Microbial Contaminants

Food monitoring, 1998-2003. Part 4.

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Food monitoring, 1998-2003,
consists of four sub-reports:

Part 1: Chemical contaminants
Part 2: Pesticides
Part 3: Food additives
Part 4: Microbial contaminants

MINISTRY OF FAMILY
AND CONSUMER AFFAIRS

Danish Veterinary
and Food Administration

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Food monitoring, 1998-2003. Part 4.

FødevareRapport 2005:04
1st Edition, 1st Circulation, April 2005

ISBN: 87-91569-56-7
ISSN: 1399-0829 (FødevareRapport)

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Danish Veterinary and Food Administration is part of the Ministry of Family and Consumer Affairs. Danish Veterinary and Food Administration is responsible for the administration and control within food and veterinary areas "from farm to fork", as well as practical matters relating to animal protection (otherwise under the Ministry of Justice).

Making of regulations, co-ordination and development, take place in the Administrations center in Moerkhoej. The 10 Regional Authorities handle the practical inspection of food and veterinary matters, including import/export etc.

The central administration of Danish Veterinary and Food Administration employ a staff of approx. 250 full-time employees, whilst the 10 regional authorities employ a further approx.1500 full-time employee.

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1 Preface

The monitoring programme for foods was established in 1983. Results are reported for periods of five or six years; thus, the present report covers the fourth period, 1998-2003.

The fourth period report of the monitoring programme consists of the following sub-reports:

Part 1: Chemical contaminants
Part 2: Pesticides
Part 3: Food additives
Part 4: Microbial contaminants

The Danish Veterinary and Food Administration coordinates the studies in collaboration with the Danish Institute for Food and Veterinary Research. The regional laboratories in Copenhagen, Odense (until 1999), Ringsted, Aalborg (until 1999), and Århus carried out the analyses of chemical contaminants. Most samples were taken by the regional veterinary and food control authorities; while samples of fish from Danish waters were taken by the Fisheries Inspections under the Danish Directorate of Fisheries. The reporting of chemical contaminants was coordinated by Arvid Fromberg, Danish Institute for Food and Veterinary Research.

April 2005

2 Sammenfatning og konklusion

Forekomsten af zoonotiske sygdomsfremkaldende bakterier i fødevarer

I perioden 1998 til 2003 er forekomsten af de fødevarebårne sygdomsfremkaldende bakterier *Campylobacter, Salmonella*, *Escherichia coli* O157, *Yersinia* enterocolitica og *Listeria monocytogenes* blevet monitoreret og kortlagt i regi af Fødevarestyrelsens centralt koordinerede laboratorieprojekter samt undersøgelser udført som led i fødevareregionernes kontrol.

Resultaterne vedrørende forekomst af *Campylobacter* (tabel 1) viser en relativt lav forekomst (0,1 – 0,2%) i svine- og oksekød samt grøntsager. Den højeste forekomst ses i ikke varmebehandlede produkter af kalkun (11 – 42%) og kylling (28 – 42%). Forekomsten i disse produkttyper viser en stigende tendens gennem perioden.

Forekomsten af *Salmonella* er i perioden blevet undersøgt i kyllinge- og kalkunprodukter, svine- og oksekød, grøntsager samt æg (Tabel 2). Undersøgelserne viser en relativt lav forekomst i grøntsager (0,2%) og æg (0,3%). Forekomsten i svinekød varierer i perioden mellem 0,6% og 1,7%. I oksekød varierer forekomsten mellem 0,1% og 2%. Undersøgelserne af kyllingekød tyder på et fald i forekomsten fra 10,6% i 1998 til 7,5% i 2003. I samme periode ses en stigning i forekomsten af *Salmonella* positive prøver af kalkunkød fra 4% til 10,2%.

Forekomsten af verocytotoksin producerende *Escherichia coli* (VTEC) – herunder *E. coli* O157 - er i perioden blevet undersøgt i fødevarer som frugt og grønt samt okse-, lam- og vildtkød (Tabel 3). VTEC er ikke påvist i disse fødevarer.

