Public health and pork and pork products: regional perspectives of Denmark

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Summary

An ambitious programme to eliminate pork as an important source of human salmonellosis was initiated in Denmark in 1993 by the Ministry of Food, Agriculture and Fisheries. The programme comprises control of feedmills, breeding and multiplying herds, slaughter herds and slaughter plants, as well as the final product, fresh pork. As a consequence, the level of occurrence of Salmonella spp. in fresh pork produced in Denmark is approximately 1%. Yersinia enterocolitica O:3 infections are common in slaughter pig herds in Denmark, and pork is considered to be the only source of human infection in the country. The incidence of pork-related occurrences of human salmonellosis and yersiniosis in 1996 was approximately nine cases per 100,000 inhabitants for both diseases. All swine in Denmark are screened for Trichinella spp. infection, although no positive results have been obtained since 1930. Swine are not considered to be a source for Campylobacter jejuni or enterohaemorrhagic Escherichia coli in Denmark. Listeria monocytogenes can be detected in relatively high rates in pork: however, the incidence of human listeriosis is only 0.5 cases per 100,000 inhabitants. Toxoplasma gondii antibodies have been demonstrated in 3% of slaughter pigs, though the importance of pork as a source of infection is probably very low. Denmark is officially free from Brucella abortus, B. melitensis and Mycobacterium bovis.

Keywords


Introduction

For many decades, meat inspection procedures have ensured that the carcasses of animals with acute and chronic infectious diseases were detected and condemned in order to prevent foodborne infections in humans. The classical meat inspection procedure consists of ante-mortem inspection of slaughter animals and visual inspection and palpation of carcasses to detect pathological changes. However, this procedure will not reveal the presence of zoonotic agents such as Salmonella spp., Yersinia enterocolitica, Campylobacter, Trichinella spiralis or Toxoplasma gondii, since these infections may often be present without overt signs of illness and with no apparent macroscopic lesions.

The salmonella control programme in Denmark

In 1993 the Ministry of Food, Agriculture and Fisheries of Denmark initiated an ambitious programme to eliminate pork as an important source of human salmonellosis. The Reduction and Control of Salmonella in Pig Herds research project was launched simultaneously as a joint venture of the Danish Veterinary Laboratory, the Danish Veterinary Service, the Royal Veterinary and Agricultural University and the Federation of Danish Pig Producers and Slaughterhouses, to provide scientific data for future initiatives.
Control of a zoonotic pathogen, such as Salmonella, can only be achieved if all steps of the food-chain, including feedmills, herds, slaughter plants, wholesale and retail outlets, are involved in surveillance and control programmes. The programme comprises a number of individual (but related) elements, which are discussed in detail below.

Control of feedmills

In general, feedmill products must be considered as a major source of Salmonella for pigs, unless the finished feedstuffs have been heat-treated. Before the mandatory programme was initiated in Denmark, numerous serotypes of Salmonella were isolated frequently from the finished product.

The compounded feedstuffs are heat-treated at 81°C to eliminate Salmonella bacteria. The programme requires mandatory Salmonella tests in all plants which produce animal feed. The test involves microbiological analysis of compounded feedstuffs, as well as the collection of samples from the critical control points of the manufacturing process to test for Salmonella. Batches found to be contaminated must be resterilised.

Each month, the Danish Ministry of Food, Agriculture and Fisheries publishes the test results from all feedmills which operate in Denmark. These results are available to the public, including farmers and their advisers. At present, based on the examination of 50 g samples, 0.05% of the final product samples taken from feedmills showed the presence of Salmonella.

Control of breeding and multiplying herds

This part of the control programme, initiated in 1993, comprises the voluntary agreement of all 350 approved breeding and multiplying herds to submit a random monthly sample of ten breeding animals aged four to six months for serological screening. The sampling scheme is identical to that used for monitoring the specific pathogen free (SPF) status of the herds. The serum is analysed in a salmonella mix-enzyme-linked immunosorbent assay (ELISA) (9). The mix-ELISA contains the lipopolysaccharide (LPS) O-antigenic factors 1, 4, 5, 6, 7 and 12 and enables detection of infection with 95% of the Salmonella serotypes found in pigs in Denmark. The sampling is performed by the farm veterinarian.

