

1st Quarter National Microbiological Survey 2005 (05NS1):

Microbiological quality/safety of loose cooked sliced ham

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Executive Summary

This study investigated the microbiological quality/safety of 923 samples of loose cooked sliced ham. Samples were obtained from retail premises and were sliced on the premises either at the time of sampling or before sampling.

Microbiological quality was assessed by analysing for Aerobic Colony Count (ACC) and *Enterobacteriaceae*; while microbiological safety was assessed by analysing for *Salmonella* spp., *Staphylococcus aureus* and *Listeria monocytogenes*. This study follows a national survey (January-March 2003) on the microbiological quality/safety of ham sliced and pre-packed in processing plants (these samples were also obtained from retail premises).

The following are the main findings:

Microbiological quality:

- 24.6% (225/916) of samples were unsatisfactory for ACC while 2.4% (22/923) were unsatisfactory for *Enterobacteriaceae*. The ACC results differed significantly to the results from the survey on the *Microbiological quality/safety of ham sliced and pre-packed in processing plants*. Significantly more samples sliced in retail premises were unsatisfactory for ACC.
- Microbiological quality was affected by the time of slicing. The quality of ham sliced in the retail premises at the time of sampling was significantly better ($p < 0.05$) than the quality of ham sliced in the retail premises prior to sampling.
- Microbiological quality was not affected by sample source (e.g. supermarket, delicatessen etc) or location of cooking.

Microbiological safety:

- All samples tested were satisfactory for *L. monocytogenes* (n=919) and *Salmonella* spp. (n=923). In relation to *S. aureus*, 99.1% (915/923) of samples were satisfactory while 0.6% (5/923) and 0.3% (3/923) of samples were classified as acceptable and unsatisfactory respectively.

Temperature Control:

- 97.7% (606/620) of samples were stored in refrigerated conditions; however, the core temperature of these samples ranged from -0.5°C to 13.7°C (refrigerated food should be maintained at $\leq 5^{\circ}\text{C}$). Of particular concern is the finding that the core temperature of 30.5% (185/606) of these 'refrigerated' samples was $> 5^{\circ}\text{C}$. Temperature control is essential to prevent microbial growth and proliferation. Retailers should be aware of these storage temperatures and should place more emphasis on temperature control.

1. Introduction

Cooked sliced ham is a popular convenient ready-to-eat (RTE) food. This product can be sliced at the point of sale (i.e. sliced in the retail premises) or sliced and pre-packed in a processing plant.

The microbiological status of cooked sliced ham is influenced by a number of parameters including the status of the raw meat, the efficacy of the cooking process and the level of post process control (e.g. the manufacturing/processing environment, the slicing operation, the food handler etc.). In terms of microbiological safety; *Salmonella* spp., *Listeria monocytogenes* and *Staphylococcus aureus* are pathogens which have been associated with commercially prepared processed foods including ham. Their presence in RTE foods raises concern as they are not eliminated from the food prior to consumption.

Salmonella spp. are one of the most common causes of bacterial food poisoning. They reside in the intestinal tract of infected animals and humans and are shed in the faeces. Foods subject to faecal contamination (e.g. agricultural products, meat) are among those which have been implicated as vehicles in the transmission of this pathogen to humans ⁽¹⁾. Salmonellosis (i.e. the disease caused by *Salmonella enterica*) is principally a food borne disease, although other possible routes of transmission include contact with infected animals or their faecal material, person to person spread and nosocomial infection. Salmonellosis is a notifiable disease and in 2003 there were 449 notifications of this disease in Ireland (crude incidence rate of 11.5 cases per 100,000 population) ⁽²⁾ and 418 cases (provisional data) were reported in 2004 ⁽³⁾.

L. monocytogenes is a pathogen which has been detected in many commercially prepared processed foods including ham ^(4,5). Although raw materials, equipment and personnel have been identified as potential sources of contamination ⁽⁶⁻¹⁰⁾; the environment has been identified as the primary source of post process contamination in commercially prepared processed foods ^(11,12). The presence of this pathogen in RTE foods raises concern as it is capable of proliferating under refrigerated conditions (i.e. the typical storage conditions for high risk RTE foods such as cooked ham). Levels of *L. monocytogenes* >100cfu/g at the point of consumption is considered to represent a risk to consumers ⁽¹³⁾ (i.e. it can cause listeriosis[‡] in susceptible members of the population). Incidence of listeriosis has been recorded in Ireland since 2004 (this disease was made notifiable by an amendment to the Infectious Disease Regulations 2003 ⁽¹⁴⁾). Nine cases of listeriosis were reported in 2004 (provisional data) ⁽³⁾.

