medical and veterinary epidemiologists and microbiologists to monitor progress in terms of effect on the human incidence of disease.

INTRODUCTION

Annually, Danish farmers produce about 21 million slaughter pigs, about 138 million broilers while about 580.000 heads of cattle are slaughtered. There are 3.5 million layers, which account for the major part of the domestic consumption of eggs. In general, Danish farmers are to a large extent export driven.

While zoonotic Salmonella infections may be involved in serious outbreaks of disease (salmonellosis) in animal holdings, generally the infections have only insignificant direct economic importance to farmers. However, even though there may be no clinical signs, infected animals constitute a source of salmonella contaminated foodstuffs, which constitute the main source of infections for humans. One avenue to control the incidence of human infections is the application of pre-harvest measures in food animal production.

In Denmark, like in many other Western countries, the incidence of human salmonellosis increased markedly during the last two decades of the 20th century (Figure 1) with a peak incidence reaching 95/100.000 in 1997.

During the 20th century programmes that were the result of a close collaboration between authorities and the farming industries achieved eradication of zoonoses such as bovine tuberculosis and brucellosis. This collaboration was greatly facilitated by the organisation of farmers in nation-wide co-operative movements. During the 1990's salmonella control programmes have been based on similar collaboration and have also involved scientists such as microbiologists and epidemiologists in the design of the programmes and in the monitoring of progress.

Finally, a hallmark of the efforts to control food borne zoonoses in Denmark has been the close collaboration between veterinarians and physicians. This has been facilitated through the formation of the Danish Zoonoses Centre in 1994. The collaboration has made it possible to continuously integrate monitoring data from humans with data from food animals and foods. This has formed the basis for decisions on the need for fine-tuning of programmes and for documentation of the public health gains made.

CONTROL PROGRAMMES

The salmonella control programmes are based on the farm-form approach and on the belief that pre-harvest control measures play a large role in reducing human exposure to food borne zoonotic salmonella serotypes. The on-farm control measures recognise that in order to reduce or entirely eliminate infection in a herd, animals and feed brought in must be free from salmonella. These are seen as the key control points in pre-harvest control of salmonella.

The strong emphasis of on-farm control measures makes it mandatory that results from individual farms can be identified in order to monitor progress. All Danish holdings with food animals are assigned a unique 6-digit code that forms the basis for identification of results when they are entered into a database. The programme for slaughter pigs relies heavily on the ability to collect samples at slaughter. This is possible because Danish farmers are paid based on the dressed carcass weight. Therefore, on top of the live animal identification system, carcasses must be identifiable until the end of the slaughter line.

Since 1994, the cost of the programmes have come to a total of 150-160 million $US. The authorities have paid approximately 40 percent of the cost. In recent years there has been increasing pressure on the industry to carry an increasing share of the cost, as it is seen as the obligation of the producers to ensure that food produced is safe.

Feeding stuffs. The Veterinary Service has carried out control of hygiene at rendering plants, including testing for Salmonella, since the 1950's. The result has been that meat and bone meal produced at Danish rendering plants is essentially Salmonella free. Since 1993, the Danish Plant Directorate has routinely monitored feed factories for Salmonella. The monitoring includes routine collection of samples from compound feeds and straight feeding stuffs, from critical control points at the processing line and from raw materials, including raw materials of animal origin. The results are shown in Figure 2. The proportion of positive samples is low and Salmonella Typhimurium and Salmonella Enteritidis are very rare.

Broilers. In the 1980^{s} it became evident that many broilers were contaminated by Salmonella, and complaints from export markets became a problem for the broiler industry.

In 1989 the industry introduced a voluntary control programme. This programme consisted of agreements with the feed industry on the production of salmonella free feed, rules for importation of breeding material as well as hygienic in all production segments. The industry also introduced continuous monitoring of all broiler flocks as well as monitoring flocks producing eggs for hatching. The industry implemented this programme, in co-operation with the Veterinary Service and the Danish Veterinary Laboratory, and although it was in principle a voluntary programme the industry made certain that it was adhered to by all sections of production.

In 1991 farm based ante mortem (AM) inspection of all broiler flocks was introduced and the monitoring of flocks for Salmonella by examination of 16 birds 3 weeks before slaughter was made compulsory. In addition, post mortem (PM) monitoring by examination of 50 neck-skin samples from each flock at the slaughterhouse was introduced as a compulsory measure. At the end of 1994 the bacteriological examination of 16 chickens was replaced by examination of 60 faecal samples per flock collected 3 weeks before slaughter. From December 1997 all samples have changed to so-called "sock samples" i.e. 15-cm pieces of tube gauze mounted on the footwear during inspection of the house. A total of 5 pairs of socks are used per flock. The samples are examined using standard microbiological techniques, including non-selective pre-enrichment and there is big emphasis on typing (sero-, phage- and antibiogram typing).

