

**REPORT ON THE NATIONAL STUDY OF
READY TO EAT MEATS AND MEAT
PRODUCTS: PART 5**

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SUMMARY

The National Study on Ready to Eat Meats and Meat Products: Part 5 surveyed 418 cooked, chilled chicken products on retail sale in England and Wales. The survey included plain portions, value added portions and whole chickens. In order to compare whole chickens with portions, the drumsticks, thighs and breasts of the whole chickens were examined separately. This resulted in a total of 758 samples undergoing microbiological examination. All products were examined at the end of their allocated shelf life for a range of bacteria to give an indication of the microbiological quality and to determine if certain pathogens were present.

The microbiological status of the different types of product was compared using the TVC, Enterobacteriaceae and *Listeria* spp. results. The statistical analysis showed that the microbiological quality of plain, portioned chicken tended to be worse than that of plain, whole chicken or value added, portioned chicken. It was also apparent that of all the products tested plain, portioned breasts were the ones that gave the poorest microbiological results.

There were no *Campylobacter* spp. isolations. *Listeria monocytogenes*, *Staphylococcus aureus* and *Escherichia coli* were detected at low levels in a minority of products. *Clostridium perfringens* was detected in one product. *Salmonella typhimurium* was detected in two products. Even at low levels, the presence of these bacteria in a ready to eat product is undesirable and, in the case of *Salmonella* spp., unacceptable. Their presence suggests that contamination took place after cooking or the products were undercooked and emphasises the importance of good hygiene practices during processing, retail sale and storage. Maintenance of the chill chain is also important to prevent or minimise any bacterial growth.

ACKNOWLEDGEMENTS

The Ministry would like to thank all samplers and laboratories who participated in the National Study Part 5 for their valuable assistance in this survey.

1 INTRODUCTION

1.1 Advisory Committee on the Microbiological Safety of Food

1.1.1 The Advisory Committee on the Microbiological Safety of Food (ACMSF) was established in December 1990 following the recommendation of the Richmond Committee¹. Its Terms of Reference were “to assess the risk to humans of micro-organisms which are used, or occur, in or on food, and to advise Ministers on the exercise of powers in the Food Safety Act relating to the microbiological safety of food.”

1.1.2 In 1995, the ACMSF was given the task of advising on the Government’s microbiological food surveillance programme, which had hitherto been the main task of the Steering Group on the Microbiological Safety of Food (SGMSF). This was the result of a merging of the functions of the two groups to ensure more efficient and streamlined consideration of food safety issues.

1.1.3 The task of co-ordinating the surveillance programme passed to a new inter-departmental body, the Microbiological Food Surveillance Group (MFSG).

1.1.4 The National Study on Ready to Eat Meats (RTE) and Meat Products was initiated by the Food Processing Working Group (FPWG), one of five sub-groups of the SGMSF. The FPWG identified Ready to Eat Meats and Meat Products as the subject for its first surveillance study. The Group decided to target RTE meat products first because the data available when the surveillance programme commenced suggested that they were one of the groups of processed foods more associated with food poisoning outbreaks. These foods are not intended to be cooked by the consumer before being eaten. Processing and handling by the manufacturer and retailer are therefore of critical importance in ensuring their safety. This was recognised by the Committee on the Microbiological Safety of Food which categorised the majority of RTE meat products as Category 1 High Risk Foods¹.

1.2.3 In view of the wide range of RTE meat products, the National Study was divided into a number of 'parts', each dealing with different aspects of RTE meat production. The first part of the Study looked at processors who cooked and further processed meat products on the same premises². Part 2 investigated secondary processors of RTE meat products (i.e. those processors who receive products fully cooked and then further process them by slicing and packing)³. Part 3 surveyed pre-packed, cooked, sliced RTE meat products on retail sale⁴. Part 4 surveyed dried and fermented meats on retail sale⁵. A summary of the main findings from Parts 1, 2, 3 and 4 is given in Appendix 2. This report covers the results obtained from the Part 5 Study which surveyed cooked, chilled chicken on retail sale.

NATIONAL STUDY ON READY TO EAT MEATS AND MEAT PRODUCTS: PART 5

2.1 Cooked chilled chicken

Cooked, chilled, ready to eat chicken for retail sale is a sector of the food market which has experienced rapid growth in recent years in line with the increased popularity of ready prepared products. As well as plain, roast chicken there is an increasing range of value added products on the market, e.g. barbecue chicken, tandoori chicken, etc.

As with any sector of the market that is rapidly increasing, it is important to be aware of the safety of the products and this can be achieved by undertaking microbiological surveillance. The principal concerns with poultry products relate to the presence of *Salmonella* spp., *Campylobacter* spp. or *Listeria monocytogenes*.

2.2 Objectives

The objectives of the study were:

- To obtain data on the microbiological status of cooked, chilled, whole and portioned chicken at retail sale.
- To compare the microbiological status of plain and value added cooked, chilled, whole and portioned chicken.
- To assess whether there were any differences in the microbiological status of whole and portioned chicken.

2.3 Study Design

Samples

2.3.1 The three product categories included in the Study were:

- plain, whole chicken,
- plain, portioned chicken,
- value added, portioned chicken.

Samples could be either pre-packed or loose.

In preparation for the survey, a research project had been undertaken to look at the most appropriate way of carrying out microbiological sampling of these types of products. The results of this project had shown that it would be impractical to include chicken wings due to the small amount of meat that was attached. The portion types included in the study were therefore drumstick, thigh or breast.

