LACORS/HPA Co-ordinated Food Liaison Group Studies: Assessment of the Microbiological Safety of Selected Retail Ready-to-Eat Foods with a focus on *Listeria monocytogenes*.

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On behalf of the Local Authorities Co-ordinators of Regulatory Services and the Health Protection Agency

Summary

Although listeriosis is a rare cause of human disease in the UK, an increase in the number of cases has been observed since 2001 and notably in persons over 60 years old. This increase prompted this study on the microbiological safety of ready-to-eat foods which included those types potentially linked to cases of listeriosis.

Between May 2006 and April 2007, 6984 ready-to-eat foods were sampled (2168 sliced meats, 1088 sandwiches, 1242 hard cheese, 725 spreadable cheese, 878 butter, 368 probiotic drinks, 515 confectionery products containing fresh or synthetic/imitation cream). Of these, more confectionery products (2.6%), sandwiches (2.0%) and sliced meats (1.1%) were of unsatisfactory quality due to high levels of *Staphylococcus aureus, Escherichia coli, Listeria monocytogenes* and/or other *Listeria* spp. than other food types (0 - 0.2%).

The food types with the highest prevalence of *L. monocytogenes* were sandwiches (7.0%) and sliced meats (3.7% within shelf-life, 4.2% end of shelf-life). *Listeria monocytogenes* at >100 cfu/g (exceeding EC food safety criteria limit) only occurred in sandwiches (0.4%) and sliced meats (0.7% within shelf-life, 1.0% end of shelf-life).

Contamination with *L. monocytogenes* was more frequent in sandwiches that were pre-packed, had a main sandwich filling of ham, tuna or egg, and/or contained salad ingredients, and in meats that were sliced to order, and stored and/or displayed at >8°C. Acceptable microbiological quality was associated with premises where the management was trained in food hygiene and those that complied with HACCP principles.

This study provides important information about the microbiological safety of ready-to-eat foods and demonstrates that the control of *L. monocytogenes* in such foods, and in particular sandwiches and sliced meats, is essential in order to minimise the potential for this bacterium to be present at levels hazardous to health at the point of consumption. The results of this study will also assist retailers, enforcement officers and policy makers to understand how different food safety practices affect microbiological safety.

Introduction

Human listeriosis is a relatively rare but serious foodborne disease, with high morbidity and mortality in vulnerable populations (e.g. pregnant women and the unborn, newborns, the elderly, and the immunocompromised)[1-2]. It is among the most important causes of death from foodborne infections in industrialised countries[3]. Since 2000, an increase in the number of listeriosis cases in humans has been observed in several EU countries, including the UK, notably in persons over 60 years old[2-5]. Numerous strains of *L. monocytogenes* have contributed to this increase in cases in the UK[2,6]. A diverse range of ready-to-eat foodstuffs, such as cheeses, butter, meat products and sandwiches, have been implicated in recent reports of transmission of listeriosis[2,3,7].

Listeria spp. including *L. monocytogenes* is widely distributed in the environment and is therefore present in a variety of raw food materials. *Listeria monocytogenes* is resistant to diverse environmental conditions, able to grow at refrigeration temperatures and survive high salt concentrations. Its ability to colonise food processing environments is also well recognized[8]. European Commission (EC) Regulation 2073/2005 on microbiological criteria for foodstuffs provides limits for the levels of this bacterium in ready-to-eat food and came into force from January 2006[9]. The limit varies according to the type of consumer, characteristics of the food and information available on the food. Absence of *L. monocytogenes* in 25g is required in some foods, e.g. ready-to-eat foods intended for infants and those for special medical purposes. While for others, such as ready-to-eat foods which do not support growth of *L. monocytogenes* or for which shelf-life assessment has been carried out, the higher limit is 100 cfu/g[9]. Although levels of $\leq$100 cfu/g are considered to be of low risk for human disease in the normal population, the risk is likely to increase for vulnerable populations, e.g. the elderly, and those with poor immune status[3,10]. The EC Regulation on the hygiene of foodstuffs (Regulation (EC) No. 852/2004)[11] provides a risk-based approach to controlling food hygiene. The Regulation requires businesses to implement a written food safety management system based on HACCP principles, and to ensure food handlers are trained or instructed in good hygiene practices.

In 2008, the Scientific Panel on Biological Hazards (BIOHAZ) of the European Food Safety Authority (EFSA) recommended that efforts to reduce risks to human health should focus on risk reduction practices both during the production process of ready-to-eat foods and at home by consumers[3]. This report recommended the further investigation of listeriosis cases and the generation and analysis of data on ready-to-eat foods where *L. monocytogenes* is most commonly found so as to better assess the risk of foods associated with listeriosis[3].

Elderly people are particularly vulnerable to infection. However, the reasons for the increase in listeriosis in this population are not clear. In an attempt to try and understand the increase better, this study focused on the prevalence of *L. monocytogenes* in some ready-to-eat foods. The food types in the study included those that were potentially linked to cases through public health investigations of *L. monocytogenes* in the UK (i.e. sliced meat, sandwiches, cheese, butter)[2,6]. A range of retail ready-to-eat foods were therefore sampled based upon a 'shopping basket' approach[12,13] over one year. The shopping basket approach, in which a list of defined food types are collected for sampling, ensures that the range of food products is covered, with a better chance of finding foods of interest at each food premises visited[12,13]. In order to reflect the potential for deterioration in microbiological quality during shelf-life, pre-packaged sliced meats were tested both immediately after collection and at the end of their shelf life. In addition, information on food labelling instructions relating to storage and use was assessed for all food products.

Materials and Methods

Sample Collection

A total of 6984 food samples collected from retail premises were examined by 31 Official Control Laboratories in the UK between 1 May 2006 and 30 April 2007. This sample set was made up of 2168 sliced meats, 1088 sandwiches, 1242 hard cheese, 725 spreadable cheese, 878 butter, 368 probiotic drinks (i.e. therapeutic milks containing beneficial or 'probiotic' cultures such as lactobacilli and bifidobacteria) and 515 confectionery products containing fresh or synthetic/imitation cream. Registered retail premises lists held by Local Authority (LA) Environmental Health Departments were used to derive an approach to sampling. Retail premises were selected at random from LAs' database of food businesses via a random number generator or every 10th entry and, if suitable, samples were collected. All samples (≥100g) were collected and transported to laboratories by staff from 296 local Environmental Health Departments, involving 51 Local Authority Food Liaison Groups (Annex I), in accordance with the Food Standards Agency Food Law Code of Practice[14] and the Local Authorities Co-ordinators of Regulatory Services (LACORS) guidance on microbiological food sampling[15].

Information on samples was obtained by observation and enquiry and recorded on a standard questionnaire (Annex II). This included relevant information concerning the type of packaging, display/storage temperature and expiry dates. Sampling officers also provided basic information on the premises and its compliance with food hygiene legislation, including: the type of premises, food hygiene inspection category rating, consumers at risk,

confidence in management, level of food hygiene training and compliance with HACCP principles. The food hygiene category rating and information on consumers at risk and confidence in management and control systems (including the application of HACCP-based systems) were based on the risk assessment criteria detailed in the Food Hygiene Inspection Rating Scheme (Annex 5 of the Food Standards Agency Food Law Code of Practice[14]).

Sample Examination

Where duplicate pre-packed sliced meat samples were collected, one sample of the two was stored in a monitored laboratory refrigerator at 6±2°C until the end of shelf life (i.e. use-by date), whereupon the samples were examined. All *Listeria* spp. (including *L. monocytogenes*), *Staphylococcus aureus* and *Escherichia coli* were enumerated or their presence sought in accordance with HPA Standard Microbiological Methods for all food samples[16-19]. 147 isolates of *L. monocytogenes* were sent to the Food Safety Microbiology Laboratory (FSML), HPA Centre for Infections, for further characterisation. This included sero-typing and amplified fragment length polymorphism (AFLP) as described previously by Doumith *et al*.[20] and Guerra *et al*.[21]. Microbiological results were compared to Regulation (EC) 2073/2005 on microbiological criteria for foodstuffs[9] and Guidelines for the Microbiological Quality of Some Ready-to-eat Foods sampled at the Point of Sale (Table 1)[22].

Statistical Analysis

Descriptive and statistical analysis of the data was undertaken using Microsoft Excel and Epi Info version 6.04d. Relative proportions were compared using the Chi squared test (χ^2) and Fisher's exact test. A probability value of less than 5% was defined as significant.

Table 1. Microbiological criteria / guidelines for shopping basket of selected ready-to-eat foods: Key to classification

Food category	Micro-organism	Microbiological quality (cfu/g unless stated)			
		Satisfactory	Acceptable	Unsatisfactory	
Regulation (EC) No. 2073/2005: Food safety criteria[9]					
RTE[a] foods placed on the market during their shelf-life	*Listeria monocytogenes*	$\leq 10^2$	-	$>10^2$	
Regulation (EC) No. 2073/2005: Process hygiene criteria (point of production)[9]					
Butter made from unpasteurised milk	*Escherichia coli*	<10	10 - $<10^2$	$\geq 10^2$	
Cheese made from heat treated milk	*Escherichia coli*	$<10^2$	10^2 - $<10^3$	$\geq 10^3$	
Fresh cheese made from pasteurised milk	*Staphylococcus aureus*	<10	10 - $<10^2$	$\geq 10^2$	
Cheese made from thermised milk and ripened cheese made from pasteurised milk	*Staphylococcus aureus*	$<10^2$	10^2 - $<10^3$	$\geq 10^3$	
Cheese made from raw milk	*Staphylococcus aureus*	$<10^4$	10^4 - $<10^5$	$\geq 10^5$	
Guidelines: Microbiological quality at the point of sale[22]		**Satisfactory**	**Acceptable**	**Unsatisfactory**	**Unacceptable**
RTE[a] foods sampled at point of sale	*Listeria* spp. (Total)	<20	20 - $<10^2$	$\geq 10^2$	N/A
RTE[a] foods sampled at point of sale	*Escherichia coli*	<20	20 - $<10^2$	$\geq 10^2$	N/A
RTE[a] foods sampled at point of sale	*Staphylococcus aureus*	<20	20 - $<10^2$	10^2 - $<10^4$	$\geq 10^4$

a, RTE, Ready-to-eat; b, N/A, Not applicable.