Undersøgelser for *Yersinia enterocolitica* er lejlighedsvist inkluderet i kortlægningsundersøgelserne udført i perioden 1998 til 2003 (Tabel 4). Undersøgelser udført på svinekød viser en forekomsten på mellem 3,2% og 6,3%. Forekomsten af *Y. enterocolitica* i oksekød er ved en enkelt undersøgelse estimeret til 7,5%. *Y. enterocolitica,* serotype O:3 blev påvist i 1% af prøver af spiseklare kødprodukter (hamburgryg, skinke).

Forekomsten af *Listeria monocytogenes* er kortlagt i et stort udvalg af især spiseklare fødevarer (Tabel 5). Andelen af prøver af varmebehandlede kødprodukter med *L. monocytogenes* i et niveau > 100 CFU pr g viser et fald i perioden fra 0,5% i 1998 til 0,1% i 2003.

Antibiotika resistens i bakterier fra fødevarer

Som led i DANMAP (Danish Integrated Antimicrobial Resistance Monitoring and Research Programme) er undersøgelser for resistens mod antibiotika blevet udført på bakterier isoleret fra fødevarer (Tabel 6 – 9).
Ved undersøgelser af *Campylobacter jejuni* ses de højeste niveauer af resistens mod stofferne tetracyklin og ciprofloxacin. Resistens mod fluoroquinoloner (ciprofloxacin) hos *C. jejuni* isoleret fra kyllingekød viser en faldende tendens i perioden.
Andelen af tetracyklin resistente *C. jejuni* fra importeret fjerkrækød er højere end i kød fra dansk produceret fjerkræ. Den same tendens ses for stofferne kloramfenikol og fluoroquinolon.
Siden implementeringen af forbudet mod antibiotiske vækstfremmere er der sket et fald i andelen af resistente enterokokker mod netop disse stoffer.

3 Summary and conclusion

Presence of zoonotic bacteria

The bacteria *Campylobacter*, *Salmonella*, verocytotoxigenic *Escherichia coli* O157, *Yersinia* and *Listeria* have all been part of surveillance programmes initiated by the Danish Food and Veterinary Administration in the period 1998 - 2003.

The results of the programme on *Campylobacter* (table 1) show a relatively low prevalence (0.1 – 0.2%) in products like raw pork, beef and vegetables. The highest prevalence of *Campylobacter* is seen in raw turkey products (11 – 42%) and raw chicken products (28 – 42%). The prevalence in raw chicken and turkey products seem to have increased within the period.

Salmonella has in the period been part of the surveillance programme on different products like raw chicken meat, raw turkey meat, raw pork and beef meat, vegetables and eggs (Table 2). The results show a relatively low prevalence in vegetables (0.2%) and eggs (0.3%). The prevalence in raw pork meat varies between 0.6% and 1.7% within the period. In raw beef meat the prevalence varies between 0.1% and 2%. In chicken meat the prevalence shows a decrease from 10.6% in 1998 to 7.5% in 2003. Within the same period the prevalence in turkey meat show an increase from 4% to 10.2%.

Related to verocytotoxigenic *Escherichia coli* O157 the surveillance programme has included projects on the occurrence in products such as fruits and vegetables and beef-, sheep- and deer meat (Table 3). Verocytotoxigenic *Escherichia coli* O157 was not detected in these products.

Projects, including analysis of *Yersinia enterocolitica* has occasionally been included in the programme. The products analysed were raw pork and beef and ready-to-eat smoked, salted and cured meat products (Table 4). The prevalence in pork meat was estimated to between 3.2% – 6.3%. In raw beef meat (one project) the prevalence was estimated to 7.5%. In ready-to-eat products 1% of the samples analysed were contaminated by *Yersinia enterocolitica*, serotype O:3.