Sampling Instructions

2.3.2 Samplers were given clear instructions as to the products which fitted into each category.

Plain, whole chickens (e.g. roast chicken)

- These should be plain, whole, cooked, chilled, ready to eat chickens.
- They must not have been smoked, stuffed or had a coating added to them to enhance the flavour, other than a sugar or caramel coating/marinade to improve the colour of the meat (e.g. chicken in dextrose marinade, chicken with added sugar).

Plain chicken portions (e.g. roast chicken breast)

- These should be plain, cooked, chilled, ready to eat chicken portions.
- They must not have been smoked, stuffed or had a coating added to them to enhance the flavour, other than a sugar or caramel coating/marinade to improve the colour of the meat (e.g. chicken in dextrose marinade, chicken with added sugar).
- The portions purchased should only be drumstick, thigh or breast.
- All portions should be skin on.

Value added chicken portions (e.g. barbecue chicken breast)

- These should be cooked, chilled, ready to eat chicken portions which have been marinated or coated to enhance the flavour of the meat.

- Samples should not include those to which a sugar or caramel coating has been applied to improve the colour of the meat. They should also not be smoked or stuffed.
- The portions purchased should only be drumstick, thigh or breast.
- All portions should be skin on.
- Examples of suitable types of flavours/marinades/coatings are: barbecue, tikka, tandoori, balti, Chinese, breadcrumbs, Mexican.

2.3.3 Samplers were also given specific instructions about which products were not included in the Study. These were:

- Products that are sold hot (i.e. held at greater than 63°C).
- Products which require cooking (i.e. is not "ready to eat")
- Products which are smoked or stuffed.
- Products from which the skin has been removed.

Sampling Plan

2.3.4 The aim when planning the Study was for samplers to collect approximately equal numbers of each product category. It was also the intention that the Study be representative of the retail market share for cooked, chilled chicken in England and Wales. However, despite a number of sources being investigated, no data were available for the retail market share of these types of product. Therefore for the purposes of this survey an assumption was made that the market share would not differ greatly from that of delicatessen meats in general. This information was available from a Mintel Market Intelligence Report on Delicatessen Meats⁶ (Table 1).

Table 1
UK Sales of Delicatessen Meats in 1994 by Type of Retail Outlet

Retail Outlet	Market Share	
	£m	%
Multiple grocer	631	73
Delicatessen	121	14
Independent grocer/others	84	10
Butchers	29	3

Sampling

2.3.5 Samples of cooked, chilled chicken were taken at point of sale and stored by participating laboratories at $5^{\circ}\text{C} \pm 1^{\circ}\text{C}$ until the end of their specified shelf life. Microbiological examinations were carried out on the 'use by' dates of the samples or one day either side.

2.3.6 Samplers were asked to record basic information about individual retailers (e.g. names and locations) and any factors which could affect the microbiological status of the samples (e.g. if there was evidence of lack of refrigeration). This information was recorded on the Sampling Form (Appendix 2).

Analyses

2.3.7 The microbiological examinations carried out in the Study are shown in Table 2. British Standard methods were used where available and applicable. Other methods employed had been tested by collaborative trial.

2.3.8 Whole chickens were divided into portions by removal of the drumsticks, thighs and breasts (the rest of the chicken being discarded). To allow comparison with the retail chicken portions, the breast and the pairs of drumsticks and thighs were then examined separately, i.e. they were treated as three separate samples for the purpose of microbiological examination.

2.4 Study Details

Samples

2.4.1 Samples were taken by 71 samplers from retail outlets throughout England and Wales during August and September 1996. All the samplers who took part in the survey had been trained by MAFF in the collection of surveillance samples.

Laboratories

2.4.2 Analysis of samples was undertaken by 16 laboratories. All of these had performed satisfactorily in the Quality Assessment Scheme (QAS) organised by MAFF for laboratories taking part in its surveillance studies. In addition to participation in the QAS, all of the laboratories used for this Study had been accredited for microbiological examination of food and food products by the United Kingdom Accreditation Service (UKAS).

Table 2
Microbiological Examinations

	Presence/ Absence	Enumeration
Total Viable Count		✓
Total Enterobacteriaceae		✓
<i>Escherichia coli</i>		✓
<i>Listeria</i> spp.	✓	
<i>Listeria monocytogenes</i>	✓	✓
<i>Staphylococcus aureus</i>		✓
<i>Salmonella</i> spp.	✓	
<i>Campylobacter</i> spp.	✓	
<i>Clostridium perfringens</i>		✓

3 RESULTS

3.1 General

3.1.1 The following definitions are used in the rest of this report to describe the different types and samples of ready to eat, cooked, chilled chicken.

- **Whole Chicken** - Plain, whole chicken
- **Plain Portion** - Plain, portioned chicken
- **Value Portion** - Value added, portioned chicken

- **Product Category** - Either whole chicken, plain portion or value portion
- **Sample Type** - Either drumstick, thigh or breast

3.2 Product Information

Samples

3.2.1 A total of 418 products were purchased for the study, as follows:

- 170 whole chickens
- 138 plain portions
- 110 value portions

3.2.2 Table 3 shows how many of each product category were purchased from each type of retail outlet (see Appendix 3 for definitions). Overall, this compared well with the original sampling plan as described in 2.3.4.

Packaging

3.2.3 Of the 418 products collected, 348 (83%) were prepacked and 67 (16%) were sold loose. For three products this information was not recorded.