Results

Listeria monocytogenes contamination of selected foods from retail premises

Overall *L. monocytogenes* was present above 100 cfu/g in 21 of 6984 (0.3%) samples. This level exceeds the food safety criteria in Regulation (EC) No. 2073/2005 for ready-to-eat foods placed on the market during their shelf-life and these samples are thus judged to be legally unsatisfactory[9]. The results were reported to the appropriate food authority, manufacturer and the Food Standards Agency and full investigations were undertaken.

A greater proportion of sandwiches contained *L. monocytogenes* (7.0%) compared to sliced meats within shelf-life (3.7%, p=0.0003) or at end of shelf-life (4.2%, p=0.0174), confectionery products (0.8%, p<0.0001), and hard cheese (0.2%, p<0.0001) (Table 2). *Listeria monocytogenes* was not detected in samples of spreadable cheese, butter, or probiotic drinks. However, a higher proportion of sliced meats contained *L. monocytogenes*

at >100 cfu/g (0.7% within shelf-life, 1.0% at end of shelf-life) compared to sandwiches (0.4%), hard cheese (0%), and confectionery products (0%) (Table 2).

Table 2. *Listeria monocytogenes* contamination of selected foods from retail premises

Product	No. samples	Detection in 25g				Enumeration cfu/g			
		Absence (%)		Presence* (%)		≤100 (%)		>100 (%)	
Sliced meats within shelf-life	**1484**	**1429**	**(96.3)**	**42**	**(2.8)**	**3**	**(0.2)**	**10**	**(0.7)**
Beef	218	210	(96.3)	5	(2.3)	1	(0.5)	2	(0.9)
Chicken	226	223	(98.7)	2	(0.9)	0		1	(0.4)
Ham	949	909	(95.8)	31	(3.3)	2	(0.2)	7	(0.7)
Tongue	91	87	(95.6)	4	(4.4)	0		0	
Sliced meats at end of shelf-life	**684**	**655**	**(95.8)**	**18**	**(2.6)**	**4**	**(0.6)**	**7**	**(1.0)**
Beef	88	84	(95.5)	3	(3.4)	0		1	(1.1)
Chicken	121	119	(98.3)	0		0		2	(1.7)
Ham	455	432	(94.9)	15	(3.3)	4	(0.9)	4	(0.9)
Tongue	20	20	(100.0)	0		0		0	
Sandwiches	**1088**	**1012**	**(93.0)**	**63**	**(5.8)**	**9**	**(0.8)**	**4**	**(0.4)**
Ham	285	265	(93.0)	17	(5.9)	2	(0.7)	1	(0.4)
Cheese	204	194	(95.1)	8	(3.9)	2	(1.0)	0	
Tuna	252	227	(90.1)	20	(7.9)	2	(0.8)	3	(1.2)
Egg mayo	347	326	(94.0)	18	(5.2)	3	(0.8)	0	
Hard cheese	**1242**	**1240**	**(99.8)**	**2**	**(0.2)**	**0**		**0**	
Cheddar	802	801	(99.8)	1	(0.2)	0		0	
Gloucester	108	107	(99.1)	1	(0.9)	0		0	
Lancashire	78	78	(100.0)	0		0		0	
Leicester	254	254	(100.0)	0		0		0	
Confectionery products with	**515**	**511**	**(99.2)**	**4**	**(0.8)**	**0**		**0**	
Fresh cream	392	388	(99.0)	4	(1.0)	0		0	
Synthetic cream	123	123	(100.0)	0		0		0	
Butter	**878**	**878**	**(100.0)**	**0**		**0**		**0**	
Spreadable cheese	**725**	**725**	**(100.0)**	**0**		**0**		**0**	
Probiotic drinks	**368**	**368**	**(100.0)**	**0**		**0**		**0**	

*Detected in 25g & <10 cfu/g

92 (62.6%) of the 147 *L. monocytogenes* isolates were serogroup 1/2a, 37 (21.1%) 4b, 21 (14.3%) 1/2b, and 3 (2.0%) 1/2c. Overall, 16 different *L. monocytogenes* subtypes were obtained with the 1/2a IX, 1/2a VII, 1/2b II, 4b I, 4b IV subtypes recovered from 74.8% of these (Table 3): 16 different subtypes were obtained from sandwiches, 9 from sliced meats, 2 from hard cheese, and 2 from confectionary products.

Table 3. Subtypes of *L. monocytogenes* isolated from sliced meats, sandwiches, hard cheese and confectionery products

Typing character (Serotype/AFLP*)	No. Samples (%)	Sliced meats (No. samples)	Sandwiches (No. samples)	Hard cheese (No. samples)	Confectionery products (No. samples)
1/2a I	1 (0.7)		1 (egg mayo)		
1/2a II	2 (1.4)		2 (ham salad)		
1/2a III	7 (4.7)	5 (ham)	2 (egg mayo (1), ham salad (1))		
1/2a VI	2 (1.4)		2 (tuna salad)		
1/2a VII	19 (12.9)	10 (beef (1), ham (9))	9 (cheese salad (1), egg mayo (4), ham (1), ham salad (2), tuna salad (1))		
1/2a IX	53 (36.1)	25 (beef (2), chicken (1), ham (21), tongue (1))	27 (cheese salad (3), egg mayo (8), ham salad (3), tuna salad (13))	1 (cheddar)	
1/2a XI	2 (1.4)		2 (egg mayo)		
1/2a XIV	5 (3.4)	3 (beef (1), ham (2))	2 (ham (1), ham salad (1))		
1/2a XVIII	1 (0.7)		1 (ham)		
1/2b II	16 (10.8)	9 (beef (2), chicken (3), ham (4))	4 (egg mayo (1), ham salad (1), tuna salad (2))		3 (dairy cream selection, chocolate éclair, vanilla slices)
1/2b IV	5 (3.4)	3 (ham)	1 (cheese salad)	1 (gloucester)	
1/2c VII	3 (2.0)	2 (ham)	1 (egg mayo)		
4b I	11 (7.5)	6 (ham (4), tongue (2))	4 (cheese salad (2), egg mayo (1), tuna salad (1))		1 (dairy cream selection)
4b IV	11 (7.5)	8 (beef (2), ham (6))	3 (cheese salad (1), ham (1), ham salad (1))		
4b V	7 (4.7)		7 (cheese salad (1), ham salad (3), tuna (1), tuna salad (2))		
4b IX	2 (1.4)		2 (ham)		
Total	147	71	70	2	4

*, Amplified fragment length polymorphism

Microbiological quality of sliced meats

Of the 1484 sliced meats sampled, 64% were ham, 15.2% chicken, 14.7% beef, and 6.1% tongue (Table 4). Overall 1.1% of sliced meats were of unsatisfactory microbiological quality due to high levels of *E. coli* (range of $1.0 \times 10^2 – 1.6 \times 10^3$ cfu/g), *S. aureus* (range of 1.6 – 2.0×10^2 cfu/g), *L. monocytogenes* (range of $1.2 \times 10^2 – 8.0 \times 10^5$ cfu/g), and other *Listeria* spp. (*L. innocua* and *L. welshimeri,* range of $3.3 \times 10^2 – 1.8 \times 10^3$ cfu/g). More sliced beef samples were of unsatisfactory quality (2.3%) than other meat types (0.4 – 1.1%) (Table 4). However, both *Listeria* spp. and *L. monocytogenes* were detected in fewer sliced chicken

samples (2.7% and 1.3%, respectively) compared to other meat types (6.6–9.2% *Listeria* spp. (p=0.0058); 3.7–4.4% *L. monocytogenes* (p=0.0357)) (Table 4).

Forty six percent (684/1484) of samples collected were duplicate pre-packed sliced meat samples, of which one sample of the two were examined at the end of shelf life (i.e. use-by date) (Table 4). There was no significant difference in the proportion of sliced meats of unsatisfactory microbiological quality at the end of shelf-life (1.4%) compared to those tested within shelf-life (1.1%) (p>0.05) (Table 4). Likewise, a similar proportion of samples at the end of shelf-life contained *Listeria* spp. and *L. monocytogenes* (7.0% and 4.3%, respectively) compared to those within shelf-life (6.6% and 3.7%, respectively) (Table 4).

Eighty percent of sliced meats sampled were not cooked on site (Table 4). There was no significant difference in the microbiological quality of sliced meats, nor to the presence of *Listeria* spp. and *L. monocytogenes*, in relation to whether the meat was cooked on or off the premises (Table 4) (p>0.05).

Eighty two percent of the sliced meats collected were pre-packed whilst the remainder (18%) were sliced to order (Table 4). More samples that were sliced to order contained *Listeria* spp. and *L. monocytogenes* (10.8% and 3.8%, respectively) compared to those that were pre-packed (5.8% (p=0.0043) and 3.0%, respectively) (Table 4). There was no significant difference in the proportion of sliced meats of unsatisfactory microbiological quality and whether samples were pre-packed or sliced to order (1.1-1.2%, p>0.05).

Of the pre-packed meat samples, 67.4% were modified atmosphere packed (MAP), 6.5% were vacuum packed (VP), 8.3% were packed in a normal atmosphere, and for 7.8% this information was not recorded (Table 4). Significantly more VP samples (3.0%) were of unsatisfactory microbiological quality compared with MAP (0.8%) or normal atmosphere packed samples (1.0%) (p=0.0254). However, a higher proportion of samples that were packed in a normal atmosphere contained *Listeria* spp. and *L. monocytogenes* (11.8% and 8.9%, respectively) compared to those that were either MAP packed (4.8% and 3.3%, respectively, p=0.0086) or VP packed (7.0% and 4.0%, respectively, p>0.05) (Table 4).

