1st Trimester National Microbiological Survey 2004 (04NS1):

Microbiological safety and quality of fermented meat

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Executive Summary

This study investigated the microbiological safety and quality of fermented meat which was available on retail sale in Ireland over a four month period (January to April 2004). Samples were analysed for *Listeria monocytogenes*, *Staphlyococcus aureus* and *Enterobacteriaceae* levels.

Using the national microbiological guidelines for ready-to-eat foods, 93.1% (702/754) of samples were classified as satisfactory, 5.3% (40/754) as acceptable and 1.6% (12/754) as unsatisfactory. No sample was classified as unacceptable/potentially hazardous.

The majority of samples were sliced fermented sausages and were obtained from supermarkets. Parameters such as sample source, sample type, nature of sample and type of storage had no significant effect (95% confidence limit) on microbiological status.

While the findings of this study are very encouraging, it is imperative that every effort is made to ensure the continued safety and quality of this product as it has been implicated in foodborne outbreaks.

1. Introduction

Fermented meats are those which have been subjected to the action of microorganisms so that the product characteristics (e.g. flavour, texture, shelf life) are altered significantly [(1)]. Fermentation is one of the oldest food technologies and continues to play an important role in the preservation of meat in many parts of the world [(2)].

There are many different types of fermented meat products (although most do not receive a heat treatment they are ready-to-eat products). They maybe categorised as follows [(1)]:
1) Fermented sausages: These are made from comminuted meat stuffed into casings, e.g. pepperoni, salami, chorizo. They are often sub-categorised according to their water activity (a_w), i.e. dry, semi dry or undried (spreadable).
2) Fermented whole meat products: These are unground meat products which are made from entire cuts e.g. serrano ham, parma ham.

The process used in the production of fermented meats depends on a number of factors (e.g. the type of product required) and varies considerably between countries. A flow diagram of a typical process used in the production of fermented sausages is provided in Figure 1. The initial step involves mixing of the raw materials (meat, fat, salt, curing agents, sugars and spices). The mixture is then filled into casings and subjected to a ripening process. The ripening process consists of 2 stages: 1) the fermentation stage (characterised by microbial activity) and 2) an ageing stage (the products are dried and develop their characteristic

flavours). In some cases the meats are also smoked and cured (curing brings about characteristic sensory changes through the action of curing agents such as nitrites and nitrates [(3)]).