The proportion of positive broiler flocks peaked at over 80 percent in 1989, however in 2000 the flock prevalence had decreased to 3-4 percent. Figure 3 shows that the pre-harvest control measures had significant impact on post-harvest levels of Salmonella.

Layers of table eggs. In 1991 the industry established a voluntary Salmonella programme for layers. This programme required control measures in connection with importation of breeding material, routine bacteriological monitoring of multiplier flocks, systematic monitoring of hygiene at hatcheries, and finally monitoring of flocks by collection of 100 cloacal swabs just prior to culling. The latter was an attempt to monitor the effect of the control measures higher in the production pyramid. In 1995, about 5% of the flocks were found to be infected at the end of laying. However, a serological test in 1995 on 30 eggs from randomly 148 selected flocks indicated the infection rate was 17%. At the same time bacteriological examination of 100 eggs from each of the 148 flocks found 0.1% of the eggs to be contaminated, mostly on the shell.

The Zoonosis Directive (92/117/EEC) was implemented in Denmark in January 1994 and the previous voluntary monitoring was made compulsory and flocks infected with S. Typhimurium or S. Enteritidis were slaughtered.

During 1995 it became clear that the increasing incidence of S. Enteritidis infections in humans could not be explained by the occurrence of this serotype in broilers, and that eggs were the most likely source. Therefore, 1996 the Danish Ministry of Food, Agriculture and Fisheries implemented

a control programme, more extensive than dictated by the Zoonosis Directive. Among other things, the programme included testing for all Salmonella serotypes in parent animal flocks and called for culling of those infected and for cleaning and sanitising of infected premises.

In the beginning of 1998, the situation in the breeder flocks had been brought under control, and a revised version of the programme was implemented when four new governmental orders concerning Salmonella in Danish poultry were put in to effect. In the revised programme, rearing and laying flocks were also tested for Salmonella serotypes other than S. Enteritidis and S. Typhimurium. The goal of the programme is the eradication of Salmonella from commercial flocks of layers.

The programme combines serological testing of samples of blood or egg yolk (Feld, N.C. et al., 1999) with bacteriological examination of faecal material. Flocks producing eggs for licensed egg packers are tested, serologically as well as bacteriologically, every 9 weeks, while flocks producing eggs for barnyard sale are tested every 6 months (Anon., 2000). Flocks testing positive for Salmonella in routine samples are re-sampled by the official veterinarian. If the repeat testing confirms the presence of Salmonella bacteria antibodies, eggs from the flock are diverted to heat treatment (pasteurised). No new flocks are permitted in the houses unless the district veterinary officer has approved cleaning and disinfecting and swab samples have found it to be free of Salmonella.

The programme has had considerable success, based largely on eradication of Salmonella in all breeding flocks (Figure 4). This has reduced the rate of infected layer flocks, however during 2000 there has been no significant improvement in the situation. The problem is now entirely associated with horizontal infection and infected flocks mainly come from premises where cleaning and sanitising has proven to be difficult. A research project has been initiated to work out solutions to the problem.

Pigs. In 1993, a major food borne outbreak that could be traced back to Salmonella Infantis in Danish pork resulted in the implementation of a programme to control Salmonella in slaughter pigs. In contrast to the above programmes involving poultry, the goal of the pig programme is not the total eradication of Salmonella, but rather reduction to an acceptable level. For 2001 the goal has been a Salmonella prevalence in pork of less than 0.5 percent. The monitoring programme is based on detection of Salmonella antibodies in juice released from muscle samples collected from carcasses on the slaughter line. I

At a central database the number of pigs sent to slaughter from each herd is registered. Accordingly a sampling plan for each herd is computed on the basis of a predetermined frequency (Mousing et. al, 1997). Following electronic tagging of carcasses for sampling on the slaughter line, slaughterhouse staff collects meat samples and dispatch them frozen in special containers marked with bar codes to the Danish Veterinary Laboratory. En route they thaw and develop juice for testing (Nielsen et al., 1998). The test results go back into the computer, which then currently suggests which of the three levels: $^{1)}$low, $^{2)}$moderate or $^{3)}$high the herd should be in. Level 1 herds have no or few reactors and intervention is not required. Level 2 herds have a higher proportion of reactors and the owner is required to seek advice on how to reduce the prevalence of salmonella. Level 3 herds have an unacceptably high proportion of reactors and the owner must seek advice as for level 2 herds and in addition the pigs are slaughtered under special hygienic precautions. Mandatory pen faecal samples are to be taken from level 2 and 3 herds as a part of the intervention plan to determine the serotype responsible for the infection and the prevalence of shedding in divisions of the herd. These samples also constitute a surveillance for S. Typhimurium DT104.