Ninety six percent of all sliced meat samples sold pre-packed were not packaged on the premises of sale (Table 4). Although the total numbers were low, more pre-packed samples packaged on the premises were of unsatisfactory microbiological quality (2.3%) than those samples packaged elsewhere (1.1%). The place of packaging was not significantly associated with contamination rates for *Listeria* spp. and *L. monocytogenes* (packaged on-site, 4.6% and 2.3%, respectively; packaged off-site, 5.8% and 3.9%, respectively) (p>0.05, Table 4).

Sixty seven percent of sliced meats had a pack size of 100 - <200g (Table 4). More samples of pack size ≥300g (2.6%) were of unsatisfactory microbiological quality compared with those of smaller pack sizes (0.8-1.5%). A significantly higher proportion of samples of

Table 4. Microbiological quality of different sliced meats

Sliced meat details	Total No. Samples n=1484 (%)		No. Samples Unsatisfactory n = 17 (%)		Samples with all *Listeria* spp. n = 99 (%)		Samples with *L. monocytogenes* n = 55 (%)	
Type								
Beef	218	(14.7)	5	(2.3)	20	(9.2)	8	(3.7)
Chicken	226	(15.2)	1	(0.4)	6	(2.7)	3	(1.3)
Ham	949	(63.9)	10	(1.1)	67	(7.1)	40	(4.2)
Tongue	91	(6.1)	1	(1.1)	6	(6.6)	4	(4.4)
Pre-packed & tested at end of shelf-life (n=684)								
Beef	88	(12.9)	1	(1.1)	7	(8.0)	4	(4.6)
Chicken	121	(17.7)	2	(1.6)	3	(2.5)	2	(1.6)
Ham	455	(66.5)	7	(1.5)	38	(8.4)	23	(5.1)
Tongue	20	(2.9)	0		0		0	
Cooked on site								
Yes	304	(20.5)	3	(1.0)	23	(7.6)	10	(3.3)
No	1180	(79.5)	14	(1.2)	76	(6.4)	45	(3.8)
Packaging								
Pre-packed	1216	(81.9)	14	(1.2)	70	(5.8)	47	(3.8)
Sliced to order	268	(18.1)	3	(1.1)	29	(10.8)	8	(3.0)
Pre-packed product (n=1216)								
Vacuum packed*	200	(16.5)	6	(3.0)	14	(7.0)	8	(4.0)
Modified atmosphere packed†	820	(67.4)	7	(0.8)	39	(4.8)	27	(3.3)
Normal atmosphere packed	101	(8.3)	1	(1.0)	12	(11.8)	9	(8.9)
Not recorded	95	(7.8)	0		5	(5.3)	3	(3.2)
Pre-packed product packed on site (n=1216)								
Yes	44	(3.6)	1	(2.3)	2	(4.6)	1	(2.3)
No	1172	(96.4)	13	(1.1)	68	(5.8)	46	(3.9)
Pack size:								
<100g	206	(13.9)	3	(1.5)	8	(3.9)	5	(2.4)
100 - <200g	991	(66.8)	10	(1.0)	64	(6.5)	34	(3.4)
200 - <300g	126	(8.5)	1	(0.8)	10	(7.9)	6	(4.8)
≥300g	78	(5.3)	2	(2.6)	11	(14.1)	9	(11.5)
Not recorded	83	(5.5)	1	(1.2)	6	(7.2)	1	(1.2)
Temperature stored/displayed								
≤ 5°C	684	(46.1)	12	(1.7)	63	(9.2)	32	(4.6)
> 5 - ≤ 8°C	680	(45.8)	4	(0.6)	25	(3.6)	17	(2.5)
> 8°C (range: 9–20°C)	65	(4.4)	1	(1.5)	8	(12.3)	5	(7.7)
Not recorded	55	(3.7)	0		3	(5.5)	1	(1.8)
Country of origin:								
Belgium	30	(2.0)	0		1	(3.3)	0	
Brazil	7	(0.5)	0		0		0	
Denmark	10	(0.7)	0		0		0	
Germany	14	(0.9)	0		0		0	
Italy	3	(0.2)	0		0		0	
Poland	2	(0.2)	0		0		0	
Republic of Ireland	23	(1.6)	0		3	(13.0)	1	(4.4)
South America	15	(1.0)	0		0		0	
UK	1088	(73.3)	13	(1.2)	72	(6.6)	43	(4.0)
Produce of EC	5	(0.3)	0		0		0	
Not known	287	(19.3)	4	(1.4)	23	(8.0)	11	(3.8)

* Vacuum packaging is essentially the evacuation of air from a package that is then hermetically sealed.
† Modified atmosphere packaging is the removal of air and replacement by a strictly controlled gaseous mixture comprising of carbon dioxide, oxygen and/or nitrogen.

pack size ≥300g contained *Listeria* spp. and *L. monocytogenes* (14.1% and 11.5%, respectively) compared to those of smaller pack sizes (3.9-7.9% *Listeria* spp. (p=0.0154);

2.4-4.8% *L. monocytogenes* (p=0.0022) (Table 4). Furthermore, the proportion of samples with *Listeria* spp. decreased as the pack size decreased (≥300g, 14.1%, 200 - <300g, 7.9%; 100 - <200g, 6.5%; <100g, 3.9% (chi-square trend p=0.0026) (Table 4).

In general storage temperatures for cooked meats should be as low as possible, i.e. ≤5°C. Higher temperatures (up to ≤8°C) may be used with an appropriate shelf-life[23,24]. At the time of sampling, the air temperature between the sliced meats on display or storage was ≤5°C for 46.1% of samples, and between >5 - ≤8°C for a further 45.8% of samples (Table 4). The display or storage temperature of the sliced meats on display had no significant effect on the microbiological quality of the meat with regard to samples of unsatisfactory microbiological quality (p>0.05) (Table 4). A higher proportion of samples that were displayed or stored at ≤5°C contained *Listeria* spp. and *L. monocytogenes* (9.2% and 4.6%, respectively) compared to those displayed/stored at >5°C to ≤8°C (3.6% and 2.5%, respectively) (p<0.0001) but not those at >8°C (12.3% and 7.7%, respectively) (p>0.05) (Table 4). *Listeria monocytogenes* at $>10^2$ cfu/g was present in 1.0% (7/684) of meat samples displayed/stored at ≤5°C.

It is illegal to sell food older than its use-by date. This date was recorded on the packaging for 94.2% (1146 of 1216) of the pre-packed sliced meat samples. Based on the use-by date, 17.4% (200 of 1146) of samples collected had remaining shelf lives ranging from 0 to 5 days, 35.2% (404) had 6 to 10 days, 46.7% (537) had 11 days or more, and 0.4% (5) had expired (4 by 1 day, 1 by 3 days) and therefore were not in compliance with the UK food labelling regulations of 1996. *L. monocytogenes* at >100 cfu/g was more likely to be found in sliced meats with a remaining shelf life of between 0 to 5 days (1.5%, 3/200) or 6 to 10 days (1.0%, 4/404) than in meats with more than 10 days left (0.4%, 2/537).

Seventy three percent of sliced meat samples were identified as being of United Kingdom origin; 7.4% of samples were identified as originating from another EU or non-EU country. The place of origin was not known for 19.3% of samples.

Microbiological quality of sandwiches

Of the 1088 sandwiches, 31.8% of samples contained egg mayonnaise as the main sandwich filling, 26.2% ham, 23.2% tuna, and 18.8% cheese (Table 5). Overall 2.0% of sandwiches were of unsatisfactory microbiological quality due to high levels of *E. coli* (range of $1.2 \times 10^2 - 6.9 \times 10^3$ cfu/g), *S. aureus* (range of $1.0 \times 10^2 - 1.8 \times 10^3$ cfu/g), *L. monocytogenes* (range of $2.2 \times 10^2 - 1.2 \times 10^3$ cfu/g), and other *Listeria* spp. (*L. innocua,* range of $3.7 \times 10^2 - 2.6 \times 10^4$ cfu/g ; *L. welshimeri,* range of $1.8 \times 10^2 - 1.7 \times 10^3$ cfu/g). More ham sandwiches were of unsatisfactory quality (3.5%) compared to other filling types (1.0 – 2.0%) (Table 5). Both *Listeria* spp. and *L. monocytogenes* was detected less

frequently in cheese sandwiches (9.8% and 4.9%, respectively) compared to other filling types (12.7–14.7% *Listeria* spp.; 6.1–9.9% *L. monocytogenes*) (Table 5).

Table 5. Microbiological quality of different sandwiches

Sandwich details	Total No. Samples n=1088 (%)		No. Samples Unsatisfactory n = 22 (%)		Samples with all *Listeria* spp. n = 139 (%)		Samples with *L. monocytogenes* n = 76 (%)	
Sandwich filling								
Ham	285	(26.2)	10	(3.5)	42	(14.7)	20	(7.0)
Cheese	204	(18.8)	2	(1.0)	20	(9.8)	10	(4.9)
Tuna	252	(23.2)	3	(1.2)	33	(13.1)	25	(9.9)
Egg mayonnaise	347	(31.8)	7	(2.0)	44	(12.7)	21	(6.1)
Sandwich filling with salad ingredients								
Yes	760	(69.9)	17	(2.2)	114	(15.0)	66	(8.9)
No	328	(30.1)	5	(1.5)	25	(7.6)	10	(3.1)
Packaging								
Pre-packed	888	(81.6)	17	(1.9)	128	(14.4)	72	(8.1)
Made to order	200	(18.4)	5	(2.5)	11	(5.5)	4	(2.0)
Pre-packed sandwiches, stored/displayed (n=888)								
≤ 5°C	520	(58.6)	7	(1.3)	80	(15.3)	48	(9.2)
>5 - ≤ 8°C	279	(31.4)	8	(2.8)	37	(13.2)	19	(6.8)
> 8°C (range: 9–24°C)	58	(6.5)	1	(1.7)	4	(8.6)	3	(5.1)
Not recorded	31	(3.5)	1	(3.2)	7	(22.6)	2	(6.4)

Seventy percent of sandwiches collected also contained salad ingredients (Table 5). The proportion of samples of unsatisfactory microbiological quality that contained salad was similar (2.2%) to those that did not (1.5%). However, significantly more sandwiches with salad ingredients contained *Listeria* spp. (15.0%) and *L. monocytogenes* (8.9%) compared with those without salad ingredients (7.6%, *Listeria* spp. (p=0.0007); 3.1% *L. monocytogenes* (p=0.0006)) (Table 5).