Analysis of *Listeria monocytogenes* (L.m.) has been part of the programme in a variety of products listed in Table 5 together with the frequency of samples with > 100 cfu L.m. pr g. For heat treated products of pork, beef, chicken and turkey handled after heat treatment the prevalence have decreased within the period from 0.5% in 1998 to 0.1% in 2003.

Antimicrobial resistance

The highest levels of resistance among *C. jejuni* were observed for tetracycline and ciprofloxacin (Table 7). Trends in resistance among *C. jejuni* from raw chicken meat indicate a decrease in occurrence of resistance towards fluoroquinolones (ciprofloxacin).
Comparison of resistance in *C. jejuni* from domestic and imported poultry reveals that the proportion of tetracycline resistance was significantly higher in imported chicken meat than in chicken meat of Danish origin. The same tendency was observed for chloramphenicol and flouroquinolones.
The occurrence of resistance towards antimicrobial growth promoters among the faecal enterococci has been monitored together with the annual consumption for food animals. Since the ban of these compounds a decrease in resistance has been documented.

4 Monitoring programme for foods

The subjects of the monitoring programme have changed over time. For the first two periods (1983-1992) the monitoring programme covered nutrients and chemical contaminants, while in the third period (1993-1997) new subjects were included under the monitoring concept: Pesticides, veterinary drugs, food additives and microbial contaminants.

The monitoring programme for nutrients has been reduced during the fourth period, and purpose of the analyses of veterinary drugs is food control rather than monitoring. Thus these two subjects are not reported for the fourth period. However, dioxin, dioxin-like PCB and selenium are included in the present monitoring period.

While each of the first two monitoring periods (1983-1987 and 1988-1992) was reported as a whole [1, 2], the reporting of the third period was divided into sub-reports according to subject [3, 4, 5, 6, 7]. The fourth period is reported in four sub-reports covering, chemical contaminants, pesticides, food additives and microbial contaminants.

The objectives of the monitoring programme are, by means of systematic studies of foods and the dietary habits of the Danish population,

- to ascertain whether our foods are subject to any long-term changes in terms of the contents of desirable and undesirable substances and/or microorganisms,
- to assess the health significance of any such changes in relation to major changes in dietary habits,
- to disclose potential problems within the area and to provide background material as well as a basis for decisions to remedy any problems which might have arisen.

The material provided may also serve as a documentation of the health quality of Danish foods, and be used for updating the Danish food composition databank. Monitoring results are used also in other connections; e.g., microbiological results are reported to the Danish Zoonosis Centre, and results concerning residues of pesticides are reported to the EU.

Work with the monitoring programme consists of the following:

- to monitor, by means of analyses, the contents of desirable and undesirable substances/ microorganisms in specific foods,
- to investigate the dietary habits of the Danish population,
- to carry out intake estimates (wherever relevant) by combining contents in foods and data on the population’s diet.

Subsequently, a nutritional and/or toxicological assessment can be made. Such an assessment will be particularly important whenever changes are found.

Since changes in the contents of foods and changes in our dietary habits usually develop slowly, the studies cover a considerable number of years. Every five or six years, the results are reviewed, and the analytical results for the foods are compared with the dietary habits over the period. This permits an assessment of whether the intake of desirable substances is adequate, and whether the intake of undesirable substances or microorganisms is acceptably low.

Content findings and intake estimates are compared with earlier results, thus permitting an assessment of the development of contents and intakes over time.

Results are evaluated continuously during the monitoring period, enabling reactions to violations of existing limits or other noteworthy observations.

The monitoring programme gives information on the immediate situation concerning Danish foods, the health significance for Danish consumers, and the direction in which matters are likely to develop. In this respect, the monitoring programme can provide background material and a basis for decisions on actions in the form of national or international regulations.