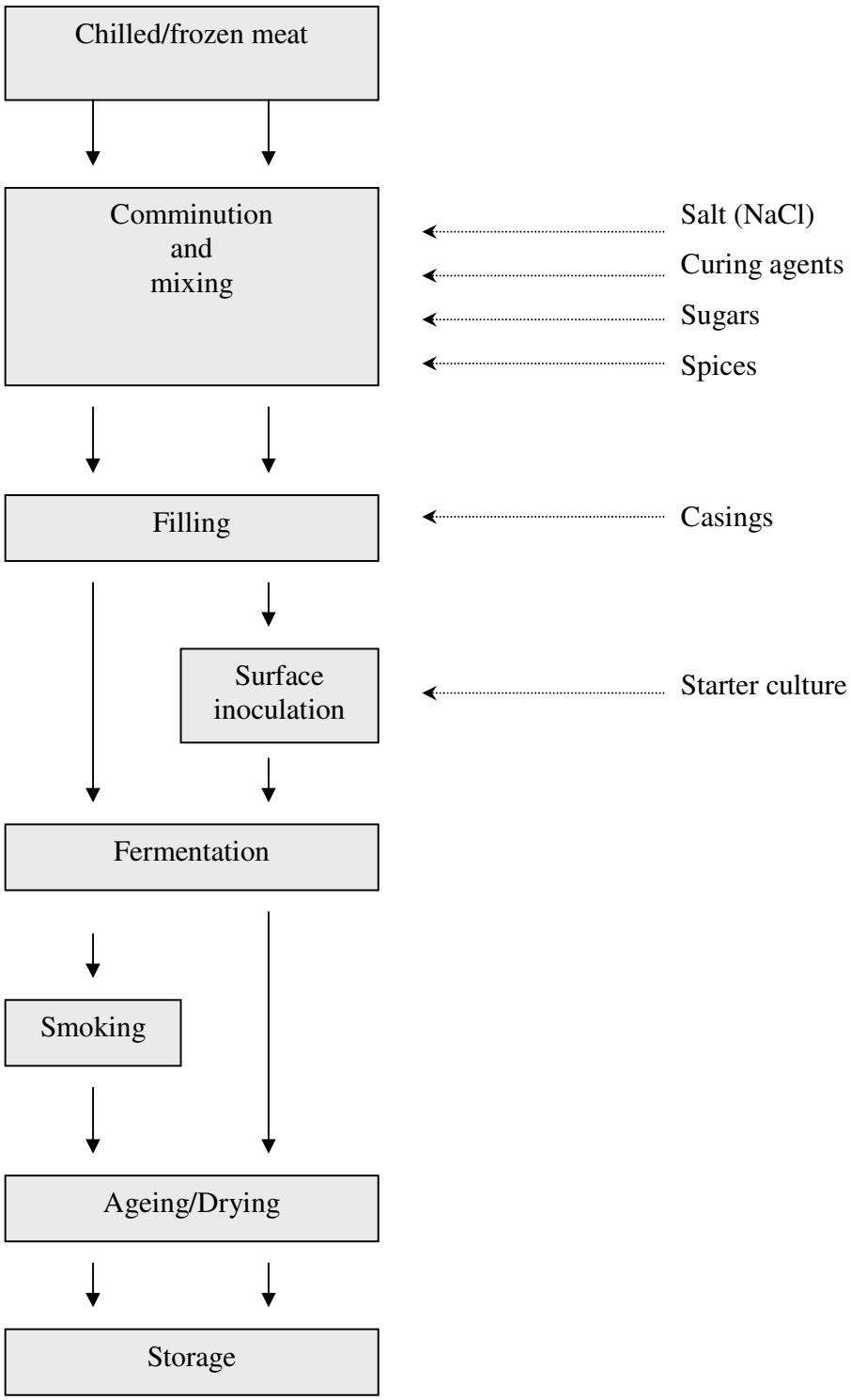
Traditionally manufacturers relied on the naturally occurring microflora to ferment the meat; however, nowadays most manufacturers initiate the fermentation process by inoculation with starter cultures [(4)]. These cultures may consist of single or multiple species of bacteria (e.g. lactic acid bacteria, *Pediococcus* spp. and *Micrococcus* spp.); however, the most common starter cultures are the lactic acid bacteria. During the fermentation process the lactic acid bacteria metabolise the sugars resulting in lactic acid formation (other organic acids are also produced but in smaller quantities). The lactic acid is released into the meat causing a decrease in the pH of the product (typically to pH 4.6-5.0 [(5)]). Both acid formation and the reduction in pH retards the growth and in some cases eliminates pathogens and/or spoilage organisms (these micro-organisms may arise from many sources including the raw meat, the environment etc). This is one of the principal factors which ensures the microbiological safety and quality of the fermented meat product [(6)].

If acid formation is delayed it increases the potential for microbial growth [(1)]. *L. monocytogenes* is a pathogen which is of particular concern because of its ubiquitous nature (e.g. it has been detected both in raw meats and in processing environments) and its ability to grow at low temperatures, relatively high salt concentrations and relatively low pH. Delayed acid formation can also lead to elevated numbers of other pathogens such as *Staphlyococcus aureus* (this pathogen may be present in the raw meat or maybe introduced into the meat through poor handling practices). It can also lead to the proliferation of *Enterobacteriaceae* (members of this group include bacteria such as *E. coli* and *Salmonella* spp.).

In terms of microbiological criteria, there are no microbiological standards[r] for fermented meats. However, the European Commission is currently in the process of revising the current legislation and microbiological standards for fermented meats are proposed in the new/revised legislation. In Ireland, there are microbiological guidelines[⊗] for fermented meat products. These are outlined in the FSAI publication '*Guidance Note No. 3. Guidelines for the Interpretation of Results of Some Ready-To-Eat Foods Sampled at the Point of Sale*' [(7)].