Eighty two percent of sandwiches collected were pre-packed whilst 18.4% were made to order (Table 5). There was no significant difference in the proportion of sandwiches of unsatisfactory microbiological quality and the packaging used (1.9-2.5%, p>0.05). However, a significantly higher proportion of samples that were pre-packed contained *Listeria* spp. and *L. monocytogenes* (14.4% and 8.1%, respectively) compared to those that were made to order (5.5% and 2.0%, respectively) (p=0.0004) (Table 5).

The British Sandwich Association recommends that sandwiches should be delivered and stored or retailed at 5°C and never higher than 8°C[25]. At the time of sampling, 58.6% of pre-packed sandwiches were displayed or stored at ≤5°C, and a further 31.4% at between >5 - ≤8°C (Table 5). The display or storage temperature of the pre-packed sandwiches on display or storage had no significant effect on the microbiological quality of the sandwiches with regard to samples of unsatisfactory microbiological quality (p>0.05) nor to the proportion of sandwiches that contained *Listeria* spp. and *L. monocytogenes* (p>0.05) (Table 5).

Thirty six percent (391/1088) of sandwiches that contained salad ingredients were pre-packed and stored or displayed at ≤5°C. Of these:

- 17.3% and 10.7% contained *Listeria* spp. and *L. monocytogenes* respectively, and
- 1.2% and 0.8% contained *Listeria* spp. and *L. monocytogenes* respectively at $>10^2$ cfu/g.

The use by date was recorded on the packaging for 83.0% (826 of 888) of the prepacked sandwich samples. Based on the use-by date, 92.4% (764 of 826) of samples collected had remaining shelf lives ranging from 0 to 2 days, 7.3% (60) had 3 to 4 days, and 0.3% (2) had expired (1 by 1 day and 1 by 2 days) and therefore were not in compliance with the UK food labelling regulations of 1996. *L. monocytogenes* was more likely to be found in sandwiches with a remaining shelf life of 2 days or less (7.5%, 57/764) than in sandwiches with more than 2 day lefts (16.7, 10/60) (p=0.0229). The four samples that contained *L. monocytogenes* at >100 cfu/g all had 2 days of shelf life remaining.

Microbiological quality of hard cheese

Most of the 1242 hard cheeses sampled were either cheddar (64.6%) or leicester (20.4%) varieties (Table 6). Overall 0.2% of hard cheese samples were of unsatisfactory microbiological quality due to high levels of *E. coli* (range of $2.4 \times 10^3 - 1.1 \times 10^4$ cfu/g). A small proportion of cheddar (0.3%) and leicester (1.3%) cheese samples were of unsatisfactory microbiological quality. Significantly, a higher proportion of lancashire cheese samples contained *Listeria* spp. (7.7%) compared with other hard cheese varieties (1.2-2.8%) (p=0.0143). *L. monocytogenes* was recovered from a 0.1% of cheddar and 0.9% of gloucester cheeses samples (Table 6).

Sixty one percent of hard cheese samples collected were made using pasteurised milk (Table 6). More cheese samples made from unpasteurised milk were of unsatisfactory microbiological quality (5.9%) and contained *Listeria* spp. (5.9%) compared to pasteurised milk cheeses (0.3% unsatisfactory quality; 2.4% *Listeria* spp.) (Table 6).

Ninety one percent of the hard cheeses collected were pre-packed and 55.7% had a pack size of between 200 and 300g (Table 6). Significantly, more samples that were cut to order (1.7%) were of unsatisfactory quality compared to those that were pre-packed (0.1%) (p=0.0248) (Table 5). *Listeria* spp. and *L. monocytogenes* were only detected in pre-packed cheeses (Table 6).

Eighty five percent of hard cheese samples were identified as being of United Kingdom origin; 1.4% of samples were identified as originating from another EU country. This place of origin was not known for 13.6% of samples.

Table 6. Microbiological quality of different hard cheeses

Hard cheese details	Total No. Samples n = 1242 (%)		No. Samples Unsatisfactory n = 3 (%)		Samples with all *Listeria* spp. n = 34 (%)		Samples with *L. monocytogenes* n = 2 (%)	
Type								
Cheddar	802	(64.6)	2	(0.3)	22	(2.7)	1	(0.1)
Gloucester	108	(8.7)	0		3	(2.8)	1	(0.9)
Lancashire	78	(6.3)	1	(1.3)	6	(7.7)	0	
Leicester	254	(20.4)	0		3	(1.2)	0	
Made from								
Pasteurised milk	758	(61.0)	2	(0.3)	18	(2.4)	2	(0.3)
Unpasteurised milk	17*	(1.4)	1†	(5.9)	1‡	(5.9)	0	
Not known	467	(37.6)	0		15	(3.2)	0	
Packaging								
Pre-packed	1125	(90.6)	1	(0.1)	34	(3.0)	2	(0.2)
Cut to order	117	(9.4)	2	(1.7)	0		0	
Pack size								
<100g	28	(2.3)	0		1	(3.6)	0	
100 - <200g	296	(23.8)	3	(1.0)	4	(1.4)	0	
200 - <300g	692	(55.7)	0		24	(3.5)	2	(0.3)
≥300g	160	(12.9)	0		3	(1.9)	0	
Not recorded	66	(5.3)	0		2	(3.0)	0	
Stored/kept								
≤ 8°C	1100	(88.6)	2	(0.2)	27	(2.5)	1	(0.1)
> 8°C (range: 9–29°C)	92	(7.4)	1	(1.1)	3	(3.3)	1	(1.1)
Not recorded	50	(4.0)	0		4	(8.0)	0	
Country of origin								
Belgium	2	(0.2)	0		0		0	
Canada	1	(0.1)	0		0		0	
Germany	6	(0.5)	0		0		0	
Netherlands	2	(0.2)	0		0		0	
Republic of Ireland	4	(0.3)	0		0		0	
UK	1057	(85.1)	2	(0.2)	30	(2.8)	2	(0.2)
Not known	170	(13.6)	1	(0.6)	4	(2.4)	0	

*Cheese types made from unpasteurised milk included: cheddar (15), lancashire (1), leicester (1)
† lancashire cheese, ‡ cheddar cheese

Eighty nine percent of cheese samples were stored or displayed at or below 8°C (Table 6). More cheese samples (1.1%) that were stored above 8ºC were of unsatisfactory microbiological quality compared to those stored below 8ºC (0.2%). Of cheese samples that were stored above 8ºC, 3.3% contained *Listeria* spp. and 1.1% *L. monocytogenes* which was similar to those stored below 8ºC (2.5% *Listeria* spp.; 0.1% *L. monocytogenes*).

Microbiological quality of butter

Eighty percent of all the 878 butter samples collected were salted, 10.2% were lightly salted and 7.4% were unsalted: for 2.4% of samples, this information was not known (Table 7). Overall, 0.2% of butter samples were of unsatisfactory microbiological quality due to high levels of *E. coli* (range of $3.5 \times 10^2 - 3.4 \times 10^4$ cfu/g). Only samples of unsalted butter were of unsatisfactory microbiological quality (3.1%, p=0.0057) or contained *Listeria* spp. (detected in 25g) (4.6%, p=0.0004) but not *L. monocytogenes* (Table 7).

Ninety seven percent of butter samples were made from pasteurised milk (Table 7). None of the seven samples made from unpasteurised milk were of unsatisfactory microbiological quality or contained *Listeria* spp. Only 0.2% of cheeses made from pasteurised milk were of unsatisfactory microbiological quality and 0.4% contained *Listeria* spp. (Table 7).

All samples were pre-packed and 90.0% were a pack size of between 200 and <300g (Table 7). Butter of unsatisfactory microbiological quality was only found in pack sizes 100 - <200g (4.6%) and 200 - <300g (0.1%). *Listeria* spp. was only found in pack sizes of 200 to 300g (Table 7). Most samples were stored or displayed at ≤8°C (89.9%) (Table 7). Butter samples of unsatisfactory quality (0.2%) were only found in butter stored or displayed at ≤8°C. *Listeria* spp. was also only found in butter stored or displayed at ≤8°C (0.4%) (Table 7).

Most butter samples were marked as from the UK (62.7%) or Denmark (17.5%) (Table 6), and 0.4% of these were of unsatisfactory quality. *Listeria* spp. was only recovered in samples of butter originating from the UK (0.6%) (Table 7).

Table 7. Microbiological quality of butter

Butter details	Total No. Samples n = 878 (%)		No. Samples Unsatisfactory n = 2 (%)		Samples with all *Listeria* spp.* n = 3 (%)	
Type						
Salted (1-2%)	703	(80.0)	0		0	
Lightly salted (<1%)	89	(10.2)	0		0	
Unsalted (0%)	65	(7.4)	2	(3.1)	3	(4.6)
Not known	21	(2.4)	0		0	
Made from						
Pasteurised milk	853	(97.1)	2	(0.2)	3	(0.4)
Unpasteurised milk	7	(0.8)	0		0	
Not known	18	(2.1)	0		0	
Pack size						
<100g	3	(0.3)	0		0	
100 - <200g	22	(2.5)	1	(4.6)	0	
200 - <300g	798	(90.9)	1	(0.1)	3	(0.4)
≥300g	17	(2.0)	0		0	
Not recorded	38	(4.3)	0		0	
Stored/kept						
≤ 8°C	789	(89.9)	2	(0.2)	3	(0.4)
> 8°C (range: 9–20°C)	52	(5.9)	0		0	
Not recorded	37	(4.2)	0		0	
Country of origin						
Channel Islands	3	(0.3)	0		0	
Denmark	154	(17.5)	0		0	
France	17	(1.9)	0		0	
Germany	16	(1.8)	0		0	
Lithuania	1	(0.1)	0		0	
New Zealand	63	(7.2)	0		0	
Poland	7	(0.8)	0		0	
Republic of Ireland	29	(3.3)	0		0	
UK	550	(62.7)	2	(0.4)	3	(0.6)
Not known	38	(4.3)	0		0	

Microbiological quality of spreadable cheese

Of the 725 pre-packed spreadable cheeses sampled, 74.8% were classified as cheese spread and 25.2% as cream cheese. Most (91.3%) were unflavoured (Table 8). Ninety one percent of the spreadable cheeses collected were of pack size 100-<200g (52.0%) or 200-<300g (36.3%), and 89.7% were stored or displayed at ≤8°C (Table 8).