A salmonella-index is calculated for each herd on the basis of the results of the past three months. The salmonella-index is a weighted average in which the last month counts for 60% of the total, and the two previous months count for 30% and 10% of the total, respectively. There is a close association between the index and the level of Salmonella shedding (B. Nielsen, personal communication). The sale of breeding animals from herds with high indexes is banned until the index reaches an acceptable level. More than 85% of the breeding and multiplying herds in Denmark have no salmonella-seropositive animals. At the beginning of the control programme, a sales ban was applied to ten to fifteen herds each month, whereas the ban is currently applied to zero to three herds each month. The period of the sales ban for a salmonella-infected herd generally lasts between one and three months.

Control of slaughter herds

Denmark produces approximately 20 million finisher pigs per year. Swine production in Denmark occurs mainly on family farms which produce between 100 and 10,000 finisher pigs per year, with a mean production of 2,400. Nearly all farmers are members of the Federation of Danish Pig Producers and Slaughterhouses, which slaughters more than 95% of all finisher pigs produced in Denmark.

In a 1996 study by Baggesen et al., Salmonella spp. were detected in 22% of 1,363 slaughter pig herds examined (2). A total of 13,468 finisher pigs were examined at slaughter by a microbiological culture of 5 g of caecal contents. Overall, 30 different serotypes of Salmonella enterica were isolated from 832 finisher pigs (6.2%). The predominant serotype found in the positive herds was S. Typhimurium (61%), followed by S. Infantis (10%), S. 4,12:b:- (8.3%), S. Panama (5%), S. Derby (4%) and S. Livingston (2.3%). The 24 remaining serotypes were all found in less than 2% of the herds.

The principle of the salmonella control programme is to test at slaughter all herds which produce more than 100 finisher pigs per year, thereby identifying herds with a high prevalence of salmonella-seropositive finisher pigs. The test is based on the detection of salmonella antibodies in juice from meat samples using a modification of the mix-ELISA described above (12). A special container has been designed in order to collect meat juice. The container consists of two parts, an upper coffee-filter-like part which holds the meat, and a lower tube-like part. At the slaughter production line, 10 g of muscle tissue from either the neck muscle (M. sternomastoideus), the diaphragm or the tenderloin is collected and put into the upper part of the container. A bar code is placed on the tube identifying the sample with respect to date, slaughterhouse, central husbandry number and pig number. The container is frozen at -20°C overnight and is subsequently allowed to thaw at 4°C for 24 hours, causing passive release of the meat juice into the lower tube part of the container (Fig. 1).

Based on the results of the serological examination, the herds are divided into three groups, designated Levels 1, 2 and 3, as follows:

- Level 1: herds with no, or an acceptably low number of, salmonella-positive animals
- Level 2: herds which have increased numbers of salmonella-positive animals
- Level 3: herds which have high numbers of salmonella-positive animals
- Level 3: herds which have unacceptably high numbers of salmonella-positive animals.

The criteria which define each group depend on the herd size, and have been determined with consumer protection in mind: the greater the number of finisher pigs produced by a herd, the lower the accepted prevalence of salmonella-positive animals before the demand for control measures is imposed on the herd.

Consequences and restrictions

No restrictions are placed on herds with a low level of salmonella (Level 1). All herds in Levels 2 and 3 are obliged to reduce the level of salmonella infection. The initiatives designed to aid in this reduction are divided into three phases.

Phase 1
Within 35 days after assignment to Level 2 or Level 3, a farmer must develop a herd-specific salmonella control plan in co-operation with the farm veterinarian and an independent consultant. A very important part of this control plan is the examination of a sufficient number of pen faecal samples from the infected farm to determine the source of infection within the herd and the serotype involved. The control plan has to be signed by the farmer, the veterinarian and the consultant, and must subsequently be sent to and approved by the slaughterhouse as a realistic control plan for that specific herd. A farmer who fails to meet these demands will be subject to monetary penalties (US$4 per slaughtered pig) until a salmonella control plan has been approved.