[r] A microbiological standard is a criterion contained in law where compliance is mandatory. The food industry must ensure full compliance with these standards which are monitored by the enforcement agencies.
[⊗] A microbiological guideline is a criterion which is not legally enforceable. It provides a benchmark against which unacceptable microbial contamination of food can be identified.

Figure 1: Flow diagram of a typical process used in the production of fermented sausages



2. Specific Objective

The aim of this study was to investigate the microbiological safety and quality of fermented meats on retail sale in the Republic of Ireland.

3. Methods

3.1 Sample source:

Samples were obtained from a variety of retail sources including:

- Supermarkets
- Food stalls e.g. country markets
- Butchers
- Catering premises (e.g. restaurants, hotels, pizzerias, etc)

3.2 Sample description:

Samples included:

- Fermented sausages (made from comminuted meat stuffed into casings, e.g. pepperoni, salami, chorizo, mettwurst)
- Fermented whole meat products (made from entire cuts e.g. serrano ham, parma ham, Jambon De Bayonne)

Only fermented meats/sausages which were sold 'loose' (whole/sliced) to the consumer were sampled. This included fermented meat which originated from large retail/catering packs.

The following were specifically excluded from this survey:

- Fermented meats which were sold pre-packed to the consumer
- All meats/sausages which were not fermented (e.g. raw sausages)
- Cured meats (e.g. pastrami, corned beef, cured poultry), smoked meats and spiced meats, unless they had also undergone a fermentation step
- Prepared dishes containing fermented meat e.g. pizza and salads

3.3 Sample collection and analysis:

Environmental Health Officers (EHOs) from the 10 health boards (Appendix 1) collected samples (150g or more) between January and April 2004 inclusive. Only one sample of each product (e.g salami, pepperoni, etc) was submitted per manufacturer, from each premises. However, if there was difficulty in obtaining samples, more than one sample was submitted provided the samples were from different batches. If a repeat sample was deemed necessary, it was not included in the survey.

The core temperature of the fermented meat was measured at the time of sampling using an insertion probe. The temperature was recorded on the questionnaire provided.

The samples were analysed in one of the 7 Official Food Microbiology Laboratories (OFML's – Appendix 2) using approved/standard methods (methods accredited by the National Accreditation Board). The samples were analysed for the following parameters:

1. *L. monocytogenes* (qualitative and quantitative)
2. *S. aureus*
3. *Enterobacteriaceae*

The results were classified according to the 2001 Irish '*Guidelines for the Interpretation of Results of Microbiological Analysis of Some Ready-To-Eat Foods Sampled at the Point of Sale'* (FSAI Guidance Note No.3 [7]). These guidelines are outlined in Table 1.

Table 1: Guidelines [7] for the assessment of the microbiological quality/safety of fermented meat.

	Microbiological quality (cfu/g)			
Parameter	**Satisfactory**	**Acceptable**	**Unsatisfactory**	**Unacceptable/ potentially hazardous**
L. monocytogenes (Quantitative)	<20	20-<100	N/A	≥100
L. monocytogenes (Qualtitative)	Not detected in 25g or detected in 25g but <20cfu/g			
S. aureus	<20	20-<100	100-$<10^4$	$\geq 10^4$
Enterobacteriaceae	<100	100-$<10^4$	$\geq 10^4$	N/A

N/A: Not Applicable

3.4 Questionnaire:

Information on i) sample source, ii) sample type (fermented sausage/fermented whole meat), iii) nature of product (sliced/whole), iv) type of storage (refrigerated, ambient, frozen), v) date of minimum durability etc. were obtained by EHOs at the time of sampling and the findings were recorded on the questionnaire provided (Appendix 3).

4. Results and Discussion

4.1 Microbiological Results

Microbiological analysis was carried out on 762 fermented meat samples. The number of samples submitted from each health board and analysed in each OFML are presented in Appendix 4.