Table 3
Product category and type of retailer

Retailer type	Whole chickens	Plain portions	Value portions	Total number of samples (%)
Multiple Grocer	139	110	101	350 (84%)
Independent Grocer	7	12	4	23 (6%)
Delicatessen/ Sandwich bar	8	9	4	21 (5%)
Butcher	14	6	1	21 (5%)
Unknown	2	1	-	3 (1%)
Total number of samples (%)	170 (41%)	138 (33%)	110 (26%)	418

3.3 Microbiological Results

General

3.3.1 As noted in paragraph 2.3.8, each whole chicken was divided into drumstick, thigh and breast samples. Therefore, the 418 products collected in the study gave a total of 758 individual samples for microbiological examination.

Total Viable Counts

3.3.2 The term Total Viable Count (TVC) is used throughout this report because of its common usage in the food industry. It refers to the enumeration of micro-organisms by British Standard 5763: Methods for microbiological examination of food and animal feeding stuffs: Part 1, Enumeration of micro-organisms - colony count technique at 30°C.

3.3.3 Table 4 summarises the range of TVC results obtained from the Study. Of the 758 analysed, 142 (19%) gave log₁₀ counts of less than 1.00. Log₁₀

counts of 4.00 or greater occurred in 35% of samples. This level was detected in 53% of portioned chicken samples, 33% of whole chicken and 20% of value portions.

3.3.4 Log₁₀ counts of 6.00 or greater occurred in 15% of samples. This level was detected in 13% of whole chicken samples, 28% of portioned chicken and 5% of value portions.

3.3.5 Six samples (5 whole chicken and one portioned chicken) had log₁₀ TVC counts of greater than 9.00.

Table 4
Summary of Total Viable Count Results

4a: Whole Chickens

log₁₀ count/g	Thighs	Breasts	Drumsticks
<1	38	42	37
1.00 - 1.99	30	32	22
2.00 - 2.99	32	23	28
3.00 - 3.99	14	22	20
4.00 - 4.99	20	18	24
5.00 - 5.99	12	14	14
6.00 - 6.99	15	10	13
7.00 - 7.99	6	7	7
8.00 - 8.99	1	1	3
>9.00	2	1	2
TOTAL	170	170	170

4b: Plain Portions

log₁₀ count/g	Thighs	Breasts	Drumsticks
<1	3	1	5
1.00 - 1.99	2	9	7
2.00 - 2.99	3	6	7
3.00 - 3.99	6	10	6
4.00 - 4.99	3	7	5
5.00 - 5.99	1	13	5
6.00 - 6.99	1	9	5
7.00 - 7.99	2	8	5
8.00 - 8.99	0	5	3
>9.00	0	1	0
TOTAL	21	69	48

4c: Value Portions

log₁₀ count/g	Thighs	Breasts	Drumsticks
<1	5	6	5
1.00 - 1.99	5	11	11
2.00 - 2.99	8	10	8
3.00 - 3.99	7	6	5
4.00 - 4.99	2	6	4
5.00 - 5.99	2	0	2
6.00 - 6.99	1	1	1
7.00 - 7.99	0	1	2
TOTAL	30	41	39

Enterobacteriaceae and Escherichia coli

3.3.6 Quantitative tests for Enterobacteriaceae and *E. coli* were carried out on all samples (Table 5). 510 of the 758 samples tested had log₁₀ Enterobacteriaceae counts of less than 1.00 (67% of samples). 751 of the 758 samples tested had log₁₀ *E. coli* counts of less than 1.00 (99% of samples).

Table 5
Summary of Enterobacteriaceae Results

5a: Plain Chickens

log₁₀ count/g	Thighs	Breasts	Drumsticks
<1	122	116	110
1.00 - 1.99	13	15	10
2.00 - 2.99	7	10	24
3.00 - 3.99	13	15	8
4.00 - 4.99	8	7	7
5.00 - 5.99	4	6	7
6.00 - 6.99	3	1	2
7.00 - 7.99	0	0	2
TOTAL	170	170	170

5b: Plain Portions

log₁₀ count/g	Thighs	Breasts	Drumsticks
<1	13	29	29
1.00 - 1.99	3	5	1
2.00 - 2.99	3	6	4
3.00 - 3.99	1	10	3
4.00 - 4.99	1	7	5
5.00 - 5.99	0	5	3
6.00 - 6.99	0	7	2
7.00 - 7.99	0	0	1
TOTAL	21	69	48

5c: Value Portions

log₁₀ count/g	Thighs	Breasts	Drumsticks
<1	23	38	30
1.00 - 1.99	2	2	0
2.00 - 2.99	0	1	2
3.00 - 3.99	4	0	4
4.00 - 4.99	0	0	1
5.00 - 5.99	1	0	2
TOTAL	30	41	39

3.3.7 Eighty two of the 758 samples had of log₁₀ Enterobacteriaceae counts of 4.00 or greater (11% of samples). This level was detected in 9% of whole chicken samples, 22% of portioned chicken, and 4% of value portions. Log₁₀ Enterobacteriaceae counts of 7.00 or greater were found in 3 samples, the highest being log₁₀ 7.49 from a portioned chicken drumstick.

3.3.8 Table 6 provides details of the 7 samples that had log₁₀ *E. coli* counts of 1.00 or greater.

Table 6
Samples with *E. coli* Counts of log₁₀ 1.00 or greater

Sample	<i>E. coli</i> log₁₀ count/g
Plain portion (thigh)	3.36
Value portion (thigh)	3.26
Plain portion (thigh)	2.34
Whole chicken (drumstick)	2.20
Plain portion (drumstick)	1.70
Whole chicken (thigh)	1.00
Plain portion (breast)	1.00

Listeria* spp./ *Listeria monocytogenes

3.3.9 All samples were tested for the presence or absence of *Listeria* spp. and *Listeria monocytogenes* in 25g of product. Of the 758 samples tested, 120 (16%) were positive for *Listeria* spp. The organism was detected in 15% of the whole chicken samples, 24% of plain portions and 10% of value portions.