S. aureus is an ubiquitous organism, occurring in the skin and mucous membrane of most warm blooded animals, including food animals and humans. It occurs naturally in a variety of foods including raw meats. In addition, food handlers are commonly implicated in the transmission of this pathogen to food. Staphylococcal food poisoning is caused by ingestion of a toxin formed by *S. aureus* in the food. *S. aureus* must grow to levels of >10⁵ cells/g before producing sufficient quantities of the heat-stable staphylococcal toxin

[‡] Listeriosis is the disease caused by *L. monocytogenes*.

to cause illness ⁽¹⁵⁾. Incidence of staphylococcal food poisoning has also been recorded in Ireland since 2004 and four cases (provisional data) were reported in that year ⁽³⁾.

This survey investigated the microbiological quality/safety of cooked ham sliced at the point of sale (i.e. sliced in the retail premises). The microbiological quality of the samples was assessed by analysing for Aerobic Colony Count (ACC) and *Enterobacteriaceae*. ACC is an indicator of hygiene and freshness, while *Enterobacteriaceae* is an indicator of hygiene and post process contamination of heat processed foods. These give an indication of the likelihood of the presence of pathogens as well as providing information on the handling and storage of the foodstuff. The microbiological safety of the samples was assessed by analysing for *Salmonella* spp., *L. monocytogenes* and *S. aureus*.

This study follows a national microbiological survey (January-March 2003) on the bacteriological safety/quality of ham sliced and pre-packed in processing plants ⁽¹⁶⁾.

2. Specific Objectives

The specific objective of this survey was to assess the microbiological quality and safety of loose cooked sliced ham on retail sale in the Republic of Ireland.

3. Methods

3.1 Sample source:

Samples were obtained from retail premises e.g. butcher shops, delicatessens, corner shops and supermarkets. Only cooked ham which was sliced on the premises was sampled. Slicing may have occurred at either:

- i) the time of sampling (i.e. the ham was sliced to order) or
- ii) prior to sampling (i.e. this ham would have been stored/displayed prior to purchase by the customer).

Sampling was carried out during the 4 month period January-April 2005.

3.2 Sample description:

All types of cooked ham (e.g. boiled, baked, honey roast etc) were sampled provided they were sliced on the retail premises.

The following were specifically excluded:

- Pre-packed cooked sliced ham or ham sliced anywhere other than on retail premises.
- Cooked ham sliced on catering premises (e.g. sliced for carvery).
- Fermented meats such as pepperoni, salami, chorizo, serrano ham, parma ham, Jambon De Bayonne.
- Uncooked smoked and cured hams.

3.3 Sample size

Samples were a minimum of 150g.

3.4 Sampling procedure

1. Generally from each premises, only one sample of each type of ham was submitted per manufacturer.
2. The core temperature of the cooked ham was measured at the time of sampling using an insertion probe and the temperature was recorded on the questionnaire provided.

For ham sliced at the time of sampling, the core temperature of the bulk meat was measured prior to slicing.

For ham sliced prior to sampling the core temperature of the sliced ham was measured.

The sample was obtained in a manner similar to that which would be used to serve customers.

3. Environmental Health Officers (EHOs) completed the relevant questions on the questionnaire at the time of sampling (the questionnaire is outlined in Appendix 1).

4. All samples were stored and transported to one of the seven Official Food Microbiology Laboratories (OFML – details outlined in Appendix 2) under normal conditions (i.e. in a cool box).

3.5 Type of analysis

Samples were analysed for the parameters outlined in Table 1:

Table 1: Type of analysis

	Microbiological parameter
Microbiological quality	Aerobic Colony Count (ACC)
	<i>Enterobacteriaceae</i>
Microbiological safety	<i>Listeria monocytogenes</i>
	<i>Salmonella</i> spp.
	<i>Staphylococcus aureus</i>

3.6 Reporting of Results

Laboratory reports were forwarded to both the relevant EHO and the Food Safety Authority of Ireland (FSAI).