4.1.1 Overall microbiological status

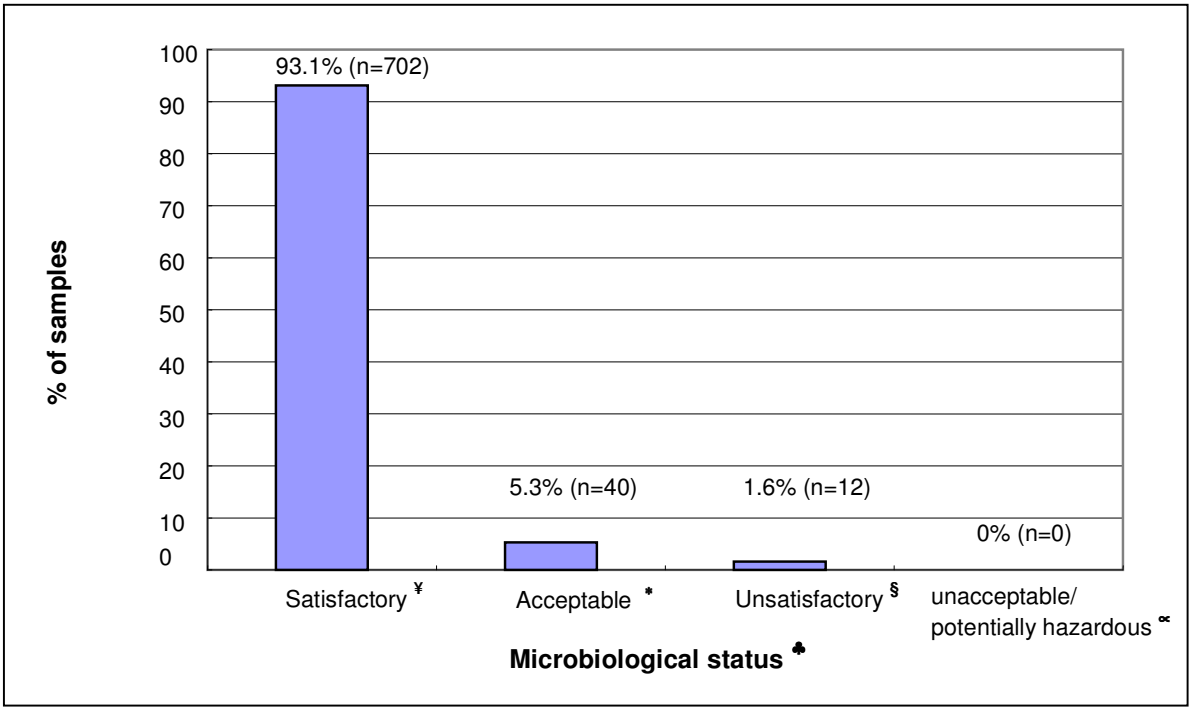
Of the 762 samples submitted for analysis, 754 (98.9%) were analysed for all 3 microbiological parameters (*Enterobacteriaceae*, *S. aureus* and *L. monocytogenes*) (Table 2).

Table 2: Number of samples analysed

	Microbiological parameter				
No. of samples submitted for analysis	***Enterobacteriaceae***	***S. aureus***	***L. monocytogenes***		**All three parameters**
			Qualitative	**Quantitative**	
762	762 (100%)	754 (98.9%)	757 (99.3%)	762 (100%)	754 (98.9%)

Applying the national microbiological guidelines for RTE foods [7] to the results of the 754 samples which were analysed for all 3 microbiological parameters showed that 93.1% (n=702) of samples were classified as satisfactory, 5.3% (n=40) as acceptable and 1.6% (n=12) as unsatisfactory. The overall microbiological status of these samples is presented in Figure 2.

Figure 2: Overall microbiological status of fermented meat samples (n=754) ♣



♣ Overall status was determined based on the results for the 3 microbiological parameters: *L. monocytogenes, S. aureus* and *Enterobacteriaceae*

¥ **Satisfactory:** Sample satisfactory for all 3 microbiological parameters

* **Acceptable:** Sample acceptable for one or more microbiological parameter and satisfactory for the remaining parameter(s).

§ **Unsatisfactory:** Sample unsatisfactory for one or more microbiological parameter and satisfactory and/or acceptable for the remaining parameter(s).

∝ **Unacceptable/potentially hazardous:** Sample unacceptable/potentially hazardous for *L. monocytogenes* and/or *S. aureus* and either unsatisfactory, acceptable or satisfactory for the remaining parameter(s).