3.3.10 Of the 120 samples from which *Listeria* spp. were isolated, 49 (i.e. 6% of the 758 samples tested) were confirmed as being *L. monocytogenes*. The organism was detected in 6% of whole chicken samples, 9% of plain portions and 5% of value portions. Table 7 provides a summary of the positive isolations of *Listeria* spp. and *L. monocytogenes*.

3.3.11 In addition to the presence/absence tests for *L. monocytogenes*, a quantitative analysis for this organism was carried out on all 758 samples. Table 8 provides details of the 5 samples where log₁₀ *L. monocytogenes* counts of 2.00 or greater were obtained.

Table 7**Positive Isolations of *Listeria* spp. and *Listeria monocytogenes***

Product Category	Sample Type (total number of samples)	<i>Listeria</i> spp. (%)	<i>L. monocytogenes</i> (%)
Whole chicken	Thigh (170)	23 (13.5)	13 (7.6)
	Breast (170)	29 (17.1)	11 (6.5)
	Drumstick (170)	24 (14.1)	8 (4.7)
	All samples (510)	76 (14.9)	32 (6.3)
Plain portions	Thigh (21)	6 (28.6)	3 (14.3)
	Breast (69)	15 (21.7)	3 (4.3)
	Drumstick (48)	12 (25)	6 (12.5)
	All samples (138)	33 (23.9)	12 (8.7)
Value portions	Thigh (30)	5 (16.7)	3 (10)
	Breast (41)	1 (2.4)	0
	Drumstick (39)	5 (12.8)	2 (5.1)
	All samples (110)	11 (10)	5 (4.5)

Table 8**Samples with *L. monocytogenes* counts of log₁₀ 2.00 or greater**

Sample Type	<i>L. monocytogenes</i> log₁₀ count/g
Value portion (drumstick)	3.30
Whole chicken (thigh)	3.20
Whole chicken (drumstick)	3.00
Value portion (thigh)	2.48
Whole chicken (breast)	2.00

3.3.12 For each plain, whole chicken three samples were tested - thigh, breast and drumstick. There were 18 occasions where *Listeria* spp. was found in all 3 samples, 6 where it was found in 2 of the samples and 10 where the organism was isolated from one sample. For *L. monocytogenes*, there were 5 occasions when the organism was found in all 3 samples, 3 where it was found in 2 samples and 11 occasions where it was isolated from one sample.

Staphylococcus aureus

3.3.13 A quantitative analysis for *Staphylococcus aureus* was carried out on all samples. Five samples were found to contain *S. aureus* (Table 9). One of these samples was also positive for *L. monocytogenes* and one for another *Listeria* spp.

Table 9

Samples with *S. aureus* counts of log₁₀ 1.00 or greater

Sample	<i>S. aureus</i> log ₁₀ count/g
Plain portion (thigh)	3.52
Plain portion (drumstick)	1.90 ^a
Whole chicken (thigh)	1.48 ^b
Whole chicken (drumstick)	1.30 ^b
Plain portion (breast)	1.00 ^c

a - *L. monocytogenes* also present

b - samples from same whole chicken

c - *Listeria* spp. also present

Campylobacter spp.

3.3.14 All samples were tested for the presence or absence of *Campylobacter* spp. in 25g of product. None was isolated from any of the 758 samples.

Clostridium perfringens

3.3.15 A quantitative analysis for *Clostridium perfringens* was carried out on all samples. A detectable level (log₁₀ 1.00) was found in one sample, a whole chicken drumstick.

Salmonella spp.

3.3.16 All samples were tested for the presence or absence of *Salmonella* spp. in 25g of product. This organism was found in two (0.3%) of the 758 samples examined (Table 11).

Table 11
Positive Isolations of *Salmonella* spp.

Sample	<i>Salmonella</i> spp.
Whole chicken (drumstick)	<i>Salmonella typhimurium</i> DT287
Whole chicken (drumstick)	<i>Salmonella typhimurium</i> DT287

4. STATISTICAL ANALYSIS OF THE RESULTS

4.1 TVC

4.1.1 Statistical analysis of the TVC results showed that:

- The mean level for plain portions was significantly higher (at a 0.1% level of significance) than for either whole chicken or value portions.
- With plain portions the mean level from breast samples was significantly higher (at a 5% level of significance) than for thigh samples.
- The mean level for plain portion breast samples was significantly higher (at a 0.1% level of significance) than breast samples from whole chickens or value portions.
- The mean level for plain portion drumstick samples was significantly higher (at a 5% level of significance) than drumstick samples from whole chickens.

Table 12

Mean Levels of TVC (\log_{10} count/g)

	Breast	Thigh	Drumstick	Total
Whole chickens	2.58	2.77	3.02	2.79
Plain portions	4.84	3.41	3.97	4.32
Value portions	2.33	2.60	2.70	2.53
All samples	3.10	2.82	3.15	3.03

4.2 Enterobacteriaceae

4.2.1 Statistical analysis of the Enterobacteriaceae results showed that:

- The mean level for plain portions was significantly higher (at a 0.1% level of significance) than for either whole chicken or value portions.

- With plain portions the mean level for breast samples was significantly higher (at a 5% level of significance) than for thigh samples.
- With value portions the mean level for drumstick samples was significantly higher (at a 5% level of significance) than for breast samples.
- The mean level for plain portion breast samples was significantly higher (at a 0.1% level of significance) than breast samples from whole chickens or value portions.