Once a herd enters Level 3, slaughterhouses must use increased hygiene precautions to slaughter finisher pigs from that herd and must conduct microbiological sampling of carcasses. These activities are performed under the supervision of the meat inspection service.

Phase 2

Three months after entering Level 3, the farmer, the veterinarian and the consultant must meet again to ensure that the recommended changes have been implemented, and all three must sign a report stating that this has been done. The report has to be approved by the slaughterhouse. Again, the farmer is liable to a penalty of US$4 per slaughtered pig if the demands of the slaughterhouse are not met.

Phase 3

If a herd has been at Level 3 for six months, the owner will consistently face a US$4 fine per slaughtered pig until the herd improves substantially and can be moved to Level 1 or Level 2. In addition, herds which have been at either Level 2 or Level 3 for six months must elaborate a new, improved salmonella reduction plan for the herd.
Generation and flow of data among the institutions involved

A large-scale serological surveillance survey such as that described here can only be successful if there is close co-operation between the several institutions and private organisations involved in the swine industry. In Denmark, a specific database was established to co-ordinate the considerable quantities of data generated from this large-scale surveillance. The following chapter describes the institutions and private organisations involved and the use of the database.

Six main components are involved in the salmonella control scheme:
- zoonosis database
- farms
- slaughterhouses
- Danish Veterinary Laboratory
- Danish Veterinary Service
- veterinary advisers.

The zoonosis database (ZOOR) is part of the central husbandry register owned by the Ministry of Food, Agriculture and Fisheries in Denmark. In ZOOR, the herds are identified by the official central husbandry number assigned to all stocks in Denmark. Information on the number of finisher pigs produced per herd, per year, is routinely estimated in ZOOR by taking the number of finisher pigs slaughtered during the past thirteen weeks and adjusting this figure according to annual production. The sampling of finisher pigs at slaughter is described in Table I. Based on the expected number of finisher pigs slaughtered, the sample size is given by ZOOR. The number of samples varies between 4 and 60 per quarter. The decision regarding whether to sample a carcass or not is made by a computer on-line at the slaughter floor grading station. The computer bases the decision on data transferred from ZOOR. Approximately 800,000 mandatory meat samples are taken per year.

The meat samples are sent to the Danish Veterinary Laboratory in specially designed meat juice containers with bar codes identifying each sample. At the Danish Veterinary Laboratory, meat juice is drained from the meat and analysed in the mix-ELISA. Results of the analysis are returned to ZOOR and merged with the herd information using the sample bar codes.

The salmonella level of each farm is calculated by ZOOR on a monthly basis. If new results cause a herd to be moved into a different level, the Danish Veterinary Service must approve this change. Approval of status by the Danish Veterinary Service is made on-line in ZOOR, and the information is sent to the slaughterhouse, so that the special preparation for the slaughter procedures used for Level 3 finisher pigs can be made. Movement to Level 3 prompts a letter from the Danish Veterinary Service informing the farmer about this change and the consequences. Farms in Levels 1 or 2 receive information about their status directly from ZOOR, which simultaneously sends the information to the slaughterhouse.

The mix-ELISA test permits adequate monitoring to be carried out in a cost-effective way. Of the 20 million finisher pigs slaughtered annually in Denmark, 800,000 samples of meat juice are examined at a price of just US$0.2 per finisher pig. A central database is required to receive, calculate, co-ordinate and transmit the considerable amount of data generated in a national screening programme. The establishment of a system in which all farms have a unique identification number has been crucial, as one of the most important functions of the register is to handle the data and trace back seropositive finisher pigs to specific herds.

Results of the serological screening programme performed between February 1995 and February 1997 show that 4%-7% of the finisher pigs slaughtered demonstrated the presence of salmonella at the screening cut-off level (Fig. 2). The distribution of herd level was more or less stable from the beginning of the screening in February 1995 until autumn 1996 (Fig. 3), when the percentage of Level 3 herds appeared to decline. The lowest number of Level 3 herds, 1.3%, was observed in February 1997.