5 Surveillance of zoonotic pathogenic bacteria and antimicrobial resistance among bacteria in raw foods 1998 – 2000

5.1 Introduction

Analytical data – chemical as well as microbiological – to be used in the Danish Food and Veterinary Administration (DFVA) are generated according to the structure within the Risk Analysis concept. This means that data are generated with the purpose of surveillance (risk profile, risk assessment), monitoring (long term effects of management options, estimates on nutrition) and control (implemented management options). Data published in this report are generated by the regional food control units and their associated laboratories as part of the Centrally Coordinated Laboratory projects and the regional control carried out at production and retail level.

In the table below the number of microbiological surveillance projects carried out in Denmark is summarized for the period 1998 – 2003.

Year	No of projects	No of samples
1998	6	5,182
1999	6	5,995
2000	3	4,390
2001	6	10,242
2002	7	11,189
2003	13	14,071

The projects were mainly focused on the presence of zoonotic bacteria like *Campylobacter*, *Salmonella*, verocytotoxigenic *Escherichia coli* O157, *Yersinia* and *Listeria* commonly associated with food borne disease. But also projects related to the monitoring of antimicrobial resistance among bacteria in raw foods was included.

For further information on the results of the microbiological projects within the framework of DFVA the reader is referred to the publication "Annual report on Zoonosis in Denmark" (http://www.dfvf.dk/Default.asp?ID=9606) published by the Danish Zoonosis Centre at the Danish Institute for Food and Veterinary Research.

6 Campylobacter

A nation-wide surveillance programme of thermotolerant *Campylobacter* in foods from retail outlets was established in 1996. The programme has been continued every year. The results are presented in Table 1.

Table 1. Occurrence of thermotolerant *Campylobacter* in retail food in Denmark 1998-2003*.

	Retail cuts and products of broiler meat		Retail cuts and products of turkey meat		Other birds**	Retail pork meat		Retail beef meat		Fruits and vegetables
	not heat treated	heat treated	not heat treated	heat treated	not heat treated	not heat treated	heat treated	not heat treated	heat treated	not heat treated
1998	28.0 (819)	nd	14.0 (411)	nd	21 (293)	nd	nd	nd	nd	nd
1999	34 (994)	nd	11.0 (351)	nd	24 (391)	nd	nd	nd	nd	nd
2000	41.1 (708)	1.2 (82)	30.4 (303)	0 (34)	nd	nd	nd	nd	nd	nd
2001	36.3 (978)	0 (129)	22.1 (705)	0 (71)	nd	0.2 (2413)	nd	0.1 (3046)	nd	0.2 (954)
2002	41.7 (712)	0 (29)	21.2 (104)	0 (7)	nd		0 (205)		0 (42)	nd
2003	37.3 (563)	0 (1)	42.0 (50)	0 (3)	nd	0 (50)	0 (88)	0 (45)	0 (12)	0 (548)
Trends in prevalence within the period ***	↑	↓	↑	-	-	-	-	-	-	-

* Percent positive samples of the total number of samples analysed. Numbers in brackets indicate the numbers of samples analysed. nd, not done

** e.g. ducks, pigeons, quails, and ostriches

*** ↑, increase; ↓, decrease; →, unchanged; -, to few data to conclude on trends

7 Salmonella

As a part of the yearly routine surveillance, samples of meat and meat products are analysed for the presence of Salmonella. Further, some CKL projects have focussed on Salmonella in different raw foods. The results are presented in Table 2.

Table 2. Occurrence of Salmonella in retail food in Denmark 1998-2003*.