Table 13
Mean Levels of Enterobacteriaceae (log₁₀ count/g)

	Breast	Thigh	Drumstick	Total
Whole chickens	-0.38	-0.98	-0.16	-0.49
Plain portions	1.84	0.35	0.20	1.07
Value portions	-1.80	-1.50	-1.63	-2.41
All samples	-0.24	-0.87	-0.33	-0.46

4.3 *Listeria* spp. / *Listeria monocytogenes*

4.3.1 Statistical analysis of the *Listeria* spp. and *L. monocytogenes* results showed that:

- The prevalence of *Listeria* spp. and *L. monocytogenes* was significantly higher (at a 5% level of significance) in plain portions than in whole chickens.
- For drumsticks, the prevalence was significantly higher (at a 0.1% level of significance) in plain portions than in whole chickens.

4.4 Appendix 4 provides information on how the statistical analysis of the results was undertaken.

5. DISCUSSION

5.1 General

5.1.1 Retailers were not generally informed that microbiological surveillance was being carried out on their products. However, where they were aware they were offered the opportunity to receive the results of the tests carried out on the products bought from their shops.

5.1.2 Samples taken for surveillance purposes are distinct from sampling for enforcement purposes under the Food Safety Act 1990⁷. However, samples were taken without prejudice to any action that may have proved necessary in the event that they revealed an immediate hazard to health.

5.1.3 In order that prompt action could be taken if required, laboratories were asked to contact the study organisers immediately should any of the following results be found:

- *Salmonella* spp. (presence)
- *Campylobacter* spp. (presence)
- *Clostridium perfringens* (count)
- *Listeria monocytogenes* (presence or count)
- *Escherichia coli* (if $>10^3$ per gram)
- *Staphylococcus aureus* (count)

5.1.4 Where such results were notified to the study organisers, each was assessed on an individual basis in consultation with the Department of Health. In appropriate cases, the local Environmental Health Department and the retailer were informed of the results so that they could investigate how the contamination could have occurred and take any follow up action deemed necessary.

5.2 Comparisons of microbiological quality

5.2.1 As well as aiming to gather data on the microbiological status of cooked, chilled chicken, the objectives of the survey were:

- To compare the microbiological status of plain and value added cooked, chilled, whole and portioned chicken.
- To assess whether there are any differences in the microbiological status of whole and portioned chicken.

5.2.2 Statistical comparisons could only be undertaken where there were sufficient numbers of positive results. This was only found to be the case for TVC, Enterobacteriaceae and *Listeria* spp.

5.2.3 Statistical analyses indicated that the microbiological quality of plain portions tended to be worse than that of whole chickens or value portions. It was also apparent that of all the samples tested, plain breast portions were the ones that gave the poorest microbiological results.

5.2.4 A possible reason for the differences observed between plain portions and whole chickens is that the former have undergone some additional steps during processing (e.g. separation from the rest of the carcass, removal of bone, trimming, etc.) These steps may be carried out automatically or manually, with either method increasing the opportunity for cross contamination.

5.2.5 However, this would not explain why value portions tended to be of better microbiological quality than plain portions. A possible reason is that the production and cooking processes were different and value portions received a greater level of heat treatment. The marinade or coating may also affect bacterial growth during storage, providing poorer growth conditions than those on the plain portions.

5.3 Detection of pathogens

Listeria spp. and *L. monocytogenes*

5.3.1 *Listeria* spp. were found to be present at low levels in 16% of the samples. This is a higher prevalence than found in Parts 1, 2, 3 and 4 of the Study where the prevalence ranged from 4.3% (Part 1) to 9.3% (Part 2).

5.3.2 *L. monocytogenes* was found in 6% of the samples tested and counts of greater than \log_{10} 2.00 were detected in five of these. This is a slightly higher

prevalence than found in Parts 1, 2, 3 and 4 of the Study where the prevalence ranged from 2.9% (Part 2) to 5.3% (Part 3).

Staphylococcus aureus

5.3.3 A similar situation to *L. monocytogenes* was seen with *S. aureus* contamination. Low levels were found in 0.7% of samples and this was comparable with results from Parts 1, 2, 3 and 4 of the Study.

E. coli

5.3.4 *E. coli* was isolated at low levels from 0.9% of the samples. The presence of *E. coli* is indicative of possible faecal or environmental contamination and is therefore undesirable. Samples were not examined for *E. coli* in Parts 1, 2 and 3 of the Study and in Part 4, <1% of samples were contaminated with this bacteria.

5.3.5 The presence of *Listeria* spp., *S. aureus* and *E. coli* on the chicken suggests that contamination took place after cooking or the product was undercooked. Even at low levels, the presence of these bacteria in a ready to eat product is undesirable. These results emphasise the importance of good hygiene practices during processing, retail sale and storage. Maintenance of the chill chain is also important to prevent or minimise any bacterial growth.

Clostridium perfringens

5.3.6 One sample was found to contain *Clostridium perfringens*. This is consistent with the very low prevalence of this bacteria found in poultry products in Parts 2 and 3 of the Study.

Salmonella

5.3.7 *Salmonella typhimurium* DT287 was isolated from the drumstick portion of two whole roast chickens (0.3%). Both products were found to originate from the same manufacturer and this is discussed in more detail in section 5.4.

5.3.8 The presence of *Salmonella* in a ready to eat product is obviously unacceptable and suggests that cross contamination occurred from the raw to the cooked product or there was inadequate cooking.

Campylobacter spp.

