

New strategies for the use of microbiological examinations in food control in Denmark

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Abstract

The development of the use of microbiological examinations in Danish food control is described. At the end of the millennium an increased number of cases of food-borne disease caused by zoonotic microorganisms necessitated a new strategy. The developments of international concepts and risk analyses procedures have been valuable guides on this route. The organisation of the Danish control structure is described, as well as a summary of the experiences with the new strategy that have been gathered until now.

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1. Introduction

During the last 20 years Denmark, as many other countries, has registered a heavy increase in the number of people who suffer from food-borne disease. This has made it necessary to develop new strategies for prevention and control of the microorganisms that are involved.

Microbiological analyses are an important tool in the control of microbiological contamination in foods. Apart from specific control programmes for *Salmonella* spp., microbiological analyses for specific pathogens have only been used to a limited extent. Microbiological analyses have mainly focused on indicator organisms (hygiene parameters). Although helpful in the evaluation of the hygiene in a specific food establishment, these parameters have a questionable correlation to the occurrence of pathogenic microorganisms and thus to food safety.

Therefore, it was decided that a change in focus towards pathogenic microorganisms, at the cost of hygienic para-

meters, was needed. In the present paper we describe the Danish governments' new strategies for using microbiological analyses as a tool to enhance food safety. In addition we describe the organisational changes that have enabled this change in strategy, as well as the influence of the new concept of risk analysis that has been agreed upon internationally.

2. New ideas and a new organisation

For the past 10 years a number of initiatives and new concepts with regard to microbiological food safety have emerged from the World Trade Organisation, i.e. the WTO/SPS Agreement (Anonymous, 1994), and Codex Alimentarius, especially concerning the use of HACCP (Anonymous, 1969), and Principles for the Conduct of Microbiological Risk Assessment (Anonymous, 1999). These concepts and ideas have had a great impact on the development in countries all over the world, including Denmark.

Before 1999, the Danish control system was organised in a central governmental agency (the Danish Veterinary and

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Food Administration) and a number of local municipal food control units. During the last five years The Danish Veterinary and Food Administration has undergone reorganisation. In 1999, the Danish food safety regulation was consolidated under one authority: the Ministry of Food, Fisheries and Agriculture. In 2000, the local food control units were moved from municipal to governmental rule, and at the same time reduced in numbers, from about 32 units to 11. This number was further reduced to 3 in 2005. After this reorganisation, the Danish Veterinary and Food Administration consists of a central headquarter with three Regional Veterinary and Food Control Authorities. The control of foods from farm-to-table is hereby joined in one body, under direct governmental jurisdiction.

The internationally agreed recommendations of separating risk management and risk assessment resulted in 2004 in the separation of the research institute (Institute for Food Safety and Nutrition), from the Danish Veterinary and Food Administration. The research institute was at the same time merged with the Danish Veterinary Institute to form the Danish Institute for Food and Veterinary Research. In this way research from farm-to-table was joined, and is now the responsibility of one single institutional body.

3. A risk-based approach

In order to follow a risk-based approach, knowledge on the occurrence of the hazards of concern is a necessary prerequisite.

In Denmark, the prevalence of various pathogenic microorganisms is monitored to various extent, and for the most important organisms surveillance and control programmes have been implemented. Due to the increasing incidence of human salmonellosis during the last 15 years, *Salmonella* is the most surveyed organism in Denmark. Epidemiological typing has been able to produce a so-called *Salmonella* account that quantifies the contribution of different sources to human salmonellosis. This has been possible due to a heterogeneous distribution of subtypes from the most important sources (Hald, Vose, Wegener, & Koupeev, 2004). It has been demonstrated that Denmark has experienced three waves of human salmonellosis, with the majority of cases caused by three distinct sources: Broilers in the late 1980's, pork in the mid 1990's and eggs in the mid/late 1990's. In relation to each peak, a new control programme has been implemented. Subsequently a decline of human cases attributable to that particular source has been demonstrated, indicating that controlling *Salmonella* in the primary production is an efficient method for reducing human salmonellosis (Anonymous, 2002; Mousing et al., 1997; Wegener et al., 2003). Used as such, the *Salmonella* account has proved to be a powerful tool for the Danish Veterinary and Food Administration (the risk managers) in assessing the need for and/or the effect of *Salmonella* control programmes.

In 1997, the Danish Veterinary and Food Administration decided to initiate a strategy for the control of patho-

genic microorganisms in foods based on the principles of Food Safety Risk Analysis.

A ranking of the most important hazards, as recommended by the Codex Alimentarius Commission, the risk management stated that special attention should be given to *Campylobacter* species. In 1998 it was decided to initiate the risk management procedure on *Campylobacter* and *Escherichia coli* O157 by elaborating risk profiles on these organisms. It was subsequently decided to order a formal risk assessment on *Campylobacter* that should focus on thermophilic species of *Campylobacter* in chicken from slaughter to consumption.