Of the cheese spread samples, 0.2% were of unsatisfactory microbiological quality due to high levels of *E. coli* at 4.6 x 10^2 cfu/g. *Listeria* spp. was recovered from 0.4% of the cheese spreads and 0.6% of the cream cheese samples (Table 8).

The spreadable cheeses samples were produced in nine countries. The majority of samples were produced in Germany (24.1%), Belgium (21.1%), the UK (18.8%), or Denmark (13.3%) (Table 8). Of the samples of UK origin, 0.7% were of unsatisfactory microbiological quality. *Listeria* spp. was recovered from 2.3% and 1.1% of spreadable cheeses originating from the Republic of Ireland and Germany, respectively (Table 8).

Table 8. Microbiological quality of different spreadable cheeses

Spreadable cheese details	Total No. Samples n = 725 (%)		No. Samples Unsatisfactory n = 1 (%)		Samples with all *Listeria* spp. n = 3 (%)	
Type						
Cheese spread	542	(74.8)	1	(0.2)	2	(0.4)
Cream cheese	183	(25.2)	0		1	(0.6)
Flavour						
Unflavoured	662	(91.3)	1	(0.2)	3	(0.5)
Flavoured (chives, garlic, herbs, pepper)	63	(8.7)	0		0	
Pack size						
<100g	37	(5.1)	0		0	
100 - <200g	377	(52.0)	0		1	(0.3)
200 - <300g	263	(36.3)	0		1	(0.4)
≥300g	14	(1.9)	0		0	
Not recorded	34	(4.7)	1	(2.9)	1	(2.9)
Stored/kept:						
≤ 8°C	650	(89.7)	1	(0.2)	2	(0.3)
> 8°C (range: 9–20°C)	33	(4.6)	0		0	
Not recorded	42	(5.7)	0		1	(2.4)
Country of origin						
Belgium	153	(21.1)	0		0	
Denmark	97	(13.3)	0		0	
France	49	(6.8)	0		0	
Germany	175	(24.1)	0		2	(1.1)
Italy	2	(0.3)	0		0	
Poland	11	(1.5)	0		0	
Republic of Ireland	43	(6.0)	0		1	(2.3)
Spain	2	(0.3)	0		0	
UK	136	(18.8)	1	(0.7)	0	
Not known	57	(7.8)	0		0	

Microbiological quality of probiotic drinks

Of the 368 probiotic drinks sampled, 47.8% were unflavoured and 52.2% were flavoured. The majority of samples were of pack size 100-<200g (35.1%) or ≥300g (36.1%). Ninety percent (90.2%) were stored or displayed at ≤8°C (Table 9).

No samples were of unsatisfactory microbiological quality. *Listeria* spp. was recovered from 1.7% of the unflavoured and 0.5% of the flavoured drinks (Table 9).

Probiotic drinks collected were produced in nine countries. The majority were produced in the UK (22.3%), France (14.7%) or Belgium (12.0%) (Table 9). *Listeria* spp. was only recovered from 1.1% of probiotic drink samples. *Listeria* spp. was recovered in 5.0% of samples that originated from Poland, 4.6% from Belgium and 1.9% from France (Table 9).

Table 9. Microbiological quality of pre-packed probiotic drinks

Probiotic drinks details	Total No. Samples n = 368 (%)		Samples with all *Listeria* spp. n = 4 (%)	
Type				
Unflavoured	176	(47.8)	3	(1.7)
Flavoured (i.e. strawberry, raspberry, orange, mixed fruit)	192	(52.2)	1	(0.5)
Pack size				
<100g	46	(12.5)	0	
100 - <200g	129	(35.1)	1	(0.8)
200 - <300g	6	(1.6)	0	
≥300g	133	(36.1)	2	(1.5)
Not recorded	54	(14.7)	1	(1.8)
Stored/kept				
≤ 8°C	332	(90.2)	4	(1.2)
> 8°C (range: 9–19°C)	8	(2.2)	0	
Not recorded	28	(7.6)	0	
Country of origin				
Austria	20	(5.4)	0	
Belgium	44	(12.0)	2	(4.6)
France	54	(14.7)	1	(1.9)
Germany	16	(4.4)	0	
Netherlands	27	(7.3)	0	
Poland	20	(5.4)	1	(5.0)
Republic of Ireland	4	(1.1)	0	
Spain	6	(1.6)	0	
UK	82	(22.3)	0	
Not known	95	(25.8)	0	

Microbiological quality of confectionery products

Of all the 515 confectionery products sampled, 76.1% contained fresh cream and 23.9% synthetic or imitation cream (Table 10). Amongst those containing fresh cream, 2.6% were of unsatisfactory microbiological quality due to high levels of *E. coli* (range of $2.2 \times 10^2 – 7.0 \times 10^3$ cfu/g), *S. aureus* ($1.0 – 3.0 \times 10^2$ cfu/g), or *Listeria* spp. (*L. innocua* 1.7×10^3 cfu/g); this finding was not statistically significant ($p>0.05$). More samples of confectionery products

with fresh cream contained *Listeria* spp. (3.3%) than those with synthetic cream (0.8%). *L. monocytogenes* were only recovered from products with fresh cream (1.0%) (Table 10).

Of confectionery products collected, 61.7% were pre-packed whilst 38.3% were open (Table 10). Significantly more samples that were open were of unsatisfactory microbiological quality (4.6%) compared with those that were pre-packed (0.3%) (p=0.0010). A higher proportion of samples that were open contained *Listeria* spp. and *L. monocytogenes* (5.1% and 1.0%, respectively) compared to those that were pre-packed (1.3% and 0.6%, respectively). This finding was statistically significant for *Listeria* spp. (p=0.0124) but not for *L. monocytogenes* (Table 10).

Of all the confectionery products, 72.4% were stored or displayed at ≤8°C (Table 10), and amongst these, 2.4% were of unsatisfactory microbiological quality. More samples that were displayed or stored at ≤8°C contained *Listeria* spp. and *L. monocytogenes* (3.2% and 1.1%, respectively) compared to those displayed or stored at >8°C (1.0% and 0%, respectively) (Table 10).

Ninety seven percent of the confectionery products were produced in the UK (Table 10), and of these 1.8% were of unsatisfactory microbiological quality. *Listeria* spp. and *L. monocytogenes* was only recovered from confectionery products of UK origin (2.8% and 0.8%, respectively) (Table 10). However, it should be noted that the proportion of samples produced outside the UK and examined was small and that no statistical conclusions should be drawn from these results.

Table 10. Microbiological quality of confectionery products

Confectionery product details	Total No. Samples n = 515 (%)	No. Samples Unsatisfactory n = 10 (%)	Samples with all *Listeria* spp. n = 14 (%)	Samples with *L. monocytogenes* n = 4 (%)
Containing				
Fresh cream	392 (76.1)	10 (2.6)	13 (3.3)	4 (1.0)
Synthetic/imitation cream	123 (23.9)	0	1 (0.8)	0
Packaging				
Pre-packed	318 (61.7)	1 (0.3)	4 (1.3)	2 (0.6)
Open	197 (38.3)	9 (4.6)	10 (5.1)	2 (1.0)
Stored/kept:				
≤ 8°C	373 (72.4)	9 (2.4)	12 (3.2)	4 (1.1)
> 8°C (range: 10–26°C)	104 (20.2)	0	1 (1.0)	0
Not recorded	38 (7.4)	1 (2.6)	1 (2.6)	0
Country of origin				
Denmark	2 (0.4)	0	0	0
Germany	2 (0.4)	0	0	0
Republic of Ireland	1 (0.2)	0	0	0
UK	499 (96.9)	9 (1.8)	14 (2.8)	4 (0.8)
Not known	11 (2.1)	1 (9.1)	0	0

Microbiological quality of selected foods from retail premises in relation to product labelling, storage information, shelf-life and durability dates

Amongst all the 5558 pre-packed foods sampled, 43.4% had no instructions on the packaging/label relating to shelf-life after opening (e.g. consume within 3 days), whilst 39.8% did. This information was not recorded for 16.8% of samples. Most foods sampled (87.0%) had storage temperature information present on the packaging or label. Of these, 64.8% advised to keep the product refrigerated with 22.2% specifying a refrigeration temperature (Table 11). Where a particular storage temperature was provided on the packaging for 1234 samples, 79.0% specified a temperature between 0 and ≤5°C and 30.0% between >5 and ≤8°C (Table 11). Samples that had no storage temperature information (1.7%) or instructions to store at a particular temperature (1.2%) were more likely to be of unsatisfactory microbiological quality compared to those that instructed to 'keep refrigerated' (0.3%) ($p<0.0001$) (Table 11). However, more samples that gave specific a storage temperature of ≤5°C contained *Listeria* spp. and *L. monocytogenes* (8.0% and 5.0%, respectively) compared to those that specified to 'keep refrigerated' or provided no information (*Listeria* spp. 3.0-6.1% ($p=<0.0001$, $p=0.0465$), *L. monocytogenes* 1.1-3.8% ($p=<0.0001$, $p=0.0460$)) (Table 11).