Identification of critical control points on the farm

In herds showing high levels of salmonella presence, veterinarians will be heavily involved in the control programme. The programme includes culture of faeces from different age groups and of environmental samples to determine the serotypes involved and the level of infection in different sections of the herd. Furthermore, the normal biosecurity measures applied by most pig farmers in Denmark are sufficient to prevent the introduction of infection from the herd surroundings.

<table>
<thead>
<tr>
<th>Table I</th>
<th>Sampling scheme for the serological monitoring of Salmonella in swine herds in Denmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected pig production per year</td>
<td>Sample size as a percentage of expected production</td>
</tr>
<tr>
<td>1-100</td>
<td>0.0</td>
</tr>
<tr>
<td>101-200</td>
<td>11.1</td>
</tr>
<tr>
<td>201-500</td>
<td>9.9</td>
</tr>
<tr>
<td>501-1,000</td>
<td>7.2</td>
</tr>
<tr>
<td>1,001-2,000</td>
<td>4.3</td>
</tr>
<tr>
<td>2,001-3,000</td>
<td>3.3</td>
</tr>
<tr>
<td>3,001-5,000</td>
<td>3.3</td>
</tr>
<tr>
<td>&gt;5,001</td>
<td>3.5</td>
</tr>
</tbody>
</table>
Several measures appear to contribute to the control of the prevalence of *Salmonella* infection in swine herds in Denmark. These measures include the following:

- feeding either a meal with large particles or a fermented mash, which increases the resistance of the pigs to *salmonella* (4)
- acidification of drinking water or feed with organic acids, to which may increase resistance colonisation (17)
- establishment of a consistent one-way flow of pigs, as well as solid pen and section separation
- establishment of effective cleaning and disinfection procedures between batches of pigs.

Results from studies in Denmark also indicate that the shedding level of *salmonella* may differ significantly between different sections of a herd irrespective of whether the herd is managed according to 'all in-all out' or continuous production methods. Sows, although very often infected, shed very low numbers of *salmonella*, if any. Weaners are often free of *salmonella*, while the level of infection among growers varies considerably.
Overall, very strict observation of routines to prevent transportation of faecal material between different sections of a herd, including a complete ban on retrograde movement of infected animals, has proved to be of primary importance in the control of salmonella in a herd.

Critical control points at the slaughterline

Several processes during the slaughter of finisher pigs have been identified as critical control points. In particular, loosening of the rectum and removal of the pluck set (tongue, larynx, trachea, lungs, heart and liver) may contribute significantly to contamination of the carcass with zoonotic agents, such as *Salmonella* spp. and *Yersinia enterocolitica*. Loosening of the rectum often occurs with the Jarvis rectum loosener. During this procedure, faeces frequently spread to the carcass. The problem can be avoided by using a plastic bag to seal off the rectum (Fig. 4). The plastic bag is pulled down over the rectum after the rectum has been loosened and pulled free of the carcass. Nesbakken *et al.* compared the prevalence of *Y. enterocolitica* O:3 on carcasses on which a bag was used and then on those on which a bag was not used (8). When a bag was not used, 10% of the carcasses were contaminated, whereas only 0.8% of those on which a plastic bag was used were contaminated. The plastic bag method is now widely used in Denmark, Norway and Sweden.

In Denmark, the tongue is removed along with the pluck set and placed on the conveyer belt. *Salmonella* spp. and *Y. enterocolitica* may be present in large numbers in the tonsils and pharynx. Consequently, the spread of these zoonotic agents from the tonsils and the pharynx to the carcass and pluck set is unavoidable. In a study performed in Denmark, the pluck set removal procedure was changed to leave the tongue untouched in the un-split head until the head was removed from the carcass (3). This change caused a significant reduction in the prevalence of salmonella and *Y. enterocolitica* in the carcasses. However, in countries of the European Union (EU), a change in the pluck set removal procedures is not possible, since the Fresh Meat Directive 64/433/EEC requires inspection of the tongue, mouth and pharynx, which can only be performed if the tongue is removed from the head prior to meat inspection (5).