	Retail cuts and products of broiler meat		Retail cuts and products of turkey meat		Retail pork meat		Retail beef meat		Fruits and vegetables	Shell eggs
	not heat treated	heat treated	not heat treated	heat treated	not heat treated	heat treated	not heat treated	heat treated	not heat treated	not heat treated
1998	10.6 (283)	0 (158)	4.0 (525)	0 (72)	0.7 (2660)	0.08 (2311)	0.5 (2600)	0.13 (745)	nd	nd
1999	8.0 (262)	0.4 (411)	8.1 (160)	0 (18)	1.2 (2261)	0 (2078)	1.4 (2440)	0.5 (602)	nd	nd
2000	4.3 (94)	0.5 (216)	8.7 (69)	0 (50)	1.1 (1782)	0.08 (1228)	1.2 (1599)	0.3 (372)	nd	nd
2001	7.5 (40)	0 (141)	10.2 (49)	0 (48)	1.7 (715)	0.1 (976)	2.0 (642)	0.5 (206)	0.2 (1149)	0.3 (14960)
2002	0 (14)	0 (75)	0 (8)	0 (40)	1.3 (7003)	0 (1117)	1.0 (1400)	0 (235)	nd	
2003	0 (4)	0 (27)	0 (5)	0 (5)	0.6 (183)	0 (228)	0.1 (2035)	nd	nd	nd
Trends in prevalence within the period **	↓	-	↑	-	↑↓	→	↑↓	↑↓	-	-

* Percent positive samples of the total number of samples analysed. Numbers in brackets indicate the numbers of samples analysed. nd, not done

** ↑, increase; ↓, decrease; →, unchanged; -, to few data to conclude on trends

8 Verocytotoxigenic Escherichia coli

Analysis of the presence of verocytotoxigenic *Escherichia coli* O157 in retail food is not part of the routine surveillance carried out by DVFA. Data have been generated within specific CKL-projects. The results are presented in Table 3.

Table 3. Occurrence of verocytotoxigenic *Escherichia coli* O157 in not heat treated retail food in Denmark 1998-2003*.

	Beef meat (cutting plants and retail level)	Deer meat	Sheep meat	Fruit and vegetables
1998	nd	nd	nd	nd
1999	nd	0 (84)	0 (332)	nd
2000	nd	nd	nd	nd
2001	0 (543)	nd	nd	0 (1149)
2002	0 (444)	nd	nd	nd
2003	0 (a few)	nd	nd	nd
Trends in prevalence within the period **	-	-	-	-

* Percent positive samples of the total number of samples analysed. Numbers in brackets indicate the numbers of samples analysed. nd, not done

** ↑, increase; ↓, decrease; →, unchanged; -, to few data to conclude on trends

9 Yersinia enterocolitica

Analysis of the presence of *Yersinia enterocolitica* in retail food is not part of the routine surveillance carried out by DVFA, and information on the prevalence of this organism in various types of food is therefore scarce, unless specific projects have been initiated. The results are presented in Table 4.

Table 4. Occurrence of *Yersinia enterocolitica* in retail food in Denmark 1998-2003.

	pork meat	beef meat	ready-to-eat meat, smoked, salted or cured products
	not heat treated	not heat treated	not heat treated
1998	nd	nd	1*** (600)
1999	3.2 (306)	7.5 (136)	nd
2000	6.3 (96)	nd	nd
2001	0 (14)	nd	0 (5)
2002	0 (20)	nd	nd
2003	nd	nd	nd
Trends in prevalence within the period **	-	-	-

* Percent positive samples of the total number of samples analysed. Numbers in brackets indicate the numbers of samples analysed. nd, not done

** ↑, increase; ↓, decrease; →, unchanged; -, to few data to conclude on trends

*** in this project only serotype O:3 was reported

10 Listeria monocytogenes

According to the Danish regulatory authorities (circular concerning microbiological analyses of foods) investigations of the level of *L. monocytogenes* in foods have been performed on certain ready-to-eat products. The results of this investigation are presented in Table 5.

Table 5.
Occurrence of *Listeria monocytogenes* in ready-to-eat foods in Denmark 1998-2003.
Percent of samples with >100 *Listeria monocytoges* per g*.