Table 11. Microbiological quality of pre-packed foods from retail premises in relation to product labelling, storage information, shelf-life and durability dates

	Total No. Samples n = 5558 (%)		No. Samples Unsatisfactory n = 36 (%)		Samples with all *Listeria* spp. n = 246 (%)		Samples with *L. monocytogenes* n = 123 (%)	
Storage temperature information on packaging/label								
Keep refrigerated	3603	(64.8)	11	(0.3)	108	(3.0)	39	(1.1)
Particular temperature given	1234	(22.2)	15	(1.2)	96	(7.8)	60	(4.8)
0 - ≤5°C	975	(79.0)	15	(1.5)	78	(8.0)	49	(5.0)
>5 - ≤8°C	259	(30.0)	0		18	(6.9)	11	(4.2)
No temperature indicated	519	(9.3)	9	(1.7)	32	(6.1)	20	(3.8)
Not recorded	202	(3.7)	1	(0.5)	10	(4.9)	4	(2.0)
Storage, shelf-life, durability date details								
Easily visible & clearly legible								
Yes	5120	(92.1)	29	(0.6)	228	(4.4)	115	(2.2)
No	278	(5.0)	5	(1.7)	8	(2.9)	4	(1.4)
Not recorded	160	(2.9)	2	(1.3)	10	(6.3)	4	(2.5)
In black type on white background								
Yes	3450	(62.1)	19	(0.6)	162	(4.7)	74	(2.1)
No	1708	(30.7)	11	(0.6)	61	(3.6)	38	(2.2)
Not recorded	400	(7.2)	6	(1.5)	23	(5.6)	11	(2.3)
Font size of type/print								
10 point	2468	(44.4)	12	(0.5)	101	(4.1)	55	(2.2)
8 point	1033	(18.6)	7	(0.7)	46	(4.5)	26	(2.5)
Other (6,12,14,16,18 point)	1456	(26.2)	7	(0.5)	71	(4.9)	27	(1.8)
Not recorded	601	(10.8)	10	(1.7)	28	(4.6)	15	(2.5)

The storage, shelf-life information and durability dates were easily visible and clearly legible as judged by the sampling officer for 92.1% of all the samples collected (Table 11). A significantly lower proportion of samples where these details were easily visible or legible were of unsatisfactory microbiological quality (0.6%) as compared to those where it was not (1.7%; p=0.0285) (Table 11). For 62.1% of the samples, the storage, shelf-life information and durability dates were printed or written in black type on a white background, with 44.4% having a 10 point font size (Table 11). In 2.6% of the packages this information was printed in yellow and white, and in 2.9% using 6 point font size, which is a format that is difficult to read (as shown here).

There was no significant difference in the proportion of samples of unsatisfactory microbiological quality and the colour of print type and background used (0.6%) or the font size used (0.5-0.7%) (p>0.05). There was also no significant difference in the proportion of samples that had *Listeria* spp. and *L. monocytogenes* present and storage, shelf-life and durability marking details (Table 11) (p>0.05).

Microbiological quality of selected foods in relation to premises details

Amongst all of the samples, 64% were collected from supermarkets, and 21.1% from convenience shops. The remaining 15.0% of samples were collected from bakeries (3.5%), delicatessens (3.2%), butchers (2.2%), farm shops/markets (1.9%), sandwich bars (1.7%), market stalls (0.2%) and other premises (2.3%) (Table 12).

Food businesses are categorised from A to E in accordance with risk assessment criteria of the Food Hygiene Inspection Rating Scheme (Annex 5 of the FSA Food Law Code of Practice[14]). Premises in Category A receive the highest minimum inspection frequency. Category ratings are based findings at inspection, and take into account the type of food and method of handling, compliance with food hygiene legislation, and confidence in management and control systems. Over half (54.0%) of samples were collected from premises categorised as Category C in the Food Hygiene Inspection Rating Scheme (Table 12). Significantly, more samples of unsatisfactory microbiological quality were collected from Category A premises (13.0%) than premises in other categories (0.4-1.1%) (p=0.0011). A significantly higher proportion of samples containing *Listeria* spp. and *L. monocytogenes* were from Category A premises (17.3% and 8.7%, respectively) than premises in other categories (4.2-6.6% Listeria spp. (p<0.0001); 2.0-2.6% *L.monocytogenes* (p=0.0183)) (Table 12).

As part of the Food Hygiene Inspection Rating Scheme, businesses receive a 'Consumer at Risk' score based on the number of consumers likely to be at risk if there is a failure of food hygiene and procedures[14]. This score ranges from 0 to 15, with a score of 0 indicating very few consumers at risk. Eighty seven percent of samples were obtained from

Table 12. Microbiological quality of selected foods collected from retail premises

Premises details	Total No. Samples n= 6299 (%)		No. Samples Unsatisfactory n = 55 (%)		Samples with all *Listeria* spp. n = 296 (%)		Samples with *L. monocytogenes* n = 137 (%)	
Premises Type								
Bakery	217	(3.5)	12	(5.5)	18	(8.3)	8	(3.7)
Butcher	140	(2.2)	3	(2.1)	17	(12.1)	6	(4.2)
Convenience shop	1331	(21.1)	15	(1.1)	92	(6.9)	55	(4.1)
Delicatessen	201	(3.2)	4	(1.9)	5	(2.5)	1	(0.5)
Farm shop/market	119	(1.9)	4	(3.3)	7	(5.8)	2	(1.7)
Market shop/stall	15	(0.2)	0		0		0	
Sandwich bar	106	(1.7)	3	(2.8)	12	(11.3)	6	(5.7)
Supermarket delicatessen	203	(3.2)	0		6	(3.0)	2	(1.0)
Supermarket pre-packed	3820	(60.7)	13	(0.3)	134	(3.5)	55	(1.4)
Other (Service station, cash & carry, greengrocer, village shop)	147	(2.3)	1	(0.7)	5	(3.4)	2	(1.4)
Inspection Rating Category								
Category Minimum Frequency of Inspection								
A At least every 6 months	23	(0.4)	3	(13.0)	4	(17.3)	2	(8.7)
B At least every 12 months	499	(7.9)	3	(0.6)	33	(6.6)	13	(2.6)
C At least every 18 months	3403	(54.0)	39	(1.1)	152	(4.5)	69	(2.0)
D At least every 2 years	1141	(18.1)	4	(0.4)	61	(5.4)	29	(2.5)
E Alternative enforcement strategy	707	(11.2)	4	(0.6)	30	(4.2)	17	(2.4)
Not recorded	526	(8.4)	2	(0.4)	16	(3.0)	7	(1.3)
Consumers at Risk Score								
0 (Very few)	121	(1.9)	0		7	(5.6)	5	(4.1)
5 (Few)	4368	(69.3)	49	(1.1)	227	(5.2)	110	(2.5)
10 (Intermediate)	1099	(17.5)	2	(0.2)	35	(3.2)	12	(1.1)
15 (Substantial)	41	(0.7)	0		1	(2.4)	1	(2.4)
Not recorded	670	(10.6)	4	(0.6)	26	(3.9)	9	(1.3)
Confidence in Management Score								
0 (High)	443	(7.0)	1	(0.2)	15	(3.3)	8	(1.8)
5 (Moderate)	2173	(34.5)	12	(0.6)	78	(3.6)	23	(1.1)
10 (Some)	2398	(38.1)	30	(1.3)	132	(5.5)	68	(2.8)
20 (Little)	549	(8.7)	8	(1.5)	42	(7.6)	27	(4.9)
30 (None)	30	(0.5)	0		3	(10.0)	2	(6.7)
Not recorded	706	(11.2)	4	(0.6)	26	(3.7)	9	(1.3)
Compliant with principles of HACCP† (EC No. 852/2004, Article 5)								
Yes	4434	(70.4)	35	(0.8)	189	(4.3)	40	(0.9)
No	926	(14.7)	13	(1.4)	61	(6.6)	74	(7.9)
Not recorded	939	(14.9)	7	(0.8)	46	(4.9)	23	(2.4)
Manager Food Hygiene Training								
Received training & attended	4735	(75.1)	40	(0.8)	204	(4.3)	89	(1.9)
- Foundation	3031	(64.0)	34	(1.1)	147	(4.9)	72	(2.4)
- Intermediate	882	(18.6)	4	(0.5)	29	(3.3)	11	(1.3)
- Advanced	195	(4.1)	1	(0.5)	10	(5.1)	1	(0.5)
- Other course (Company training, MLC HACCP, C&G)	333	(7.0)	1	(0.3)	12	(3.6)	3	(0.9)
- Not recorded	294	(6.3)	0		6	(2.0)	2	(0.7)
No training	697	(11.1)	8	(1.1)	51	(7.3)	33	(4.7)
Not recorded	867	(13.8)	7	(0.8)	41	(4.7)	15	(1.7)

†, Hazard Analysis and Critical Control Points

premises with a Consumer at Risk score of 5 (69.3%) or 10 (17.5%) (Table 12). A significantly greater proportion of samples collected from premises with a Consumer at Risk score of 5 (1.1%) were of unsatisfactory microbiological quality as compared to those from

premises with higher Consumer at Risk scores (0.2%, intermediate to substantial numbers) (p=0.0014) (Table 12). A higher proportion of samples contained *Listeria* spp. and *L. monocytogenes* were recovered from premises with Consumer at Risk score of 0 to 5 (5.2% and 2.7%, respectively) compared to those with scores of 10-15 (3.4% and 1.2%, respectively) (p<0.0024) (Table 12). Furthermore, the proportion of samples with *Listeria* spp. decreased as the Consumer at Risk score increased (0 (very few consumers at risk), 5.6%; 5 (few), 5.2%; 10 (intermediate), 3.2%; 15 (substantial), 2.4%) (chi-square trend p=0.0046) (Table 12).

In accordance with the Food Hygiene Inspection Rating Scheme, businesses are allocated a score of 0 to 30 based on Confidence in Management/Control Systems, with 0 indicating a high level of high confidence[14]. Seventy three percent of samples were collected from premises that had a Confidence in Management[14] score 5 (34.5%, moderate confidence in management/control systems) and 10 (38.1%, some confidence in management/control systems) (Table 12). The proportion of unsatisfactory samples was significantly higher from premises where there was no, little or some confidence in management (1.3%) compared to premises where there was moderate or high confidence in management (0.5%) (p=0.0027) (Table 12). A significantly higher proportion of samples from premises where there was no, little or some confidence in management contained *Listeria* spp. and *L. monocytogenes* (5.8% and 3.3%, respectively) compared to premises where there was moderate or high confidence in management (3.6% and 1.1%, respectively) (p<0.0001) (Table 12). Furthermore, the proportion of samples with *Listeria* spp. decreased as confidence in management increased (0 (high confidence), 3.3%; 5 (moderate), 3.6%; 10 (some), 5.5%; 20 (little), 7.6%, 30 (none), 10.0%) (Chi-square trend p<0.0001) (Table 12).