5.3.9 No samples were found to contain *Campylobacter* spp. This is consistent with previous Parts of the Study where only one ready to eat meat product has been found to be contaminated with this bacteria.

5.4 Results from Company A

5.4.1 It was identified early in the study that samples manufactured by a particular company were providing a high proportion of the isolations of *L. monocytogenes*. Whilst discussions were underway about whether action was required, *Salmonella* spp. were isolated from two whole chicken drumstick samples produced by the company. The local Environmental Health Department were informed and the manufacturing plant was visited by officials from MAFF and DH. The company undertook a period of voluntary closure in order to address a number of areas of concern that had been identified and product from the affected batch was withdrawn from sale.

5.4.2 Once the study had been completed, analysis of the results showed that:

- Of the 418 products purchased for the study, 65 (16%) were produced by Company A. These 65 products led to a total of 121 samples.
- The mean TVC and Enterobacteriaceae counts from Company A were significantly greater (at a 0.1% level of significance) than for non-Company A samples.
- 40 (33%) of the 121 samples contained *Listeria* spp. (in comparison to 13% of the non-Company A samples).
- 18 (15%) of the 121 samples contained *L. monocytogenes* (in comparison to 5% of the non-Company A samples).
- Company A produced 3 of the 5 samples where *L. monocytogenes* was detected at log₁₀ counts of 2.00 or greater.
- Company A provided 2 of the 7 samples where *E. coli* was detected.
- Both *Salmonella* spp. isolations were from Company A.

5.5 Comment on Company A Results

5.5.1 Taken as a whole, the company's products sampled during the survey were of a poorer microbiological quality than those from the other companies surveyed. However, it was not possible to conclude that the company's products were 'worse' than products from any other individual company. This is because the survey was not planned with the intention of making comparisons between individual companies and insufficient samples were taken to make such an analysis.

5.5.2 Consideration was given to undertaking the statistical analysis without the results from the company. The rationale was that this would be a better reflection of the microbiological status of cooked, chilled chicken samples on retail sale in England and Wales. However, this was felt to be inappropriate as:

- the study was a 'snapshot' of the current situation at the time the survey was undertaken. Removing the results from one company would give a false impression of the microbiological status of these products at that time.
- if the results from one company were to be considered as 'outliers' and removed, then there would be a need to assess the results from all other companies whose products were tested in the study to see whether they too should be removed.

5.5.3 It should also be noted that the majority of the conclusions made during the statistical analysis of the results are the same regardless of whether the company's results are included or not.

6 CONCLUSIONS

6.1 There were no *Campylobacter* spp. isolations. *Listeria monocytogenes*, *Staphylococcus aureus* and *Escherichia coli* were detected at low levels in a minority of products. *Clostridium perfringens* was detected in one product. *Salmonella typhimurium* was detected in two products.

6.2 Even at low levels, the presence of these bacteria in a ready to eat product is undesirable and, in the case of *Salmonella* spp., unacceptable. Their presence suggests that contamination took place after cooking or the product was undercooked. These results highlight the potential for this type of product to be contaminated with food poisoning bacteria and thus emphasise the importance of good hygiene practices during processing and retail sale. Maintenance of the chill chain is also important to prevent or minimise any bacterial growth.

6.3 The microbiological status of the different types of product was compared using the TVC, Enterobacteriaceae and *Listeria* spp. results. The statistical analysis showed that the microbiological quality of plain, portioned chicken tended to be worse than that of plain, whole chicken or value added, portioned chicken. It was also apparent that of all the samples tested plain, portioned breasts were the ones that gave the poorest microbiological results.

6.4 The microbiological results from this part of the National Study were found to broadly reflect those from Parts 1 - 4, although the prevalence of *Listeria* spp. and *L. monocytogenes* was found to be slightly higher.

7 APPENDICES

APPENDIX 1

NATIONAL STUDY ON READY TO EAT MEATS AND MEAT PRODUCTS: PARTS 1, 2, 3, & 4

Part 1

1. Part 1 of the Study surveyed processors who cooked and further processed on the same premises. Three types of cooked meat products were surveyed: a sliced meat product (i.e. ham); a comminuted meat product (i.e. pâté); and a bakery product (i.e. pork pie). Each of the products was sampled at three stages in the production process: directly after cooking; after a further processing stage; and just before distribution from the premises (i.e. the final hold stage). In addition to samples being taken for analyses, supplementary information on the manufacturer and the process were collected.

2. This part of the Study involved 22 samplers, predominantly Environmental Health Department personnel, and nine laboratories which carried out the microbiological and chemical analyses of the surveillance samples. Forty-eight ham, 53 pork pie and sixteen pâté processors were visited. A total of 122 visits to processing establishments were made and 352 samples were collected for analysis. A total of 2,196 analyses (1,952 microbiological and 244 chemical) were carried out.

3. The study found fifteen isolations of *Listeria* spp. (4.3% of samples) of which eleven (3.1% of samples) were confirmed as being *Listeria monocytogenes*. In all cases the level of *L. monocytogenes* found in the samples was low (less than twenty organisms per gram of food). Analysis for *S. aureus* was carried out on samples at the final hold stage; five samples (4.2%) were positive. In all cases the level of *S. aureus* isolated was less than 100 organisms per gram of food. Tests for *Salmonella* spp. and *Campylobacter* spp. were also carried out on samples at the final hold stage, but these organisms were not isolated from any of the samples examined. Tests for Total Viable Count (TVC) and Enterobacteriaceae were carried out on all samples. The results from these tests did not indicate any cause for concern.