When the pluck set and intestines are removed, tools and equipment can become contaminated by zoonotic agents which may subsequently be transferred to the carcasses following on the slaughter production line. This can be prevented by consistent disinfection of tools and equipment between each carcass.

Control of salmonella in pork

All meat plants are subjected to bacteriological end-product testing, supervised by meat inspection staff, to monitor the level of salmonella in cuts of fresh pork. In total, approximately 2,200 samples of pork are examined for salmonella every month, with the number of samples per plant determined by the size of the kill. If the level of salmonella in the end-products exceeds a predetermined limit, the slaughterhouse is obliged to conduct microbiological process controls to trace any critical contamination points.

Finisher pigs from Level 3 herds can only be slaughtered at special slaughter production lines, at the end of the day and under more stringent hygiene procedures. A sample of carcasses from such herds is examined bacteriologically, and all carcasses are retained for heat treatment unless they are found to be microbiologically safe.

Before the control programme was initiated, the level of *Salmonella* spp. in fresh pork produced in Denmark was approximately 3%, with a level in offal of 10%-15%. Since the control programme was established, the level of *Salmonella* spp. in fresh pork has been reduced to less than half that.
figure (Fig. 5). Salmonella Typhimurium is the predominant serotype (70%) found in pork in Denmark, followed by exotic serotypes, such as S. Infantis, S. Derby, etc. (Table II).

**Human salmonellosis**

The incidence of human salmonellosis in Denmark has increased during the last decade and, in 1995, the disease affected 70.2 registered cases per 100,000 inhabitants (Fig. 6). More than 100 different serotypes are involved in human infections: however, two serotypes (S. Typhimurium and S. Enteritidis) predominate (Fig. 6). Most human cases occur as sporadic, isolated incidents. Approximately 15% of human cases are thought to be contracted while travelling abroad, while the remaining 85% of cases are of domestic origin. Outbreaks (defined as two or more cases associated with the same source) of salmonellosis are notifiable in Denmark. Occasionally large outbreaks occur (>100 registered cases). Two large outbreaks of salmonellosis were associated with pork distributed from private slaughterhouses in 1993 and 1996. The first outbreak, comprising approximately 550 registered cases, was caused by S. Infantis (15) and the more recent outbreak, comprising approximately 170 registered cases, was caused by S. Typhimurium (7). In both outbreaks, epidemiological investigations led to the hypothesis that high levels of salmonella infection in one or more delivery herds, in combination with temporary hygiene failure at the slaughterhouse due to 'overcrowding and/or high speed at the slaughter production line', led to the outbreaks.

The sources of sporadic salmonellosis in Denmark have been investigated by continuous comparative typing of salmonella isolates from animals and humans since 1994. The predominant serotype in pigs and pork is S. Typhimurium, and the predominant phage types are DT10, DT12 and DT66. The number of human infections caused by DT10, DT12 and DT66 was markedly reduced from 1994 to 1995 (Fig. 7): the same trend was observed for salmonella in pork. (Phage type 12 also predominates in cattle and beef in Denmark, but the occurrence is low and the consumption of beef is about one third of that of pork.) Thus, the reduction in the human incidence of pork-associated salmonellosis from 1994 to 1995 in Denmark can be assumed to result from the reduced occurrence of salmonella in pork. According to preliminary data, a moderate increase was recorded in the number of sporadic pork-associated human cases in 1996, which is associated with a similar increase in occurrence of salmonella in pigs during the same year. In 1995, the proportion of human cases of salmonellosis in Denmark associated with pork was estimated to be 10%-15%, compared to approximately 15%-20% associated with poultry and 40%-50% associated with eggs (16).