Of the 12 samples which were classified as unsatisfactory, 83.3% (10/12) were unsatisfactory for *Enterobacteriaceae* alone and 16.7% (2/12) were unsatisfactory for *S. aureus* alone (Note: 'unsatisfactory' is not applicable as a classification for *L. monocytogenes* - see table 1). In addition, no sample was unsatisfactory for more than 1 microbiological parameter (Table 3).

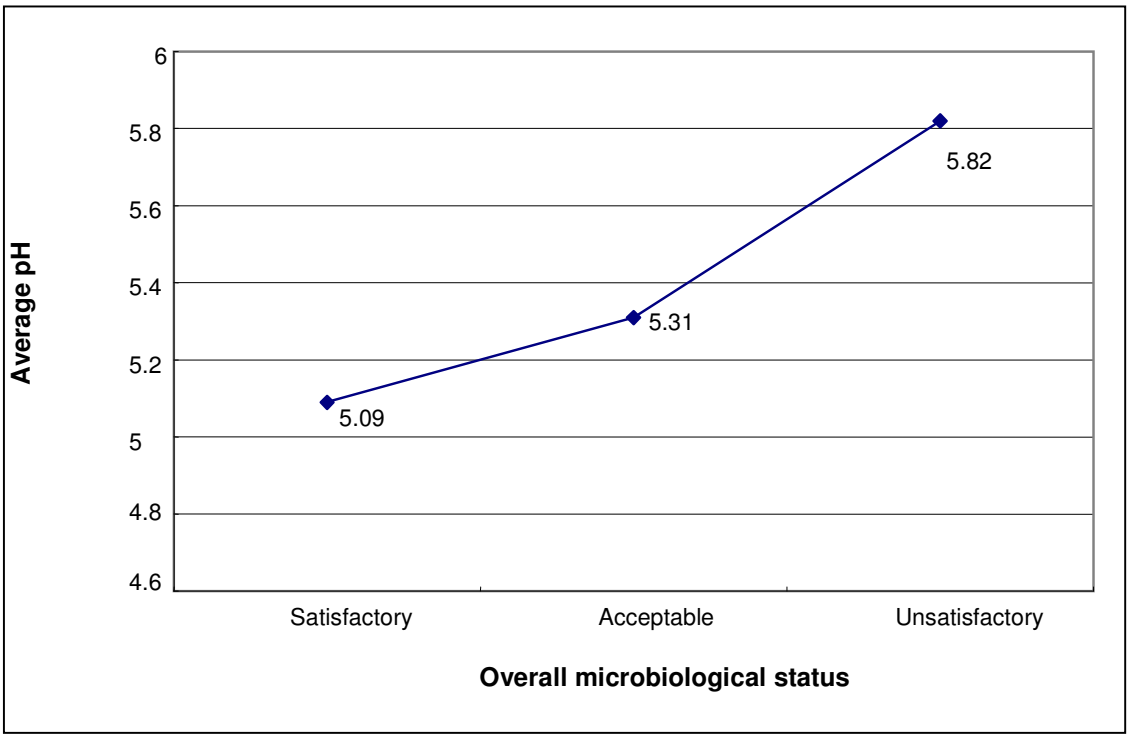
Table 3: Samples with an overall classification of unsatisfactory (n=12)

	Number of samples	
Total	**Unsatisfactory for *Enterobacteriaceae* only (%)**	**Unsatisfactory for *S. aureus* only (%)**
12 [¥]	10 (83.3)	2 (16.7)

[¥] No sample was unsatisfactory for more than 1 microbiological parameter

Where possible, the laboratories tested the pH of the samples. pH testing was carried out on 47.9% (365/762) of the samples submitted. The relationship between the overall microbiological status and pH (average) is presented in Figure 3.

Figure 3: Relationship between average pH and overall microbiological status (n=365)



As expected, deterioration in microbiological status is associated with an increase in sample pH (i.e. an increase in the alkalinity of the samples).