4. The main findings of the Part 1 Study were:
- the Study's microbiological results did not indicate any hazard to consumers;
 - however, information collected on production practices showed that there was the potential for microbiological contamination, survival and growth to occur in the products studied. This reinforces the need for effective hygiene practices, for example through the introduction of HACCP (Hazard Analysis and Critical Control Points) - a structured approach to the identification, assessment and control of hazards associated with food production;
 - *Listeria monocytogenes* and *S. aureus* were found to be present in some samples albeit at levels which, according to the Public Health Laboratory Service (PHLS) Guidelines, would not be considered a cause for serious concern. However, their presence is undesirable and emphasises the need for strict temperature controls throughout storage and distribution in order to minimise growth of these organisms.

Part 2

5. Part 2 of the National Study surveyed RTE meat products from secondary processors. The four product types included in this part of the Study were: cooked, cured pork; cooked, cured, comminuted meat; poultry; and corned beef. Samples were taken from each of the products at pre-slice, slice and final hold stages in production. As in Part 1 of the Study, supplementary information on manufacturers and production processes were also obtained in Part 2.

6. This part of the Study involved 35 samplers who took a total of 204 samples from 68 processors. The sixteen laboratories who participated in Part 2 of the Study carried out a total of 1,852 analyses of which 1,686 were microbiological and 166 were chemical.

7. Nineteen isolations of *Listeria* spp. were made out of the 204 samples tested (9.3% of samples) of which six (2.9% of samples) were identified as being *L. monocytogenes*. In all cases the numbers of *L. monocytogenes* detected

were low (i.e. less than 100 organisms per gram of food). *Staphylococcus aureus* was found to be present in seventeen samples (8.3% of samples). In most cases, the level of *S. aureus* isolated was less than 100 organisms per gram of food. However, seventeen samples contained detectable levels of *S. aureus*. The highest levels were found in two samples of cooked, cured pork. Samples were also tested for *Salmonella* spp., *Campylobacter* spp. and *E. coli* O157:H7 but none of these organisms were isolated from the 204 samples tested. Poultry samples were additionally analysed for *Cl. perfringens* but this organism was not found to be present in the 54 samples tested. All samples were also tested for TVCs and Enterobacteriaceae.

8. The main findings of Part 2 of the Study were very similar to those from Part 1 in that although the results of the microbiological analyses did not indicate any cause for concern, the information obtained on processing practices showed that there was the potential for microbial contamination, survival and growth to occur. This further reinforces the need for effective hygiene practices and, in particular, strict temperature controls.

Part 3

9. Part 3 of the National Study surveyed pre-packed, cooked, sliced RTE meat products on retail sale. The four product types included in this part of the Study were: cooked, cured pork; cooked, cured, comminuted meat; poultry; and corned beef. Samples were stored under refrigeration and microbiological and chemical analyses carried out on the appropriate 'Use By' dates.

10. A total of 414 samples were taken by 74 samplers from retail outlets in England and Wales. The twenty laboratories who participated in Part 3 of the Study carried out a total of 5334 analyses of which 4239 were microbiological and 1095 were chemical.

11. Twenty four isolations of *Listeria* spp. were made (5.8% of samples) of which 22 (5.3% of samples) were identified as *L. monocytogenes*. In 21 samples, the levels of *L. monocytogenes* were found to be at or below 100 organisms per gram of food. One sample of poultry was found to contain *L. monocytogenes* at a level of 30,200 organisms per gram of food. *Staphylococcus aureus* was found to be present in four samples (1.0% of samples). In three samples, *S. aureus* levels were found to be less than 100

organisms per gram. However, one sample of corned beef was found to contain *S. aureus* at a level of 1,820,000 organisms per gram. One sample was found to be contaminated with *Campylobacter* spp. Poultry samples were additionally tested for *Cl. perfringens*. Of the 99 samples tested, one was found to contain *Cl. perfringens* at a level of 10 organisms per gram. Tests for *Salmonella* spp. and *E. coli* O157:H7 were carried out on all 414 samples. Neither of these two organisms were detected. All samples were also tested for TVCs and Enterobacteriaceae.

12. The microbiological results were not found to indicate a hazardous situation. However, although present in a minority of samples, the presence of potential pathogens *L. monocytogenes*, *S. aureus* and *Campylobacter* spp. in ready to eat products is undesirable and highlights the need for effective hygiene practices to prevent contamination during processing and strict temperature controls during storage to prevent bacterial growth.

Part 4

13. Part 4 of the National Study surveyed ready to eat dried and fermented meats on retail sale in England and Wales. The sampling plan was designed to take into account the UK market in dried and fermented meats.

14. Four hundred and fifty five samples were taken at retail and tested at the end of their allocated shelf lives. Examinations for a range of bacteria were carried out to give both an indication of the microbiological quality and to determine if certain potential pathogens were present. Chemical analyses were also carried out to determine the water activity, salt and pH levels.

15. The microbiological results showed there to be very little evidence of contamination by food poisoning bacteria in these types of products. However, the potential pathogens *Listeria monocytogenes* and *Staphylococcus aureus* were detected in fifteen and seven samples, respectively. The pathogen *Salmonella* spp. was isolated from one sample. Microbiological examinations for the pathogens *Campylobacter* spp. and *Escherichia coli* O157:H7 were also carried out on all samples. Neither of these organisms was detected. The presence of *L. monocytogenes* products in ready to eat meat products is undesirable. The presence of high levels of *L. monocytogenes* and *S. aureus* is unacceptable, as is the presence of *Salmonella* spp.. These results highlight the

need for good hygiene practices during processing and retail sale to prevent contamination and minimise bacterial growth.

Comments

Any other comments, in particular any difficulties in sampling.