**Yersinia enterocolitica**

In Denmark, Y. enterocolitica biotype 4, serotype 3 (Y. enterocolitica O:3) is the only zoonotic species of Yersinia present. Pork or pork products are assumed to be the major

### Table II

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Prevalence (%)</th>
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<tbody>
<tr>
<td>S. Typhimurium</td>
<td>70.0</td>
</tr>
<tr>
<td>S. Infantis</td>
<td>4.9</td>
</tr>
<tr>
<td>Non-typable</td>
<td>4.7</td>
</tr>
<tr>
<td>Rough</td>
<td>4.4</td>
</tr>
<tr>
<td>S. Derby</td>
<td>3.8</td>
</tr>
<tr>
<td>S. Meleagridis</td>
<td>3.4</td>
</tr>
<tr>
<td>S.1.9.12:LV:</td>
<td>2.1</td>
</tr>
<tr>
<td>S. Livingstone</td>
<td>1.3</td>
</tr>
<tr>
<td>S. 4.12:b:-</td>
<td>1.1</td>
</tr>
<tr>
<td>S. Bredeney</td>
<td>0.8</td>
</tr>
</tbody>
</table>

(Y. enterocolitica O:3) is the only zoonotic species of Yersinia present. Pork or pork products are assumed to be the major

![Graph](image-url)  

**Fig. 5**

The level of salmonellosis in fresh pork in Denmark, 1994-1996

The total level of *Salmonella* spp. as well as the specific level of *Salmonella* Typhimurium is shown
source of human yersiniosis in Denmark, where the incidence of human yersiniosis peaked in 1985 with 29 cases per 100,000 inhabitants, followed by a nearly constant decline to 15 cases per 100,000 inhabitants in 1995 (Fig. 8). Preliminary data suggest a further reduction to approximately 9 cases per 100,000 inhabitants in 1996. The reduction in human yersiniosis is most probably caused by improved hygiene at slaughter, e.g., the use of plastic bags or similar arrangements to reduce the faecal contamination of the carcass.

Yersinia enterocolitica O:3 is very common among swine in many countries. The presence of the bacteria in the herd may be demonstrated either by culture (tonsil swabs, faecal or pen samples) or by use of a serological test (serum, meat juice) (10).

Serological investigations showed that 70%-90% of the slaughter pig herds in Denmark are infected with Y. enterocolitica O:3 and that nearly all finisher pigs in infected herds are seropositive (11). Cross-section examinations of conventional herds showed that sows and piglets never shed Y. enterocolitica O:3 or shed the organism below the detection level, whereas growers, and especially finisher pigs, shed Y. enterocolitica O:3 in the faeces (18).

A further reduction in the incidence of human yersiniosis in Denmark may be achieved by a combination of pre- and post-harvest activities as demonstrated for salmonella.

**Campylobacter jejuni and Campylobacter coli**

The incidence of human campylobacteriosis in Denmark more than doubled in the period from 1992 to 1995, reaching 50 cases per 100,000 inhabitants in 1995. This is the highest incidence ever recorded. Most human cases are caused by C. jejuni (90%-95%); the remaining 5%-10% are caused by C. coli and C. lari. The isolation rate of thermophilic campylobacter from the faeces of slaughter pigs is approximately 100% and the species found are C. coli (98%), C. jejuni (0.3%) and C. lari (0%) (13). The prevalence of thermophilic campylobacter in fresh pork collected at retail outlets from different regions of Denmark in April and September 1995 was found to be 1.2% in 408 samples investigated (16). As C. jejuni is only rarely isolated from pigs and pork, and C. coli only rarely from humans, pork is...
assumed to constitute only a minor source of human campylobacteriosis in Denmark.

**Enterohaemorrhagic Escherichia coli**

The prevalence of zoonotic *E. coli* infections remains very low in Denmark, and no outbreaks caused by enterohaemorrhagic *Escherichia coli* (EHEC) have been recorded to date. The number of sporadic cases of infection with *E. coli* O157:H7 has ranged from 2-6 per year since 1990 in a population of 5.2 million inhabitants. The sources of these infections have remained obscure. Pigs are not suspected as a reservoir of this pathogen. Verotoxin-producing *E. coli* O157:H7 have been detected sporadically in cattle in Denmark, but no report has been made in pigs. Verotoxin-producing *E. coli* O157:H7 have been detected sporadically in cattle in Denmark, but no report has been made in pigs. Pork cross-contaminated by beef during processing and handling may serve as a potential source of human infections, as shown in a recent Danish survey of beef and pork at retail sale. Verotoxin-producing *E. coli* O157:H7 were detected in two of 1,584 samples of beef (0.1%), and in two of 524 samples of pork (0.4%) (J. Boel, personal communication). A survey of *E. coli* O157:H7 in the United States of America did not detect any positive samples among 4,229 pig carcasses sampled in 1996 (1).