4.1.2 *Listeria monocytogenes* results

L. monocytogenes is a bacterial pathogen which is ubiquitous in the environment and is often present in many raw foods including meat (*L. monocytogenes* was detected in 8% of raw beef & veal and 5% of raw poultry tested in Ireland in 2001 [(8)]). Studies on the behaviour of *L. monocytogenes* have shown that this pathogen maybe reduced but not necessarily eliminated from meat during the fermentation process [(9)]. Its reduction maybe attributed to a number of factors including the rapid reduction in pH, the presence of nitrates/nitrites, the presence of bacteriocins and competitive inhibition from other bacteria.

To date there is little or no epidemiological evidence for the involvement of fermented meats in outbreaks of listeriosis[ϒ] [(1, 3)]. In addition, ***a risk assessment of L. monocytogenes in ready-to-eat foods*** carried out by the Food and Agricultural Organisation (FAO)/World Health Organisation (WHO) [(10)], has estimated the risk of listeriosis from fermented meat to be very low (a risk of $2.1x10^{-12}$ cases per serving). Despite this information, it is imperative that the food industry does not become complacent as it is well known that *L. monocytogenes* (particularly when present at high numbers in the raw meat) may not be eliminated during the fermentation process. In addition, poor process control (e.g. a delay in acid formation) and post process contamination may lead to further contamination. Levels of *L. monocytogenes* exceeding 100cfu/g in ready-to-eat food represent a risk to consumer health [(11)].

In this study samples were analysed both qualitatively and quantitatively for *L. moncytogenes*. The results of the samples submitted from each health board are presented in Appendix 5.
Qualitative analysis was carried out on 757 fermented meat samples. *L. monocytogenes* was detected in 2.6% (n=20) of samples. Quantitative analysis was carried out on 762 samples (this included the 20 samples in which *L. monocytogenes* was detected qualitatively). Applying the national microbiological guidelines for RTE foods [(7)] to the results showed that all samples were classified as satisfactory (i.e. <20cfu/g) (Table 4). This finding is very encouraging and suggests that adequate steps are taken throughout the food production and distribution chain to control this pathogen.

[ϒ] Listeriosis is the disease caused by *L. monocytogenes*. It most often affects immunocompromised people, pregnant women, babies and the elderly. Symptoms of listeriosis includes infections of the central nervous system (meningitis, encephalitis), miscarriage, still births and neonatal disease.

Table 4: *L. monocytogenes* results

Qualitative Analysis		Quantitative Analysis			
No. of samples	*L. monocytogenes* detected (%)	**No. of samples**	Satisfactory <20 cfu/g (%)	Acceptable 20-<100 cfu/g (%)	Unacceptable/ Potentially Hazardous ≥100 cfu/g (%)
757	20* (2.6)	762	762 (100)	0 (0)	0 (0)

* These 20 samples were also analysed quantitatively.

Many studies are reported in the literature on the prevalence and incidence of *L. monocytogenes* in fermented meat products. A comprehensive review of these studies is provided in the recent FAO/WHO publication on the *Risk Assessment of Listeria monocytogenes in Ready-To-Eat Foods* [(5)]. The data presented in Table 5 are adapted from this publication. These data show that the prevalence of *L. monocytogenes* in fermented meat products ranges from 0 to 80%. The prevalence of *L. monocytogenes* in this Irish study (2.6%) is at the lower end of this range.

Table 5: Reported prevalence and incidence *of Listeria monocytogenes* in fermented meat products (adapted from ref 5)