	Heat-treated products of pork, beef, chicken and turkey handled after heat treatment	Preserved, not heat-treated or slightly heat-treated products of pork, beef, chicken and turkey	Gravad, smoked, salted, not heat-treated or slightly heat-treated fish products	Sprouts or sliced vegetables	Vegetable mayonnaise	Cheese and cheese products	Ready-prepared dishes
1998	0.5 (4141)	1.4 (512)	0 (193)	0.2 (505)	0.5 (2283)	0 (50)	0.2 (1531)
1999	0.5 (5534)	0.9 (212)	0.6 (178)	0.3 (398)	0.2 (2393)	0 (53)	0 (1816)
2000	0.4 (3861)	2.5 (162)	0.8 (120)	0 (160)	0.2 (2163)	0 (44)	0.2 (1410)
2001	0.2 (2952)	0.9 (115)	2.0 (152)	0 (87)	0.1 (1664)	0 (31)	0.2 (1239)
2002	0.2 (1331)	0.8 (244)	0 (157)	0 (71)	0.3 (573)	0 (34)	0 (482)
2003	0.1 (799)	2.6 (77)	0 (222)	0 (84)	0 (225)	0 (8)	0 (284)
Trends in prevalence within the period **	↓	→	↑↓	-	→	-	→

* Numbers in brackets indicate the numbers of samples analysed.
** ↑, increase; ↓, decrease; →, unchanged; -, to few data to conclude on trends

11 Monitoring of antimicrobial resistance among bacteria in raw foods.

The occurrence of antimicrobial resistance in bacteria from foods in Denmark has been monitored since 1996 as part of The Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP), that is the coordinated national surveillance and research programme for antimicrobial consumption and antimicrobial resistance in bacteria from animals, foods and humans.

The monitoring of antimicrobial resistance in food is based on the zoonotic bacteria *Campylobacter* and Salmonella and on the indicator bacteria *E. coli*, *Enterococcus faecium* and *Enterococcus faecalis* (Table 6). Zoonotic bacteria are included as they are able to develop antimicrobial resistance in the animal reservoir and this may subsequently lead to treatment failure in humans. Indicator bacteria are included due to their ubiquitous nature in food production environments and due to their ability to develop antimicrobial resistance in response to selective pressure from antibiotics.

Raw food samples were collected at wholesale and retail outlets by the Regional Veterinary and Food Control Authorities during the course of routine inspection or on request specifically for the monitoring programme. The food samples were analysed for the presence of relevant bacterial species using standard methods. Presumptive isolates were shipped to the Danish Institute for Food and Veterinary Research for verification and resistance determinations.

One strain from each positive food-sample was selected for susceptibility testing.
The number of isolates tested depended on the number of collected food-samples and on the prevalence of the bacteria within the food.

The antimicrobial resistances were determined by susceptibility testing towards a large range of antimicrobials applied for the treatment of animal and human infections and as antimicrobial growth promoters. In order to cover all major therapeutic groups of compounds specific test-panels of relevant antimicrobial agents were designed for each species.

Resistance monitoring of zoonoses

Isolates of zoonotic bacteria were obtained from other relevant Centrally Coordinated Laboratory Projects (CKL) regarding raw foods and a number of available isolates was included in the yearly resistance testing.

The highest levels of resistance among *C. jejuni* were observed for tetracycline and ciprofloxacin, whereas macrolide resistance (erythromycin) was rarely detected (Table 7). Trends in resistance among *C. jejuni* from raw chicken meat indicate a decrease in occurrence of resistance towards fluoroquinolones (ciprofloxacin). The occurrence of resistance to tetracycline has been fluctuating between 13% and 3% with a tendency of increase within the last two years of monitoring.

Comparison of resistance in *C. jejuni* from domestic and imported poultry reveals that the proportion of tetracycline resistance was significantly higher ($P < 0.005$) in *C. jejuni* isolated from im-

ported chicken meat (N=88) than in *C. jejuni* from Danish chicken meat (N= 367). The same tendency was observed for chloramphenicol, flouroquinolones ($P < 0.05$).

Resistance monitoring of indicator bacteria

Isolates of indicator bacteria were obtained by collection of approximately 1000 raw food samples per year in CKL projects specifically designed for the monitoring programme.