**Listeria monocytogenes**

Outbreaks of human listeriosis occurred in Denmark in 1986 and 1990. The sources of these outbreaks were not identified, but dairy products, rather than pork, were suspected as the most likely sources (14). Between 1992 and 1996, only sporadic cases of human listeriosis were observed at the relatively low incidence of approximately 0.5 cases per 100,000 inhabitants. *L. monocytogenes* can be demonstrated at relatively high rates in pig faeces, on the carcasses of pigs at slaughter and in various pork products, including heat-treated and processed products such as sliced ham, sausage, pâté, etc. The possibility of propagation of *L. monocytogenes* in sausage and pâté, which are consumed without further heat treatment, does pose a risk to consumers. In a survey of meat samples collected in Denmark in 1995, *L. monocytogenes* was demonstrated in 31% of 343 samples of fresh meat and 9% of 431 samples of heat-treated meat products. Approximately 25% of the heat-treated products had cell counts above 100 colony-forming units (CFU)/g (16). The investigation did not differentiate between beef, pork and poultry. The frequent occurrence of elevated levels of *L. monocytogenes* in foods must be viewed in the light of the low incidence of human disease. The reason for this discrepancy remains unexplained.

**Toxoplasma gondii**

Toxoplasmosis is not a notifiable disease in Denmark and the incidence of clinical toxoplasmosis in humans is unknown. The most important source of human toxoplasmosis in Denmark is presumed to be consumption of food and water contaminated with oocysts from cat faeces. An estimated 1% of the cat population is shedding *Toxoplasma gondii* oocysts, and an estimated 33% of all cats are seropositive. In 1992, an investigation of 4,016 slaughter pigs showed positive results in 3.1% of samples, while an investigation of 807 gilts and sows from 30 herds showed an average seroprevalence of 11.9%, where the prevalence of positive cases increases with the mean age of the population investigated.

**Trichinella spiralis**

All carcasses of slaughter pigs are examined for *Trichinella* in accordance with an EU directive (6). *Trichinella* has not been demonstrated in pigs in Denmark since 1930. During 1995, all of 19,431,485 pigs slaughtered in Denmark were examined at slaughter, and all gave negative results.
Examination of slaughtered wild boars for *Trichinella* is also mandatory. In 1995, 1,484 wild boars were examined, and none were found to harbour *Trichinella*. During the same period, 776 horses were examined and all gave negative results. A national programme for screening wild foxes was implemented in 1995 and 1996. Of a total 3,133 foxes, 3 foxes from the same region were suspected of carrying *Trichinella*. Although the species could not be definitively determined, analysis pointed to *T. nativa* as the most likely species in all three suspect animals. No domestically acquired cases of human trichinellosis have been recorded in Denmark.

**Erysipelothrix rhusiopathiae**

Erysipeloïd is recognised as an occupational disease among pig slaughterhouse workers in Denmark. The incidence rate is not known. Human erysipeloïd is not a notifiable disease in Denmark.

**Brucella abortus and Brucella melitensis**

Denmark has been declared officially free from brucellosis in cattle since 1979. Brucellosis is a notifiable disease, and clusters of abortions are also notifiable. Monitoring is performed by examination of abortion material. Brucellosis has not been diagnosed in cattle since 1962. In 1994, a single case of *Brucella suis* biotype 2 occurred in a herd of free-range sows and boars; no cases occurred in pigs in 1995. Bulls and boars are subject to serological examination prior to entering artificial insemination stations. After entering the station, bulls are examined annually, and boars are tested at least every 18 months before leaving the station.