3.7 Analysis of Results

According to the 2001 Irish microbiological guidelines ‘Guidelines for the Interpretation of Results of Microbiological Analysis of Some Ready-To-Eat Foods Sampled at Point of Sale’ (FSAI Guidance Note No.3⁽¹⁷⁾), the following guidelines apply to cooked sliced ham (category D):

Table 2: Guidelines for the assessment of the microbiological quality/safety of cooked sliced ham

Type of parameter	Parameter	Microbiological safety/quality (cfu/g)			
		Satisfactory	Acceptable	Unsatisfactory	Unacceptable/ Potentially hazardous
Indicator	ACC	<10 ⁶	10 ⁶ -<10 ⁷	≥10 ⁷	N/A
	<i>Enterobacteriaceae</i>	<100	100-<10 ⁴	≥10 ⁴	N/A
Pathogen	<i>L. monocytogenes</i> (Quantitative)	<20	20-<100	N/A	≥100
	<i>Salmonella</i> spp.	Not detected in 25g	N/A	N/A	Detected in 25g
	<i>Staphylococcus aureus</i>	<20	20-<100	100-<10 ⁴	≥10 ⁴

N/A: Not Applicable

Upon receipt of the OFML reports, the EHO determined the microbiological status of the samples and completed the relevant section on the questionnaire. EHOs were requested to return all completed questionnaires to the FSAI within one month of the survey completion date.

4. Results and Discussion

4.1 Microbiological Quality (ACC & *Enterobacteriaceae*)

4.1.1 Microbiological Results

The microbiological quality of the samples is presented in Table 3. Almost a quarter (24.6%) of samples were classified as unsatisfactory for ACC, while 2.4% were classified as unsatisfactory for *Enterobacteriaceae*. The microbiological quality of samples from each Health Service Executive (HSE) region is presented in Appendix 3.

Table 3: Microbiological quality of cooked ham sliced at the time of sampling

Parameter	Microbiological Quality			Total
	No. of samples satisfactory (%)	No. of samples acceptable (%)	No. of samples unsatisfactory (%)	
ACC	528 (57.6%)	163 (17.8%)	225 (24.6%)*	916
<i>Enterobacteriaceae</i>	745 (80.7%)	156 (16.9%)	22 (2.4%)*	923

* 15 samples were unsatisfactory for both ACC and *Enterobacteriaceae*

The incidence of ACC at unsatisfactory levels (i.e. $\geq 10^7$ cfu/g) is higher than that reported in a UK study ⁽¹⁹⁾; while the incidence of *Enterobacteriaceae* at unsatisfactory levels (i.e. $\geq 10^4$ cfu/g) is lower than that reported in both a Greek ⁽¹⁸⁾ and a UK study ⁽¹⁹⁾ (Table 4).

Table 4: Microbiological quality of cooked ham – A comparison with other studies

Location of study	Year of study	ACC (>10 ⁷ cfu/g)	<i>Enterobacteriaceae</i> (>10 ⁴ cfu/g)
This study	2005	24.6% (225/916)	2.4% (22/923)
Greece ^{(18)†}	2000	38% (27/71) *	2.8% (2/71)
UK ^{(19)▲}	2002	16% (464/2890)	7.6% (219/2890)

▲ 88% of these samples were sliced on the premises while 10% were sliced elsewhere. Information regarding slicing was not available for 2% of samples.

† All samples were sliced at the time of sampling

* This is the % of samples with an ACC count > 10⁶cfu/g (the number of samples with an ACC count >10⁷ was not provided)

While this study investigated the microbiological safety/quality of loose cooked ham sliced in retail premises, an Irish survey undertaken in 2003 investigated the microbiological quality/safety of cooked ham which was sliced and pre-packed in manufacturing premises ⁽¹⁶⁾. A comparison of both surveys (Table 5) revealed that the

location of slicing did not effect ($p=0.05$) the *Enterobacteriaceae* results; however it had a significant effect ($p<0.05$) on the ACC results (almost a quarter of all samples sliced in retail premises were unsatisfactory for ACC compared to 13% of samples sliced in manufacturing premises). This differs to the finding of a UK study ⁽¹⁹⁾ where the microbiological quality of meat sliced in retail premises was significantly better ($p<0.0001$) than meat sliced elsewhere.