The raw foods from retail shops represent the last sampling point before the food is entering the private household. Additionally, they represent the link between the primary production and the human intestinal tract. As the indicator bacteria can be found in substantial numbers in both animal faecal samples, raw foods and in human faecal samples it is possible to analyse the trends in resistance in a farm-to-fork perspective. Table 8 is a recent example hereof. By the use of molecular techniques the routes of transmission of specific resistance genes have been further analysed.

The occurrence of resistance towards antimicrobial growth promoters among the faecal enterococci has been monitored together with the annual consumption for food animals (data not shown). Since the ban of these compounds a decrease in resistance has been documented. For some of the antimicrobial growth promoters the resistance levels are now at a minimal level. For others the resistance seems to be of a more continual nature, due to cross-resistance to other therapeutic agents in the animal production environments, to the persistence of resistant clones or due to mobile genetic elements.

Recently, it has been observed that similar occurrences of resistance among indicator bacteria are found in healthy human faecal samples and raw food samples of domestic origin. These observations indicate exchange of bacteria between food products and humans.

All results of the monitoring of antimicrobial resistance among bacteria in raw foods have been reported on an annual basis in the DANMAP reports. Additionally, stakeholders were invited to a yearly seminar with presentations of monitoring results and related research.

The present report is a brief presentation of the monitoring of antimicrobial resistance among bacteria in raw foods, however the number of available data on antimicrobial resistance in foods is extensive. For further details, see: DANMAP 2003. Use of antimicrobial agents and occurrence of antimicrobial resistance from food animals, foods and humans in Denmark. ISSN 1600-2032, also available online:
http://www.dfvf.dk/Files/Filer/Zoonosecentret/Publikationer/Danmap/Danmap_2003.pdfT

Table 6.

Summary of bacterial isolates that were included in the monitoring of antimicrobial resistance in raw foods 1998 – 2003.

A limited number of isolates originated from other food sources is not included in the table.

Bacterium	Food source	Number of isolates tested for antimicrobial resistance
Salmonella Typhimurium	Pork	210
Salmonella Enteritidis	Poultry	117
Campylobacter sp.	Poultry	673
E. coli	Beef	663
E. coli	Pork	459
E. coli	Poultry	988
E. faecalis	Beef	230
E. faecalis	Pork	265
E. faecalis	Poultry	225
E. faecium	Beef	229
E. faecium	Pork	178
E. faecium	Poultry	465

Table 7.

Trends in antimicrobial resistance (%) among Campylobacter jejuni from raw chicken meat collected from 1999 to 2003 and susceptibility tested by plate dilution (N=460). Data from 1998 are not included as these were generated by a different method, the agar diffusion test.

Antimicrobial agent	1999	2000	2001	2002	2003
Tetracycline	13	5	3	7	10
Streptomycin	4	9	7	0	1
Erythromycin	0	2	1	0	0
Ciprofloxacin	11	10	11	6	2

Table 8.

Occurrence of resistance (%) to selected antibiotics among *Escherichia coli* from domestic food animals, Danish and imported foods and humans, Denmark 2003.

Antimicrobial agent	Broilers	Chicken meat	Chicken meat	Cattle	Beef	Beef	Pigs	Pork	Humans
	Danish	Danish	Imported	Danish	Danish	Imported	Danish	Danish	
Tetracycline	14	9	59	4	7	16	31	22	15
Chloramphenicol	0	1	9	1	1	0	7	4	3
Ampicillin	15	10	18	2	5	13	23	15	21
Sulfonamide	20	14	14	4	4	13	31	21	21
Streptomycin	4	8	18	4	7	10	44	24	20
Number of isolates	120	153	22	86	161	31	317	123	107

Table 9.

Trends in tetracycline resistance among *Enterococcus faecium* from pigs, pork and healthy humans.

Source	**2002**	**2003**
Pigs	53 %	50 %
Pork	7 %	4 %
Healthy humans	13 %	5 %

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