Seventy percent of samples collected were from premises that, in view of the sampling officer, complied with HACCP requirements as provided in Article 5 of Regulation (EC) No. 852/2004[10] (Table 12). Samples collected from premises that did not comply with this requirement were more likely to be of unsatisfactory microbiological quality (1.4%) than those collected from premises that did (0.8%) (Table 12). A significantly higher proportion of samples collected from premises that did not comply with the HACCP requirements contained *Listeria* spp. and *L. monocytogenes* (6.6% and 4.3%, respectively) compared to those that did (4.3% and 1.7%, respectively) (p=0.0035) (Table 12).

Seventy five percent of samples were collected from premises whose managers had received food hygiene training (Table 12). Samples collected from premises with managers that had not received food hygiene training were more likely to be of unsatisfactory microbiological quality (1.1%) than those with managers who had received training in food hygiene (0.8%) (Table 12). Significantly, a higher proportion of samples collected from premises with managers that had not received food hygiene training contained *Listeria* spp.

and *L. monocytogenes* (7.3% and 4.7%, respectively) than those with managers with training in food hygiene (4.3% and 1.9%, respectively) (p=0.0010) (Table 12).

Discussion

This study has shown that overall the vast majority (99.1%) of selected ready-to-eat foods on retail sale in the UK were of satisfactory or acceptable microbiological quality according to criteria in Regulation (EC) No. 2073/2005 (as amended)[9] and published microbiological guidelines[22]. Of the foods examined, a higher proportion of confectionery products (2.6%), sandwiches (2.0%) and sliced meats (1.1%) were of unsatisfactory quality due to high levels of *S. aureus, E. coli, L. monocytogenes* and/or other *Listeria* spp. than hard cheese (0.2%), butter (0.2%), spreadable cheese (0.2%) and probiotic drinks (0%). High *E. coli*, *S. aureus* and *Listeria* levels may indicate problems with production hygiene, and/or that the temperature of these foods in storage or on display was inadequate to prevent bacterial growth.

The prevalence of *L. monocytogenes* observed in sandwiches (7.0%) and sliced meats (3.7% within shelf-life, 4.2% end of shelf-life) was higher than that found in all other ready-to-eat foods examined (0 – 0.8%). Furthermore, *L. monocytogenes* at >100 cfu/g (food safety criteria limit)[8] only occurred in sandwiches (0.4%) and sliced meats (0.7% within shelf-life, 1.0% end of shelf-life). Full investigations of these incidents were undertaken by the appropriate food authorities, manufacturers and the UK Food Standards Agency. In Wales during 2005 to 2006, retail sandwiches were found to have a similar prevalence of *L. monocytogenes* (5.2%) and exceeded 100 cfu/g in 0.3% of sandwiches[26]. Previously in 1996 Wilson[27] reported *L. monocytogenes* present at >100 cfu/g in 0.7% of retail sandwiches in Northern Ireland whereas in Ireland in 2002, 11% of retail sandwiches contained *L. monocytogenes,* and 0.3% at >100 cfu/g[28]. Sandwiches supplied to hospitals and residential or care homes in the UK during 2005-2006 were also found to have a similar rate of contamination of *L. monocytogenes* (7.5%) to that reported in the present study[29]. While *L. monocytogenes* is the species of concern, the presence of any *Listeria* spp. in food is an indication of poor hygiene conditions and possible *L. monocytogenes* contamination. Significant risk factors identified with the presence of *Listeria* spp. and *L. monocytogenes* in sandwiches sampled in the present study were if: pre-packed; contained ham, tuna or egg mayonnaise as the main sandwich filling; and/or contained salad ingredients. A range of food types have been associated with transmission of listeriosis, these food types have also included sandwiches[2,3]. The microbiological quality of ingredients incorporated in to sandwiches is, therefore, of importance as is for all ready-to-eat products. The British Sandwich Association recommends a target level of <10 cfu/g of *L. monocytogenes* in sandwiches at production, and that the presence of any *Listeria* spp. in a product be

investigated as it could indicate a failure in procurement, preparation and/or storage of food materials[24].

The prevalence of *L. monocytogenes* observed in cold-sliced meats in the UK in the present study (3.7%) was lower than that found in Belgium (7.5%)[30], Denmark (5%)[31], Norway (11%)[32] but higher than that reported in the US (3.5%)[33] and previously in the UK (2.0%)[34]. The prevalence of *L. monocytogenes* found in cold-sliced meats at the end of shelf-life in the current study (4.2%; 1.0% >100 cfu/g) concurred with that found previously in sliced meats examined at the end of shelf-life during 2003 in the UK (4.8%; 0.9% >100 cfu/g)[35]. This study has also highlighted contributory factors likely to cause problems with retail sliced meats. Sliced meats were more frequently contaminated with both *Listeria* spp. and *L. monocytogenes* when they were from premises that sliced meats to order, sold in large pack sizes, and stored or displayed above 8°C. Continuous efforts should be made to improve food safety of sliced meats by adequate cooking and appropriate hygienic measures to avoid contamination, and through use of appropriate refrigeration temperatures and shelf-life to prevent growth of *L. monocytogenes* in these products. Storage of chilled foods such as meats must comply with Regulation (EC) No 852/2004 on the hygiene of foodstuffs[11], i.e. should not be kept at temperatures that might result in a risk to health.

Management food hygiene training and the presence of hazard analysis systems in food premises has been shown to make a significant contribution to an improvement in the microbiological quality of ready-to-eat foods[36]. This is corroborated by the results from this study. The implementation of a hazard analysis system or similar food safety management plans in food premises provides a pragmatic framework for good hygiene practice. Compliance with the principles of HACCP and associated relevant supervision and instruction and/or food hygiene training for all employees is a legal requirement[11]. Evidence from this study also highlights smaller retail premises (as indicated by Consumer at Risk scores), and premises with poor Confidence in Management scores, as an area for concern with regard to microbiological quality of ready-to-eat food (including presence of *L. monocytogenes*) and food safety risks.

Several European countries, including the UK, are experiencing an increased incidence of listeriosis among persons in their 'golden years' (≥60 years of age)[3-6]. The serogroups most often causing human infection in the UK are serogroups 4b and 1/2a, with the subtype 4b AFLP I being most common in England and Wales[6,37]. A preliminary case/case study of human *L. monocytogenes* subtypes in relation to food exposure history from 2005 to 2007 in England and Wales found that those infected with serotype 1/2a were more likely to report the consumption of tongue, chicken pies, various fish, cheese, sandwiches and salads, and those infected with 4b with consumption of cold cooked beef and sandwiches containing hard cheese[6]. The same study further revealed associations

between exposures of *L. monocytogenes* sero-AFLP types, to pork or dairy products (4b I), fish and dairy products (1/2a IX), and sliced meats (ham, chicken turkey), cheese, and sandwiches (1/2a VII)[6]. The predominant serogroup of *L. monocytogenes* recovered in this study from sliced meats (ham, beef, chicken, tongue) and sandwich (egg, ham, tuna, cheese with & without salad) isolates in the present study was serotype 1/2a (63%), with AFLP subtypes IX and VII prevalent. However, 21% of meat and sandwich food isolates were serotype 4b, with AFLP subtypes I and IV most common. The predominant serogroup recovered from all food isolates in the UK from 2005 to 2007 was also serogroup 1/2a (52%), of which 80% were AFLP IX (60%) or VII (20%) (HPA unpublished information*).*

Consumers are believed to benefit from clear recommendations on good food hygiene practice (i.e. at what temperature to keep food chilled at all times), and from being encouraged to take careful note of the shelf-life of food in their refrigerators[3]. Packaging/labelling safety based guidance on the proper storage and handling of refrigerated ready-to-eat foods should therefore help to reduce the risk of listeriosis. A small proportion of ready-to-eat foods in this study had this information present in a format that many consumers would have difficulty in reading and should be avoided, i.e. using 6 point font size (shown here for example). Labelling design should continue to make every effort on legibility and clarity, particularly as there is a growing elderly population where there will be more people with sub-optimal vision[38]. This is being currently considered as part of an EU food labelling review[38].

Dietary recommendations about when to avoid certain foods and educational messages about food preparation are also important. Advice from the Food Standards Agency to pregnant women in the UK warns against consumption of pâté, soft mould-ripened cheeses such as camembert and brie, and blue veined cheeses, and to cook raw meat thoroughly[39]. Dietary advice on the avoidance of high-risk foods should also be provided routinely to other susceptible groups, such as the elderly population. An ACMSF Group[40] is currently considering this issue and is to provide recommendations to the Food Standards Agency on whether current advice needs to be amended.

Listeriosis is predominantly transmitted by the consumption of contaminated ready-to-eat foods[3], therefore effective responses are essential to control this pathogen in the food chain. Significant progress has been made in recognising foods which present a risk of *L. monocytogenes* infection*,* and in developing strategies and processes that can minimise these risks. Current EC microbiological criteria indicate that levels of *L. monocytogenes* at $\leq$100 cfu/g in ready-to-eat foods within shelf-life are legally satisfactory[9]. This study highlights that further emphasis must be given in the reduction of *L. monocytogenes* in high-risk foods, such as sliced meats and sandwiches, which are consumed without any further treatment.