Domestically acquired human brucellosis is not recorded, but a few cases occur among immigrants each year. The infection in humans is not notifiable in Denmark.

**Mycobacterium bovis**

Denmark has been declared officially free from bovine tuberculosis since 1980. Tuberculosis is a notifiable disease in Denmark. Monitoring is performed by meat inspection, which implies that all slaughter animals are examined for lesions indicative of tuberculosis.

From 1988 to 1989, thirteen deer farms revealed animals infected with *Mycobacterium bovis*, and between 1989 and 1993, a further three farms were found to be infected. Eradication measures were taken, and restrictions have now been lifted on all sixteen farms. In 1995, no deer farms were known to be infected with this organism.

In 1995, nine cases (0.17 cases per 100,000 inhabitants) of human tuberculosis caused by *M. bovis* were registered. All cases were recorded in elderly people, the youngest being 71 years of age. No cases of human tuberculosis caused by *M. bovis* were associated with the transmission from food or animals in 1995.

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**Santé publique, viande de porc et produits de charcuterie : perspectives régionales au Danemark**

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**Résumé**

En 1993, le ministère de l’Alimentation, de l’Agriculture et de la Pêche du Danemark a mis en œuvre un programme ambitieux visant à supprimer les risques de salmonellose humaine qui pourraient être associés à la consommation de viande de porc. Ce programme a pour objectif le contrôle des usines d’aliments pour animaux, des élevages de sélection et de reproduction, des animaux de boucherie, des abattoirs, ainsi que du produit final, la viande de porc fraîche. Le taux de présence de *Salmonella* spp. dans la viande de porc fraîche produite au Danemark est d’environ 1 %. Les infections dues à *Yersinia enterocolitica* O:3 sont fréquentes chez les porcins abattus et la viande de porc est considérée comme la seule source d’infection pour l’homme dans ce pays. L’incidence des salmonelloses et des yersinioses humaines liées à la consommation de viande de porc était, en 1996, d’environ neuf cas pour 100 000 habitants, pour ces deux maladies. Une recherche systématique de *Trichinella* spp. est effectuée au Danemark sur tous les porcins, même si aucun résultat positif n’est observé.
Salud pública, carne de cerdo y embutidos: perspectiva regional en Dinamarca

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Resumen
En 1993, el Ministerio de Alimentación, Agricultura y Pesca de Dinamarca dio comienzo a un ambicioso programa para eliminar los riesgos de salmonelosis asociados al consumo de carne de cerdo en ese país. El programa contempla el control de las fábricas de piensos, las piasas de reproductores, de multiplicación y de engorde, los mataderos y también el producto final, esto es, la carne fresca de cerdo. Fruto de ese programa es la baja tasa de aparición de Salmonella spp. (aproximadamente un 1%) que se registra en la carne de cerdo fresca producida en Dinamarca. Las infecciones por Yersinia enterocolítica 0:3 son frecuentes entre las piaras de cerdos de engorde de Dinamarca; el cerdo está considerado la única fuente de infección humana del país. En 1996, la incidencia de salmonelosis y yersiniosis humanas ligadas al consumo de carne de cerdo fue, para ambas enfermedades, de aproximadamente 9 casos por cada 100.000 habitantes. En Dinamarca, todos los cerdos son sometidos a pruebas de detección de Trichinella spp., aunque desde 1930 no se ha obtenido ningún resultado positivo. Tampoco se considera que el cerdo sea una posible fuente de Campylobacter jejuni ni de Escherichia coli enterohemorrágica. Aunque es posible detectar niveles relativamente altos de Listeria monocytogenes en la carne porcina, la incidencia de listeriosis humana es de apenas 0,5 casos por cada 100.000 habitantes. Ha podido demostrarse asimismo la presencia de anticuerpos contra Toxoplasma gondii en el 3% de los cerdos destinados al sacrificio, aunque lo más probable es que la carne de cerdo no revista ninguna importancia como fuente de infección. Dinamarca está libre oficialmente de Brucella abortus, B. melitensis y Mycobacterium bovis.

Palabras clave
References