Please return the completed form to:
Ms G Hoad, Food Hygiene Division, Branch A,
Room 429A, Ergon House, 17 Smith Square, London SW1P 3JR

APPENDIX 3

Definitions of type of retail outlet

Multiple Grocer

A multiple grocer was defined as a national or regional supermarket chain.

Small independent grocer

Small, independent grocers were usually corner shops or mini-markets with no more than 2 or 3 outlets within the area. This category also included shops where food was only sold in a section of the shop (e.g. sub-Post Offices, petrol stations or newsagents).

Delicatessen/Sandwich Bar

A delicatessen was defined as a small, specialist food shop and did not include the delicatessen counter of supermarkets. A sandwich bar was defined as a shop predominantly selling ready to eat foods such as sandwiches/rolls, fruit, yoghurts etc., which also sold cooked meat products.

Butcher

A butcher was defined as a small specialist meat shop which, as well as selling fresh meat, sells cooked meat products. It did not include the butcher's counter of supermarkets.

APPENDIX 4

STATISTICAL APPROACH

Statistical comparisons could not be made for *Salmonella* spp. and *Campylobacter* spp. because only two and zero samples respectively tested positive for these organisms. Similarly, statistical comparisons were not possible for those quantitative microbiological tests where very few samples had detectable levels of organisms. Only 5, 5, 7 and 1 samples of *L. monocytogenes*, *S. aureus*, *E. coli* and *C. perfringens* were found to be over the level of detection.

Therefore only the presence of *Listeria* spp. and *L. monocytogenes* and the level of the Total Viable Count and Enterobacteriaceae were considered in the statistical analysis. For the latter two organisms, most samples observed had no or very small counts and a few samples had very high counts. Therefore, the results have been reported as log₁₀ counts for convenience.

One measure of location often used for skewed data is the geometric mean. However, the data for TVC and Enterobacteriaceae contain zero counts, so this cannot be calculated directly. Therefore, estimates for the geometric means were made on the assumption that the distributions of counts were close to a log-Normal distribution. They were calculated using a function to find maximum likelihood estimates of left-censored data. This was written in the statistical package S-PLUS. Samples below the limit of detection (1 log₁₀ count/g) were treated as censored below that level.

The tests to find significant differences

Comparisons were made between whole chicken, portioned chicken and value portions of the same sample type for each of the measures of the four organisms. Comparisons were also made between drumsticks, thighs and breasts of the same product category. Comparisons were also made pooling over sample type and product category.

To avoid the difficulty of finding suitable distributions for the data, comparisons were made using non-parametric tests. The Mann-Whitney test was used for TVC and Enterobacteriaceae, and Fisher's exact test for the categorical variables. Samples of one sample type were not assumed to be

independent of samples of another type for comparisons within whole chickens. This was because a sample of each sample type came from each whole chicken. Therefore comparisons within whole chickens were tested using the Wilcoxon signed rank test for TVC and Enterobacteriaceae and McNemar's test for categorical variables.

The Mann-Whitney test is based on ranking the counts in order of size, and totalling the ranks in each category. The Wilcoxon signed rank test is based on ranking the differences in counts between sample types from the same whole chicken. They both test the hypothesis that each category of the variable has the same median count of the organism. The goodness-of-fit statistics and p-values were calculated using the *wilcox.test* procedure in the statistical package S-PLUS. Very small p-values indicate that the level of the organism is higher for one category.

Fisher's exact test is a test of homogeneity on a contingency table. This tested the hypothesis that each category of the variable for some subset has the same prevalence of listeria. The goodness-of-fit statistics and p-values were calculated using the *fisher.test* procedure in the statistical package S-PLUS. Very small p-values indicate that the prevalence is higher for one category.

McNemar's test is a test of symmetry of a table of some sample types A and B. It tests the hypothesis that the proportion of whole chickens with *Listeria* in type A but not type B is the same as for chickens with listeria in type B but not type A. The goodness-of-fit statistics and p-values were calculated using the *mcnemar.test* procedure in the statistical package S-PLUS. Very small p-values indicate that the prevalence of *Listeria* is higher for one category.

When two groups with the same level of an organism are compared, there is still a 5% chance that they will be found to 'significantly different' at a 5% significance level. Since twenty-four comparisons are made for each organism, it is likely that some 'significant differences' are spurious and have arisen at random. However, the differences at a 0.1% level of significance are much less likely to arise at random.

The problem of Company A.

One problem that arose from the data was that the samples from company A had much higher levels of each of the four organisms than the other companies' samples. For example, samples from company A have a median count of TVC a hundred times larger and a prevalence of *Listeria* spp. ten times greater than samples from other companies.

Some of the comparisons were between a group containing just non-Company A samples versus a mixed group containing Company A and non-Company A samples. If a “significant difference” is found for one of these comparisons, it could just indicate that there is a difference between Company A and non-Company A samples. A similar situation arises when the proportion of Company A samples is much greater in one group than another. Such spurious “significant” differences were not reported.

For comparisons of *Listeria*, suspected spurious “significant differences” were tested using the Mantel-Haenszel test. Like Fisher’s exact test, this is a test of homogeneity on a contingency table. It tests the hypothesis that each category of the variable for some subset has the same prevalence of listeria. However, it allows the prevalence of Company A samples to differ from non-Company A samples. The goodness-of-fit statistics and p-values were calculated using the *mantelhaen.test* procedure in the statistical package S-PLUS. Very small p-values indicate that the prevalence is higher for one category. Differences that were not significant for the Mantel-Haenszel were not reported.

8 REFERENCES

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