Breeding- and multiplier herds are monitored by serological analysis of blood samples collected routinely by the pig industry for other purposes. The owners of these herds are obliged to take pen faecal samples for bacteriological examination if a specific cut-off level in the monthly serological tests is reached. If serological reactions reach a pre-determined level, all movement of livestock from the herd is stopped.

Sow herds selling fattening pigs to slaughter pig herds that come into level 2 or 3 are also obliged to take pen faecal samples. This is done in order to clarify the distribution of Salmonella within the herd and to clarify a possible transmission of Salmonella from the sow herd to the slaughter pig herd.

The total number of samples tested each year is about 800.000, which means that about 4% of all slaughter pigs are tested, ranging from 3% of pigs in large herds to 25% from small herds.

A bacteriological screening in 1998 of 10 caecal samples per herd from 2.633 herds showed a 50% reduction in salmonella prevalence in slaughter pig herds, from 22% in 1995, when the program was initiated to 11% in 1998 (Christensen et al., 1999).

To supplement the herd-monitoring programme there is a continuous random bacteriological examination of pork products and offal at all slaughterhouses. In both product groups there has been a trend towards lower infection rates during the programme. In 2000, the proportion of salmonella positive cuts of pork varied between 0.5% and 1.5% with a mean of 0.6.

Cattle. There is at present no programme to control Salmonella in cattle, as cattle so far has not constituted a major reservoir for food borne Salmonella infections in Denmark. However, a programme is under development attempting to protect consumers against Salmonella Dublin and to control this in herds. S. Typhimurium and particularly to DT104 will also be included in this programme.

At present at cattle slaughterhouses cuts of beef are collected randomly for a continuous bacteriological monitoring. In 2000 less than 0.5 % of the samples were found contaminated with Salmonella.

EFFECT OF PROGRAMMES ON HUMAN INCIDENCE OF DISEASE

The monitoring programmes have resulted in detailed knowledge of the Salmonella prevalence and the distribution of sero- and phage types in the main reservoirs of food borne transmission, as well as in humans. It was found that certain subtypes occurred in some reservoirs but not in others. For example, S. Typhimurium DT12 was the predominant subtype in pigs, but was found only rarely in, for example broilers and S. Enteritidis DT8 was very common in layers but almost never isolated from broilers. Denmark is a net exporter of food of animal origin and while some imports of food do take place, they account for only a minor part of the total consumption. On this basis, it has been possible to determine the relative contributions of the known reservoirs to the overall number of human cases, the so-called pathogen account. Data are available for the years between 1988 and 1999. The results for 2000 have not been calculated at the time of writing. As shown in Figure 6, the trend in human salmonellosis during the 1990's is composed of three distinct phases: A declining contribution from Danish broiler chickens from 1988, reaching about one case per 100.000 in 1999. The contribution from pigs peaked in 1993 with about 22 cases per 100.000, while table eggs increased slowly from the end of the 1980's and reaching a contribution of just under 60 cases per 100.000 in 1997, before declining again.

REFERENCES

Anonymous. Annual Report on Zoonoses in Denmark. Danish Zoonosis Centre, May 2000.

Christensen, J., Baggesen, D.L., Soerensen, V. and Svensmark, B. Salmonella level of Danish swine herds based on serological examinations of meat-juice samples and salmonella occurence measured by bacteriological follow-up. Preventive Veterinary Medicine, 40, 277-292, 1999.

Feld, N. C., L. Ekeroth, K. O. Gradel, S. Kabell, M. Madsen. Evaluation of a serological Salmonella Mix-ELISA for poultry used in a national surveillance programme. Epidemiol. Infect. 125, 263-268, 2000.

Nielsen B, Ekeroth L, Bager F, Lind P. Use of muscle fluid as a source of antibodies for serologic detection of Salmonella infection in slaughter pig herds. J Vet Diagn Invest, 10, 158-63, 1998.