Table 5: Microbiological quality of loose cooked ham sliced in retail premises Vs. pre-packed ham sliced in manufacturing premises

Survey date	Location of slicing	Type of packaging	% of samples unsatisfactory for <i>Enterobacteriaceae</i> (no. of samples)	% of samples unsatisfactory for ACC (no. of samples)
This study	retail premises	Loose	2.4% (22/923)	24.6% (225/916)
2003 ⁽¹⁶⁾	manufacturing premises	Pre-packed	4% (24/615)	13% (79/618)

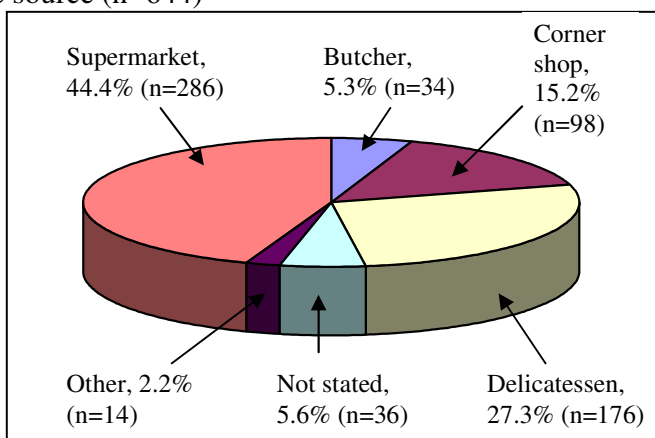
4.1.2 Relationship between questionnaire data and microbiological quality

Information on a variety of parameters such as sample source, location of cooking, time of slicing etc. was captured by means of a questionnaire (Appendix 1). Questionnaires were returned for 644 samples, i.e. there was a 69.7% (644/923) response rate. This section of the report investigates the impact (if any) of these parameters on the microbiological quality of the samples based on their ACC results (the impact of these parameters on the *Enterobacteriaceae* results was not investigated as only 2.4% of samples were unsatisfactory for this group of organisms).

A) Sample source

The majority of samples were obtained from 4 types of premises: supermarkets, delicatessens, corner shops and butcher shops. Almost half the samples (44.4%) were obtained from supermarkets. For 7.8% of samples, the premises type was not available (i.e. it was recorded as 'other' or was not stated). (Fig 1).

Fig 1: Sample source (n=644)



The microbiological quality of samples obtained from each type of premises is outlined in Table 6. Sample source had no significant effect ($p=0.05$) on the microbiological quality of the samples.

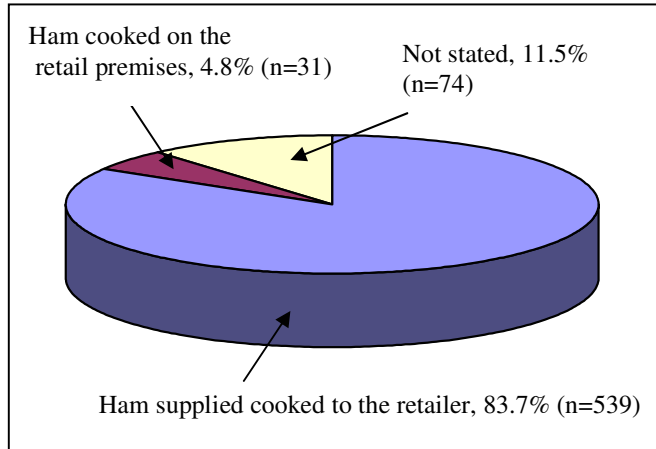
Table 6: Microbiological quality of samples based on sample source (n=603)

Type of premises	No. of samples	No. (%) of samples with the following microbiological quality		
		Satisfactory	Acceptable	Unsatisfactory
Supermarket	282	158 (56%)	43 (15.2%)	81 (28.7%)
Delicatessen	176	104 (59.1%)	32 (18.2%)	40 (22.7%)
Corner shop	98	58 (59.2%)	14 (14.3%)	26 (26.5%)
Butcher shop	33	14 (42.4%)	8 (24.2%)	11 (33.4%)
Other	14	7 (50%)	1 (7.1%)	6 (42.9%)

B) Location of cooking

83.7% of ham was supplied cooked to the retailer, while 4.8% was cooked on site by the retailer. Information regarding cooking was not provided for 11.5% of samples (Fig 2).