Simulations showed that the probability of campylobacteriosis associated with consumption of chicken meals could be reduced 25 times if a 2 log reduction of the number of *Campylobacter* on the chicken carcasses could be reached. To obtain a similar reduction of the risk of campylobacteriosis, the flock prevalence should be reduced ≈ 25 times and the kitchen hygiene should be improved ≈ 25 times (Rosenquist, Nielsen, Sommer, Nørrung, & Christensen, 2003). As a consequence the Danish Veterinary and Food Administration have implemented several initiatives:

- Initiatives for reduction of the number of *Campylobacter* infected broiler flocks. The initiatives include information to herd owners on possible hygiene improvements, i.e. use of hygiene barriers and increased payment for birds from negative flocks.
- Directing *Campylobacter* negative flocks to the production of chilled chicken meat, where possible.
- Consumer information, especially aimed at young people.
- Projects on methods for reducing the number of *Campylobacter* on chicken meat.

The effect of the management options is monitored by parameters such as the human incidence of campylobacteriosis as well as the prevalence and the concentration of *Campylobacter* in the chicken products.

The risk assessment demonstrated that data on a number of key issues were lacking. A number of projects have been established in order to remedy this. Some of these data are now gathered in specific projects ("centrally coordinated projects") as described later in this paper.

The food poisoning organisms *Bacillus cereus*, *Clostridium perfringens* and *Staphylococcus aureus* have not been subjects of increased activity in the new strategy. The reason for this is that these organisms primarily are controlled by general hygiene activities, which are covered by the own-check procedures of the establishments as well as the auditing performed by the competent authorities. Also, these organisms are not causing problems of a magnitude that has necessitated increased risk management activities. Cases are of course investigated, and action taken when a likely cause have been pointed out.

4. Changes in the use of microbiological analyses

Official microbiological control in Denmark is coordinated at the central as well as at the regional level of administration. Each Regional Veterinary and Food Control Authority is responsible for the control carried out in its respective region, and the Danish Veterinary and Food Administration is in turn responsible for regulation, control strategies and surveillance at the national level.

Previously, a large number of microbiological examinations were performed by the municipal food control units as part of their control of food establishments. Sampling of different foods for microbiological analyses was primarily performed randomly or for verification of suspected unacceptable procedures observed during inspection of food establishments. For the most part, highly processed ready-to-eat foods and minced meat were sampled, and tested for general hygiene parameters. About 500 000 microbiological analyses were performed on \approx 100 000 samples from the retail sector each year during the first half of the 1990's. Although indicator organisms may be used to disclose unacceptable hygiene procedures in a specific establishment, the overall benefit of these analyses was increasingly questioned towards the end of the millennium. Furthermore the action taken in response to the results were not entirely harmonised throughout the country. From the mid 1990's pathogenic organisms like *Listeria monocytogenes* and *Salmonella* spp. were increasingly included in the regional analyses programmes. However, because the samples were taken in relation to control, they were not taken randomly, and therefore the data were not representative for the overall situation in the country. Also, due to the low prevalence of pathogenic microorganisms in foods, the data were most of the time not very useful for the authorities performing the control of the establishment.

Organisational changes of the food control system as well as the introduction of HACCP-based own-check programmes called for changes in the control of food producing establishments. The development of new ideas in risk assessment and risk management, i.e. the formulation on the division of responsibility paved the way on how these changes could be established. The legislation on the use of HACCP-based own-check programmes in food establishments was implemented in Denmark at the end of the 1990's and the new concept of risk analysis was introduced. In addition the elaboration of principles for establishment and application of microbiological criteria (Anonymous, 1997) made it clear that the traditional way of using microbiological testing had to be reconsidered.

As a consequence the Danish government decided to change the strategy and consider whether resources for microbiological examination of foods could be used in a more efficient manner in a risk-based approach. From mid 2000 control has to a higher degree focused on problem areas. Also the need for microbiological sampling has to be evaluated in each case. Sampling at the retail level

was reduced, and some of the resources were instead allocated surveillance of pathogens at the national level.

In Denmark microbiological control today is carried out in two ways: Centrally coordinated projects and regional microbiological control. In both cases the Regional Veterinary and Food Authority carry out sampling and action on results.

The main purpose of regional microbiological analysis is to control that the own-check programs of food establishments are implemented and functioning, and that provisions of the own-check legislation are complied with. Microbiological control at the regional level is carried out as:

- (a) Plans or projects where targeted sampling primarily takes place at the retail level. The focus of sampling is either on problem areas, on certain food commodities, trades or types of food establishments. Of the budget allocated for testing, forty percent are reserved for targeted sampling in the regions.
- (b) Random sampling at the wholesale and retail level. Samples may be taken anytime on suspicion to support findings during inspection of food establishments. Samples of end products, of raw materials or semi-finished foods (still undergoing manufacturing processes) may be taken. At the wholesale level samples can also be taken to verify limits set in legislation. Samples may also be taken in relation to the investigation of food-borne disease, or in relation to consumer complaints. Thirty percent of the budget available for testing is used for random sampling at the wholesale and retail level in the regions.