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Annex I: Participating Laboratories and Local Authority Food Liaison Groups and number of samples

Table 1a. Participating HPA and HPA Collaborating Laboratories and number of samples

HPA Region	HPA/HPA Collaborating Laboratory	Number of samples
East	Chelmsford	377
	Norwich	188
East Midlands	Leicester	86
	Lincoln	316
London	London FWEM[1]	176
South East	Ashford	344
	Brighton	379
	WEMS[2]	1094
North East and	Leeds	111
Yorkshire and the	Newcastle	451
Humber	Hull	285
	Sheffield	241
North West	Carlisle	64
	Chester	230
	Preston	993
South West	Bristol	244
	Exeter	275
	Gloucester	254
	Plymouth	40
	Truro	89
West Midlands	Birmingham	149
	Coventry	37
	Shrewsbury	169
	Hereford	93
Total		**6685**

1, London Food, Water & Environmental Microbiology Services Laboratory
2, Wessex Environmental Microbiology Services

Table 1b. Other participating Official Food Control Laboratories in Wales, Scotland, Northern Ireland & England and number of samples examined.

Country	Laboratory	Number of samples
Wales	NPHS-W Microbiology Cardiff	48
	NPHS-W Microbiology Rhyl	37
Ireland	Belfast City Hospital	72
Scotland	Aberdeen City Council Public Analysts	45
	Edinburgh Analytical and Scientific Services	46
	Glasgow Scientific Services	48
England	Kings Lynn & West Norfolk	2
	Total	**298**

Table III: Participating Food Safety Liaison Groups and number of samples

Local Authority Food Liaison Group	Number of Samples
Berkshire	156
Buckinghamshire	15
Cambridgeshire	125
Cheshire	115
Cornwall	89
Cumbria	110
Derbyshire	185
Devon	206
Dorset	27
Durham	149
East Sussex	113
Essex	227
Gloucester	254
LFCG[1] Greater London NE Sector	12
LFCG Greater London NW Sector	30
LFCG Greater London SE Sector	9
LFCG Greater London SW Sector	45
Greater Manchester	421
Hampshire & Isle Of Wight	541
Hereford & Worcester	135
Hertfordshire & Bedfordshire	73
Humberside	285
Kent	594
Lancashire	525
Leicestershire	86
Lincolnshire	143
Merseyside	104
North Yorkshire	105
Northamptonshire	26
Northern Ireland Food Group[2]	72
Norfolk	148
Nottinghamshire	124
Northumberland	38
Oxfordshire	218
Scottish Food Enforcement Liaison Committee[3]	141
Shropshire	78
Somerset	108
South West Yorkshire	198
Staffordshire	1
Suffolk	66
Surrey	189
Tees Valley	115
Tyne & Wear	61
Wales South East Group	49
Wales North Group	47
Wales West Group	35
Warwickshire	1
West Midlands	173
West of England	115
West Sussex	207
Wiltshire	145
Total	**6983**

1, London Food Co-ordinating Group; 2, Northern Ireland Food Group consists of Eastern, Northern, Southern & Western Groups; 3, SFELG consists of Central Scotland, Fife & Tayside, Lothian & Scottish Borders, North Scotland, and West of Scotland

Annex II Sampling Questionnaire

Annex 5

STUDY 28: LACORS/HPA CO-ORDINATED FOOD LIASION GROUP STUDY: PROFORMA

Focused Shopping Basket Sampling of selected foods from retail premises with a focus on *Listeria monocytogenes* and *Listeria* spp.

Add Laboratory Name & Address

Local Authority Sample Reference Number(s).....

Laboratory Sample Number(s).....

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LABORATORY NAME.....

Local Authority Sampling details:

1. Local Authority.....
2. Food Liaison group .....
3. Samples collected by..... (EHO/EHT/ Sampling Officer)
4. Sample collected at..... (time) on (date) ...../...../.....
5. LA Premises Reference Number.....
6. LA Sample Reference Number(s).....

Premises details:

7. Name of premises.....
8. Address..... Postcode.....
9. Type of premises — Supermarket pre-packed ☐ | Supermarket delicatessen ☐ | Sandwich bar ☐ | Continental market ☐ | Delicatessen ☐ | Butcher ☐ | Convenience shop ☐ | Other ☐ (Specify)..... | Market stall/shop ☐ | Bakery ☐ | Farmer's Market ☐
10 (A) Inspection Rating Category (A - E): ..... (B) Consumers at risk score (0 - 15): .....
(c) Confidence in Management/Control Systems Score (0 - 30).....
11 (A). Does the premises comply with the principles of HACCP (Article 5 of EC 852/2004)? YES ☐ NO ☐
11 (B). Has the manager undertaken food hygiene training? YES ☐ NO ☐; **If YES**, what level? Foundation ☐ Intermediate ☐ Advanced ☐ Other ☐(specify).....

12. Sample details:

A. Sliced Meat * ☐	& Specify type:	Ham ☐	Chicken ☐	Beef ☐	Tongue ☐	
**** For Prepacked sliced meat samples only : Please take duplicate samples of the same batch for testing within and at end of shelf-life***						
B. Sandwiches ☐	& Specify type:	Ham ☐	Cheese ☐	Tuna ☐	Egg mayo ☐	
& does the sandwich contain salad or a salad component i.e. tomato, lettuce, cucumber? YES ☐ NO ☐						
C. Hard Cheese ☐	& Specify type:	Cheddar ☐	Gloucester ☐	Lancashire ☐	Leicester ☐	
& is the cheese made from: Unpasteurised milk ☐ or Pasteurised milk ☐						
D. Spreadable cheese ☐	& Specify type:	Cheese spread ☐		Cream cheese ☐		
	& is it:	Plain ☐	Or Flavoured	☐(specify flavour).....		
E. Butter ☐	& Specify type:	Salted (1-2%) ☐	Lightly salted (<1%) ☐	Unsalted (0%) ☐	Unknown ☐	
& is the butter made from: Unpasteurised milk ☐ or Pasteurised milk ☐						
F. Probiotic drinks ☐	& Specify type:	Plain ☐	or Flavoured	☐(specify flavour).....		
G. Confectionery Product ☐	containing	Fresh Cream ☐	Or Synthetic/ imitation cream ☐			

13. Is the product cooked on site: YES ☐ NO ☐ Not Applicable ☐
14. Is the product: Prepacked ☐ **Go to Q 15** or Cut/ Made to order ☐ **Go to Q 17**
15. Is the product: Vacuum packed ☐ Modified atmosphere packed ☐ or Packed in normal atmosphere ☐
16. Is the product packed on the premises: YES ☐ NO☐
17. What is the pack size: <100g ☐ 100-<200g ☐ 200- <300g ☐ ≥300g ☐(specify).....
18. Was the product displayed/stored at: Equal/below 8°C ☐ & Specify temperature.....°C
or above 8°C ☐ & Specify temperature.....°C

Labelling and Storage, Shelf-life and data marking details:

19. Specify Product Name **exactly** as it appears on the label/container:.....
20. Brand/ Producer (specify):..... Not applicable ☐
21. What is the storage temperature information on the packaging? Keep refrigerated ☐ | Particular temperature given ☐ & specify.....°C | No temperature indicated ☐
22. What are the shelf-life instructions on the packaging on opening? Consume within 3 days ☐ | Particular period given ☐ & specify..... | None ☐
23. Product Date (specify): Best before Date..../...../..... Use By Date. ..../...../..... Display Date...../...../..... Not Known ☐
24. Is the storage, shelf life, date marking information: Easily visible & clearly legible YES ☐ NO ☐
In black type on a white background YES ☐ NO ☐ **If NO** Specify the colour of the type & Background .....
25. What is the font size of the type/print used for this information: **10 point** ☐ 8 point ☐ Other ☐ specify .....
26. Is the product labelled as organic? YES ☐ NO ☐ 27. What is the country of origin?.....
28. Is there a batch code? YES ☐ NO ☐; **If YES** please specify code.....
29. Is there an EU approval number? YES ☐ NO ☐; **If YES** please specify code.....

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Laboratory details:

Sample(s) received in laboratory..... (time) on (date) ...../. ...../.....
Sample(s) received by.....
Sample(s) received from.....
Temperature on receipt .....°C
Within the cool box is a temperature monitoring device used e.g. data logger : YES ☐ NO ☐
Sample(s) examined. ..... (time) on (date) ...../...../ .....

RESULTS

Recording results

Please record the results of count/g tests as **ACTUAL NUMBERS** in the appropriate box within the table. Only place ticks in the column headed (<10/<20), i.e. the limit of detection for that test, and columns headed ND and Detected.

TABLE 1. Samples Tested on Receipt at Laboratory

Laboratory Sample No.....

	ND	Detected	<10/<20	20-<10^2	10^2-<10^3	10^3-<10^4	10^4-<10^5	10^5-<10^6	10^6-<10^7	≥10^7
E.coli /g										
Staphylococcus aureus /g										
Listeria spp. (total) / 25g or g										
L.monocytogenes/ 25g or g										

Microbiological Quality: Satisfactory ☐ Acceptable ☐ Unsatisfactory ☐ Unacceptable/Potentially hazardous ☐

TABLE 2. Sliced Meat Samples Tested at the End of Shelf-life

Storage temperature

Were the samples stored in a 6±2°C incubator? YES ☐ NO ☐

If NO please record the temperature of the monitored sample refrigerator that samples were stored in:.....°C

Laboratory Sample No.....

	ND	Detected	<10/<20	20-<10^2	10^2-<10^3	10^3-<10^4	10^4-<10^5	10^5-<10^6	10^6-<10^7	≥10^7
E.coli /g										
Staphylococcus aureus /g										
Listeria spp. (total) / 25g or g										
L.monocytogenes/ 25g or g										

Microbiological Quality: Satisfactory ☐ Acceptable ☐ Unsatisfactory ☐ Unacceptable/Potentially hazardous ☐

Date *L. monocytogenes* isolates sent to the Food Safety Microbiology Laboratory, HPA Centre for Infections.....
Date *S.aureus* isolates sent to the Food Safety Microbiology Laboratory, HPA Centre for Infections.....

MICROBIOLOGISTS COMMENTS.....
.....

Further Report:
Identification and type: .....
.....
Signature ..... Date reported .....

WHERE POSSIBLE THE LABORATORY SHOULD MAKE AND RETAIN A PHOTOCOPY OF THE PRODUCT LABEL FOR FUTURE REFERENCE

Methods as defined in LACORS/HPA Shopping Basket Study (Study 28); Annex 6

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