Fig 2: Location of cooking (n=644)



The microbiological quality of ham based on the location of cooking (i.e. cooked on the retail premises or cooked elsewhere) is outlined in Table 7. The location of cooking had no significant effect ($p=0.05$) on the microbiological quality of the ham (this could be related to the low sample numbers for ham cooked on the premises). This contrasts with the findings of a UK study ⁽¹⁹⁾, where the microbiological quality of meat cooked on the retail premises was found to be significantly better ($p<0.001$) than meat cooked elsewhere.

Table 7: Microbiological quality of samples based on location of cooking (n=566)

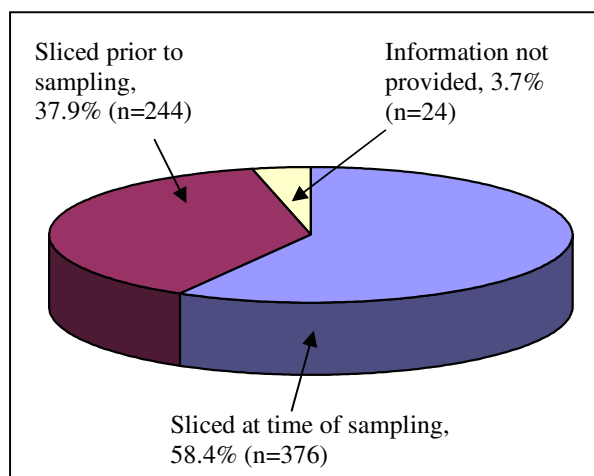
Location of cooking	No. of samples	No. (%) of samples with the following microbiological quality		
		Satisfactory	Acceptable	Unsatisfactory
Ham cooked on the retail premises	29	20 (69.0%)	6 (20.7%)	3 (10.3%)
Ham cooked elsewhere*	537	299 (55.7%)	94 (17.5%)	144 (26.8%)

* This ham was supplied cooked to the retailer

C) Time of slicing

The majority (58.4%) of meat samples were sliced at the time of sampling; while 37.9% were pre-sliced (i.e. the ham was sliced and stored in the retail premises prior to sampling). Information regarding slicing was not provided for 3.7% of samples (Fig 3).

Fig. 3: Slicing information (n=644)



The microbiological quality of the ham samples based on the time of slicing is outlined in Table 8. The microbiological quality of ham sliced at the time of sampling was significantly better ($p < 0.05$) than the quality of ham which was pre-sliced.

Table 8: Microbiological quality of samples based on the time of slicing (n=614)

Time of slicing	No. of samples	No. (%) of samples with the following microbiological quality		
		Satisfactory	Acceptable	Unsatisfactory
Sliced at the time of sampling	370	220 (59.5%)	68 (18.4%)	82 (22.1%)
Pre-sliced *	244	126 (51.6%)	34 (14.0%)	84 (34.4%)

*Pre-sliced: Sliced and stored in the retail premises prior to sampling

Slicing is a process which is carried out post-cooking and which poses a microbiological risk because of the potential for contamination via the slicing blade and handling. Subsequently, poor process control (e.g. poor temperature control during storage) can result in proliferation of the microbial cells to unsatisfactory levels. While this may explain the high incidence of unsatisfactory pre-sliced samples, this was not confirmed as i) the contamination source and ii) the level of process control (e.g. storage conditions from the time of slicing to sampling) were not investigated. However, in this study a

snapshot of i) the storage conditions and ii) the core temperature of the ham at the time of sampling were obtained.

D) Storage condition and core temperature of samples at the time of sampling

The storage conditions and core temperature of the cooked ham samples at the time of sampling are presented in Table 9.