Product Description	**No. of Samples**	**Positive (samples or proportion)**	**% positive**	**Conc. (cfu/g)**	**Location of Survey**
Fermented sausages	5	up to 0.20	20.00		Various countries
Fermented sausages					Austria
Fermented sausages	21	4	19.05		Yugoslavia
Raw sausage	20	16	80.00		Brazil
Fermented sausage		0.22 to 0.83			Spain
Dry sausages	18	0.22 to 0.83	44.00		Various countries
Fermented sausages	30	6	20.00		Canada
Raw sausage	25	13	52.00		UK
Mettwurst with onion, fresh	11	1	9.09		Germany
Sausages	8	2	25.00		Hungary
Mettwurst with onion	245	27	11.00		Germany
Spreadable, fermented	381	43	11.30		Germany
Sliceable, fermented	228	11	4.80		Germany
Raw sausage	120	30	25.00	<100	Germany
Mettwurst, coarse	30	6	20.00	<1000	Germany
Mettwurst, fresh	30	18	60.00	<1000	Germany
Raw sausage, salami type	30	5	16.67	<100	Germany
Beef sausage	1	0	0.00		UK
Sausage	3	0	0.00		UK
Raw fresh sausages	98	4	4.08		France
Raw sausage	68	12	17. 65		Germany
Mettwurst, fresh	132	22	16.67		Germany
Raw sausage, sliced	126	2	1.59		Germany
Salsiccia	52	6	11.54		Italy
Fermented sausages, salami type	70	0	0.00		Norway
Ground/minced muscle (dry fermented sausages)	308	36	11.69		Belgium
Fermented sausages	5	up to 0.20	20.00	less than in nonfermented RTE cooked meats	
Salami	128		10.00		UK
Salami	67		16.00		UK
Salami	59		5.00	20	Switzerland
Mettwurst	14		0.00		Switzerland
Dry cured	136		10.00		Hungary
Fermented	21		10.00		Hungary
Smoked	23		13.00		Hungary
Cervelat	44		0.00		South Africa
Vacuum-packed salami	19		0.00		Australia
Salami	132		40.00		Australia

4.1.3 *Staphylococcus aureus* results

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.

S. aureus is resistant to both salt and nitrite. It grows poorly under anaerobic conditions, low pH and low temperatures; thereby reducing its ability to grow in fermented meats. However, it may grow at high fermentation temperatures during the lag phase[ϒ] of the development of the starter culture [(1, 12, 13)] (i.e. before the pH has dropped sufficiently). This may result in high numbers of *S. aureus* in the outer layers of the fermented sausage [(1)]. Criticial factors in the control of *S. aureus* during the fermentation process include the initial activity of the starter culture and the initial pH [(12, 13)].

Staphylococcal food poisoning is caused by ingestion of a toxin formed by *S. aureus* in the food. *S. aureus* must grow to levels of $>10^5$ cells/g before producing sufficient quantities of the heat-stable staphylococcal toxin to cause illness [(14)]. The onset of symptoms is usually rapid (1 to 7 hours after ingestion of the food containing the toxin), however, both the onset and the severity of the symptoms depend on the persons susceptibility and the amount of toxin consumed. The main symptoms include abdominal cramps, vomiting and diarrhea [(15)]. Outbreaks of food poisoning attributed to fermented sausages have been reported in the literature [(16)].

In this study, 754 samples were analysed for *S. aureus*. Applying the national microbiological guidelines for RTE foods [(7)] to the results showed that 98.8% (n=745) of these samples were classified as satisfactory, 0.9% (n=7) as acceptable and 0.3% (n=2) as unsatisfactory for *S. aureus* (Table 6). Bacterial counts of $3x10^2$ & $8x10^2$ cfu/g and pH values of 5.7 & 6.19 respectively were recorded for the two unsatisfactory samples. The results of the samples submitted from each health board are presented in Appendix 6.

[ϒ] The lag phase is the initial growth phase, during which cell number remains relatively constant prior to rapid growth.

Table 6: Microbiological classification of samples based on *S. aureus* results

	Microbiological Classification			
No. of samples	**Satisfactory <20 cfu/g (%)**	**Acceptable 20-<100 cfu/g (%)**	**Unsatisfactory 100-<10^4 cfu/g (%)**	**Unacceptable/ potentially hazardous ≥10^4 cfu/g (%)**
754	745 (98.8)	7 (0.9)	2 (0.3) *	0 (0)

¥ A total of 762 samples were submitted for analysis; however 8 samples were not analysed for *S. aureus*

* Bacterial counts of $3x10^2$ & $8x10^2$ cfu/g and pH values of 5.7 & 6.19 respectively were recorded for these unsatisfactory samples.