Today, when a sample is taken for microbiological analysis, it is always done in consideration of the elements in the microbiological criteria, ensuring that testing is useful.

Centrally coordinated control projects is carried out as national plans or studies, the purpose of which is to disclose emerging microbiological problem areas, to survey microbiological risks in foodstuffs or to collect data for preparation of risk assessments and risk profiles. Projects are also conducted to monitor the effect of established risk management options, in order to establish if these options have provided the desired result, or if they need to be reconsidered. Table 1 provides information on centrally coordinated projects conducted in 2003 and 2004. Of the budget available for sampling and testing, thirty percent are used for centrally coordinated surveillance, monitoring or control studies.

5. Benefits from the new strategy

Today the Danish organisation of the food safety control is quite different from what it was 5–10 years ago. Food control from farm-to-table has been joined in one institution, the Danish Veterinary and Food Administration, and research in food safety from farm-to-table has

Table 1
Centrally co-ordinated microbiological studies performed in Denmark in 2003 and 2004

Studies for providing information for risk profiling:

- Presence of VTEC O26, O103, O111 and O143 in beef cattle (1500 samples)
- Presence of *Campylobacter* in pre-cut ready-to-eat salad (500 samples)
- Presence of F-RNA bacteriophages in Danish bi-valve molluscs (600 samples)
- Presence of *Enterobacter sakazakii* in powdered infant formula (200 samples)
- Presence of *Salmonella* in pasteurised egg products (300 samples)
- Presence of *Salmonella*, *Campylobacter* and VTEC in faeces from sheep and deer (600 samples)
- Presence of *Salmonella* in imported salad (30 samples)
- Presence of *Salmonella* and *Campylobacter* in imported meat products (1000 samples)

Studies for providing information for risk assessments:

- Effect of different reduction strategies on the number of *Campylobacter* on broilers at slaughter level (1800 samples)
- Presence and number of *Campylobacter* on turkeys during slaughter combined with antibiotic resistance testing (1500 samples)

Studies for monitoring and review of risk management activities:

- Surveillance on antibiotic resistance in bacteria from foods (DANMAP) (1000 samples)
- Surveillance on *Campylobacter* in fresh and frozen poultry (1050 samples)
- Surveillance on *Listeria monocytogenes* in smoked and cured fish products
- Listeria monocytogenes* in meat products (1200 samples)
- Pathogens in milk (EU control campaign) (130 samples)
- Pathogens in spices (EU control campaign) (500 samples)
- Pathogens in seafood (EU control campaign) (1000 samples)

been merged in another institution, the Danish Institute for Food and Veterinary Research. The division between risk management and risk assessment activities has improved the discipline and the awareness of the responsibilities of personnel involved in each activity.

The organisation of the entire control under one central authority has provided a more uniform food control throughout the country. As the number of food control units at the same time has been reduced the units have been made larger, which has resulted in a concentration of the expertise. This has improved the ability of the control officials to specialise, and to better match the competence of the food industries.

In 2005, a full evaluation of the new strategies for the use of microbiological examination in food control will be made in Denmark. However, until then some preliminary conclusions can be drawn from the experiences that have been gathered until now. The reorganisation of the architecture of the control system has promoted the change in the control strategy. The samples taken and the analyses performed on these have been modified in order to improve their use in different tasks as described in the principles for performing risk analysis activities. Thus routine samples for counts of indicator organisms of general hygiene have declined while coordinated plans for surveys on pathogenic microorganisms have been implemented. The data gathered today are of much more general use, as they to a higher degree are collected to gather specific knowledge on a generic problem, and therefore are sampled randomly. Last but not least, the data collected are used for the preparation of risk assessments and risk profiles providing important knowledge for the risk managers.

A risk assessment on *Campylobacter* in poultry has been carried out according to the recommendations. Risk management activities have been established. Subsequently a

decline in campylobacteriosis in the Danish population has been observed (from about 4500 to 3500 cases annually).

In this paper we have tried to advocate for the risk-based approach according to the recommendations primarily by the Codex Alimentarius. In Denmark we have made an attempt to work according to these principles, and it is our opinion that in doing so, we have managed to improve the effectiveness of the Danish food control system.

In many cases the principles for a risk-based approach have been followed even before they were formally elaborated and formulated. This is true for Denmark as well as for many other countries. However, the discussions and formulation of these principles have had a great impact on the structure of the work of the implementation that has taken place in Denmark, and on its documentation. Therefore, Denmark will continue to take an active part in the work on elaboration on recommendations on how to improve food safety worldwide.

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