Table 9: Storage conditions and core temperature of samples at time of sampling (n=620)

Time of slicing	No. of samples	Storage condition at time of sampling		Core temperature of samples			
				Temperature range (°C)	No. of samples with the following core temperature		
		Condition	No. samples		≤5°C	>5°C	N/S
Pre-sliced (i.e. sliced and stored in the retail premises prior to sampling) [†]	244	Refrigerated	239	0.04 - 13	175	54	10
		Other	2	5.4 - 7.7	0	2	0
		Not stated	3	1.4 - 3	3	0	0
Sliced at the time of sampling*	376	Refrigerated	367	-0.5 – 13.7	233	131	3
		Other	7	8.9 - 15	0	7	0
		Not stated	2	6.5 - 10.5	0	2	0

[†] The storage conditions and the core temperature of the sliced ham were recorded

* The storage conditions and the core temperature of the bulk ham (i.e. the full ham prior to slicing) were recorded

N/S: Not Stated

Although 97.7% (606/620) of samples were stored in refrigerated conditions; the core temperature of these samples ranged from -0.5°C to 13.7°C. Of particular concern is the finding that the core temperature of 30.5% (185/606) of these ‘refrigerated’ samples was >5°C. This contravenes recommendations that refrigerated food should be maintained at ≤5°C.

4.2 Microbiological Safety (*Listeria monocytogenes*, *Salmonella* spp & *Staphylococcus aureus*)

The microbiological safety of the cooked ham samples are outlined in Table 10.

All samples tested were satisfactory for *L. monocytogenes* (n=919) and *Salmonella* spp. (n=923). In relation to *S. aureus*, 99.1% (915/923) of samples were satisfactory while 0.6% (5/923) and 0.3% (3/923) were classified as acceptable and unsatisfactory respectively. Microbiological counts of 110, 280 and 520 cfu/g were reported for the 3 unsatisfactory samples (*S. aureus* counts of $>10^5$ cfu/g are required before producing sufficient quantities of the heat labile toxin to cause illness).

The microbiological safety of samples from each HSE region is outlined in Appendix 4.

Table 10: Microbiological safety of loose cooked ham

Pathogen	No. of samples	Satisfactory	Acceptable	Unsatisfactory	Unacceptable /Potentially Hazardous
<i>Listeria monocytogenes</i>	919 [†]	919 (100%)	0 (0%)	N/A	0 (0%)
<i>Salmonella</i> spp.	923	923 (100%)	N/A	N/A	0 (0%)
<i>Staphylococcus aureus</i>	923	915 (99.1%)	5 (0.6%)	3 (0.3%) [⊗]	0 (0%)

N/A: Not Applicable

[†] A total of 923 samples were tested; however because of the reporting mechanism used 4 samples could not be classified according to the *L. monocytogenes* guidelines. The results of these 4 samples were reported as follows: *Listeria* spp. = 30cfu/g (HSEWR); *L. welshimeri* = 30cfu/g (HSESR); *L. welshimeri* = 20cfu/g (HSESR) and *Listeria* spp. = 560cfu/g (HSEDMLR).

[⊗] *S. aureus* counts of 110 cfu/g, 280 cfu/g and 520 cfu/g

The findings are comparable to the findings of the national survey conducted in 2003 on the microbiological safety/quality of cooked ham sliced and pre-packed in manufacturing premises ⁽¹⁶⁾. In that survey all samples (n=615) were classified as satisfactory for *L. monocytogenes* (samples were not tested for *Salmonella* spp. or *S. aureus*).

In addition, the findings of this study are comparable if not better than the findings of other international studies (Table 11).

Table 11: Microbiological safety of cooked ham – A comparison with other studies

Pathogen	Greek study⁽¹⁸⁾	UK study⁽¹⁹⁾	Irish study (this study)
<i>Listeria monocytogenes</i> % (no.) of samples with counts >100 cfu/g *	N/S [†]	0.03% (1/2874)	0% (n=919)
<i>Salmonella</i> spp % (no.) of samples in which <i>Salmonella</i> spp. was detected in 25g [^]	N/T	0% (n=2887)	0% (n=923)
<i>Staphylococcus aureus</i> % (no.) of samples with counts >100cfu/g [⊗]	77.5% (55/ 71)	N/T	0.3% (3/923)

* Samples with *L. monocytogenes* counts >100cfu/g are classified as unacceptable/potentially hazardous according to the RTE guidelines⁽¹⁷⁾.