Mousing J, Jensen PT, Halgaard C, Bager F, Feld N, Nielsen B, Nielsen JP, Bech-Nielsen S. Nation-wide Salmonella enterica surveillance and control in Danish slaughter swine herds.
Prev Vet Med, 29, 247-61, 1997.

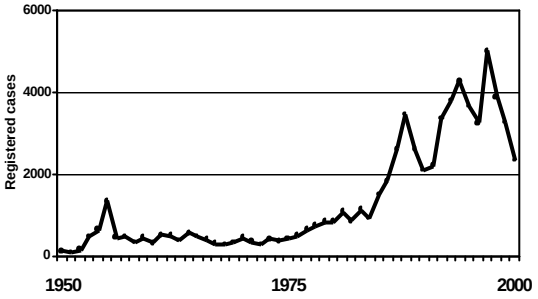

Figure 1 Trend in human salmonellosis in Denmark 1950- 2000. Data: Statens Serum Institut.

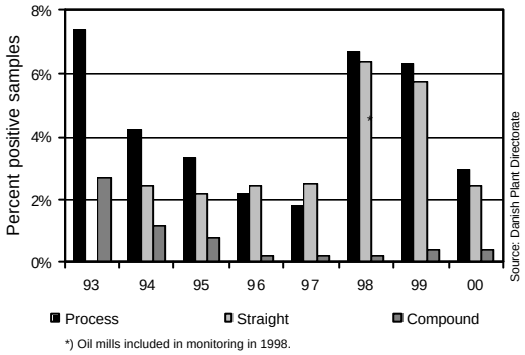

Figure 2. Trend in occurrence of salmonella in animal feeding stuffs. Data: Danish Plant Directorate.

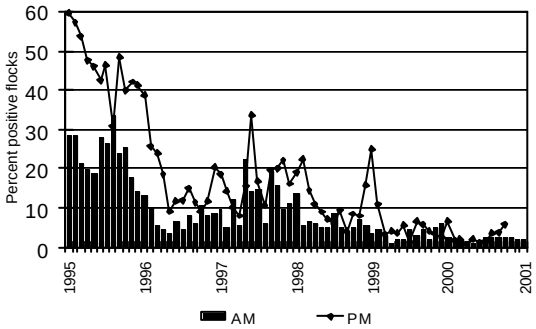

Figure 3. Trend in Salmonella prevalence in broiler flocks. Data: Danish Veterinary and Food Administration and the Danish Poultry council

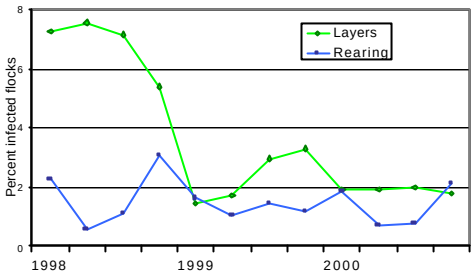

Figure 4. Trend in percent infected layer flocks 1998 - 2000. Data: Veterinary and Food Administration.

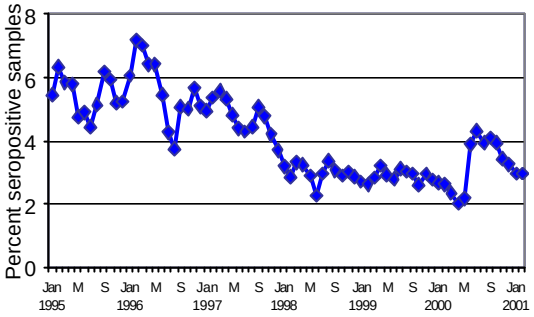

Figure 5. Trend in occurrence of individual sero-reactors among Danish slaughter pigs. Data: Danish Veterinary and Food Administration

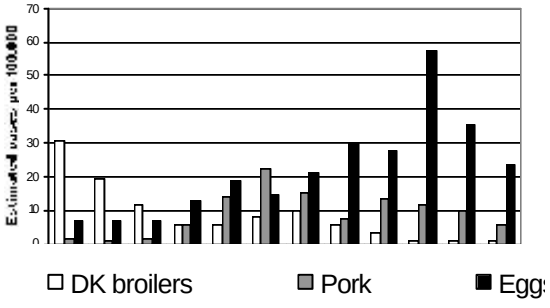

Figure 6. Trend in contribution of main reservoirs to human incidence of salmonellosis.