[†] *L. monocytogenes* was detected in 1.4% (1/71) of samples; however the count was not stated.

[^] Samples with *Salmonella* spp. detected in 25g are classified as unacceptable/potentially hazardous according to the RTE guidelines⁽¹⁷⁾.

[⊗] Samples with *S. aureus* counts >100cfu/g are classified as unsatisfactory according to the RTE guidelines⁽¹⁷⁾.

N/T: Not Tested; N/S: Not Stated

5. Conclusions

The finding that 24.6% (225/916), 2.4% (22/923) and 0.3% (3/923) of samples were unsatisfactory for ACC, *Enterobacteriaceae* and *S. aureus* respectively suggests that more emphasis must be placed on control measures (e.g. hygiene practices, handling practices and temperature control) in the retail premises. Good practices are required at all stages in the food chain (e.g. manufacturing, distribution, retail) to ensure that the microbiological quality and safety of the foodstuff is not compromised. Although this study was not designed to determine the stage in the food chain where the microbiological quality deteriorated; a comparison with a previous national survey suggests that some contamination occurred on the retail premises.

The findings of this study highlight the need for more emphasis to be placed on temperature control. Although 97.7% (606/620) of samples were stored in refrigerated conditions; the core temperature of these samples ranged from -0.5°C to 13.7°C. Of particular concern is the finding that the core temperature of 30.5% (185/606) of these 'refrigerated' samples was >5°C (refrigerated food should be maintained at ≤5°C). Temperature control is essential to prevent microbial growth and proliferation. Retailers should be aware of these storage temperatures.

The finding that all samples were satisfactory for *Salmonella* spp. and *L. monocytogenes* is very encouraging and suggests that adequate controls are in place. However retailers should not become complacent as these pathogens have been associated with cooked ham and consumption of contaminated food can have serious consequences for certain sectors of the population.

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APPENDIX 1 Questionnaire

General Information:

- * EHO Name: _____
- * EHO Sample Reference Number: _____
(i.e. EHO's own personal reference number for the sample)
- * Laboratory Reference Number: _____
(upon receipt of lab report)

Premises information (Please tick as appropriate)

(See Section 4 of Protocol):

- Butcher
- Delicatessen
- Corner shop
- Supermarket
- Other *Please specify* _____

Slicing Information (Please complete Section A or B as appropriate - See Section 3 of Protocol):

Section A (Ham sliced at time of sampling)

Storage conditions of ham: Refrigerated Other: _____
(i.e. storage condition of bulk ham prior to slicing)

Core temperature of bulk ham prior to slicing: _____ °C

Use-by date: _____ Not available:

Section B (Ham sliced prior to sampling)

Storage conditions of ham: Refrigerated Other _____
(i.e. storage condition of sliced ham)

Core temperature of sliced ham: _____ °C

Use-by date: _____ Not available:

Cooking Information:

- a) Was the ham supplied pre-cooked to the retailer? **or**
- b) Was the ham cooked by the retailer?

Brand/manufacturers name: _____ Not available:

Address of manufacturer: _____ Not available:

Date of cooking: _____ Not available:

Approved premises number: _____ Not available:

Batch number: _____ Not available:

Microbiological status (See Section 8 of Protocol):

	S	A	U	U/PH
ACC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A
<i>Enterobacteriaceae</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A
<i>L. monocytogenes</i>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	<input type="checkbox"/>
<i>Salmonella</i> spp.	<input type="checkbox"/>	N/A	N/A	<input type="checkbox"/>
<i>S. aureus</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

S=Satisfactory, A=Acceptable, U=Unsatisfactory,
U/PH=Unacceptable/Potentially hazardous, N/A: Not Applicable

Appendix 2
List of the Official Food Microbiology Laboratories (OFMLs)

Laboratory
Public Health Laboratory SWAHB at Cherry Orchard Hospital
Mid-Western Regional Hospital
Public Analysts Laboratory, Dublin
Sligo General Hospital
St Finbarr's Hospital, Cork
University College Hospital, Galway
Waterford Regional Hospital

Appendix 3

Microbiological quality of loose cooked ham samples from each HSE area

Microbiological quality* of samples based on ACC results

HSE Region	HSE Area	Microbiological quality			Total
		Satisfactory	Acceptable	Unsatisfactory	
HSEDMLR	East Coast Area	28	8	15	51
	Midlands Area	25	7	10	42
	South Western Area	40	24	25	89
HSEDNER	North Eastern Area	35	6	9	50
	Northern Area	48	13	13	74
HSESR	South Eastern Area	119	24	98	241
	Southern Area	84	46		130
HSEWR	Mid-Western Area	31	4	28	63
	North Western Area	56	20	15	91
	Western Area	62	11	12	85
Total		528 (57.6%)	163 (17.8%)	225 (24.6%)	916 (100%)

Note: There was no significant difference ($p=0.05$) in the ACC results between HSE regions.

Microbiological quality* of samples based on *Enterobacteriaceae* results

HSE Region	HSE Area	Microbiological quality			Total
		Satisfactory	Acceptable	Unsatisfactory	
HSEDMLR	East Coast Area	40	9	2	51
	Midlands Area	40	6	0	46
	South Western Area	71	12	6	89
HSEDNER	North Eastern Area	44	6	0	50
	Northern Area	68	5	1	74
HSESR	South Eastern Area	163	68	10	241
	Southern Area	116	17	0	133
HSEWR	Mid-Western Area	50	11	2	63
	North Western Area	74	16	1	91
	Western Area	79	6	0	85
Grand Total		745 (80.7%)	156 (16.9%)	22 (2.4%)	923 (100%)

Note: There was a significant difference ($p<0.05$) in *Enterobacteriaceae* results between HSE regions

* Microbiological quality of samples was determined using the national microbiological guidelines for RTE foods

Appendix 4

Microbiological safety of loose cooked ham samples from each HSE area

Microbiological safety* of samples based on *L. monocytogenes* results

HSE Region	HSE Area	Microbiological safety			Total
		Satisfactory	Acceptable	Unacceptable	
HSEDMLR	East Coast Area	51	0	0	51
	Midlands Area	46	0	0	46
	South Western Area	88	0	0	88
HSEDNER	North Eastern Area	50	0	0	50
	Northern Area	74	0	0	74
HSESR	South Eastern Area	239	0	0	239
	Southern Area	133	0	0	133
HSEWR	Mid-Western Area	62	0	0	62
	North Western Area	91	0	0	91
	Western Area	85	0	0	85
Grand Total		919 (100%)	0	0	919

Microbiological safety* of samples based on *Salmonella* spp. results

HSE Region	HSE Area	Microbiological safety		Total
		Satisfactory	Unacceptable/ potentially hazardous	
HSEDMLR	East Coast Area	51	0	51
	Midlands Area	46	0	46
	South Western Area	89	0	89
HSEDNER	North Eastern Area	50	0	50
	Northern Area	74	0	74
HSESR	South Eastern Area	241	0	241
	Southern Area	133	0	133
HSEWR	Mid-Western Area	63	0	63
	North Western Area	91	0	91
	Western Area	85	0	85
Total		923 (100%)	0	923

Microbiological safety* of samples based on *S. aureus* results

HSE Region	HSE Area	Microbiological safety				Total
		Satisfactory	Acceptable	Unsatisfactory	Unacceptable/ potentially hazardous	
HSEDMLR	East Coast Area	51	0	0	0	51
	Midlands Area	45	0	1	0	46
	South Western Area	89	0	0	0	89
HSEDNER	North Eastern Area	50	0	0	0	50
	Northern Area	74	0	0	0	74
HSESR	South Eastern Area	237	3	1	0	241
	Southern Area	132	1	0	0	133
HSEWR	Mid-Western Area	62	0	1	0	63
	North Western Area	90	1	0	0	91
	Western Area	85	0	0	0	85
Total		915 (99.1%)	5 (0.6%)	3 (0.3%)	0 (0%)	923

* Microbiological safety of samples was determined using the national microbiological guidelines for RTE foods