A questionnaire was returned with one of the two unsatisfactory samples. Information pertinent to this sample is listed in Table 7:

Table 7: Details of the sample unsatisfactory for *S. aureus*

Sample No.	Premises Type	Sample Type	Nature of product	Storage conditions	Core temp	Count (cfu/g)	Shelf life (days)	pH
1	Retail	Fermented sausage	Sliced	Refrigerated	4.9°C	$8x10^2$	31	6.19

A study carried out in the UK in 1996 [17] on the microbiological quality of ready-to-eat dried and fermented meat and meat products found that the majority of samples (99.06%) contained *S. aureus* at levels <100cfu/g (Table 8). *S. aureus* levels ≥10^4 cfu/g were found in 0.13% of samples. There is no significant difference (95% confidence limit) between these results and the results of this Irish study.

Table 8: A comparison with UK study

			***S. aureus* count**		
Location of study	**Year of study**	**No. of samples**	**<100 cfu/g (%)**	**100-<10^4 cfu/g (%)**	**≥10^4 cfu/g (%)**
UK [17]	1996	2972	2944 (99.06)	24 (0.81)	4 (0.13)
This study	2004	754	752 (99.7)	2 (0.3)	0 (0)

4.1.4 *Enterobacteriaceae* results

The microbiological quality of fermented meat products can be determined by assessing the levels of *Enterobacteriaceae*. Elevated levels of *Enterobacteriaceae* may arise on account of:

1) poor hygiene control, e.g. improperly cleaned casings and
2) poor process control, e.g. a delay in acid formation due to problems with the starter culture.

Elevated numbers of *Enterobactericaeae* can cause off-odours and off-flavours [(1)] and their presence gives an indication of the likelihood of the presence of pathogens.

In this study, 762 samples were analysed for *Enterobacteriaceae*. Applying the national microbiological guidelines for RTE foods [(7)] to the results showed that 94% (n=716) of samples were classified as satisfactory, the remaining 6% (n=46) were classified as acceptable and unsatisfactory (Table 9). The results of the samples submitted from each health board are presented in Appendix 7.

Table 9: Microbiological categorisation of samples based on *Enterobacteriaceae* results

No. of samples	Satisfactory <100 cfu/g (%)	Acceptable 100-<10^4 cfu/g (%)	Unsatisfactory ≥10^4 cfu/g (%)[¥]
762	716 (94%)	36 (4.7%)	10 (1.3%)

Details of the bacterial counts and the pH values of the 10 unsatisfactory samples are provided in Table 10:

Table 10: Enterobacteriacae counts and pH values of unsatisfactory samples (n=10)

Sample No.	*Enterobacteriaceae* count	pH value
1	1 x 10^4	N/R
2	1 x 10^4	N/R
3	1 x 10^4	N/R
4	1.1 x 10^4	5.96
5	1.5 x 10^4	6.14
6	1.6 x 10^4	5.60
7	2 x 10^4	N/R
8	2.1 x 10^4	4.62
9	6 x 10^4	6.20
10	9.5 x 10^5	6.15

N/R: Not Recorded

Questionnaires were returned with 6 of the 10 unsatisfactory samples. Information pertinent to these samples is listed in Table 11:

Table 11: Details of 6 samples classified as unsatisfactory for Enterobacteriaceae

Sample No.	Premises Type	Sample Type	Nature of product	Storage conditions	Core temp (^{o}C)	Count	Shelf life (days)	pH
1	Retail	Fermented whole meat product	Whole	Refrigerated	5.00	>1x10^{4}	N/R	N/R
2	Catering	Fermented sausage	Sliced	Refrigerated	5.50	>1x10^{4}	94	N/R
3	Retail	Fermented sausage	Sliced	Refrigerated	3.20	2x10^{4}	2	N/R
4	Catering	Fermented sausage	Sliced	Refrigerated	3.10	1.1x10^{4}	259	5.96
5	Retail	Fermented whole meat product	Sliced	Refrigerated	9.60	9.5x10^{5}	170	6.15
6	Catering	Fermented whole meat product	Sliced	Refrigerated	5.90	2.1x10^{4}	N/R	4.62

It is worth noting that highest *Enterobacteriaceae* count was recorded for the sample with the highest core temperature (9.6^{o}C) and the highest pH (6.15). (Note: the average core temperature and average pH of satisfactory samples was 4.34^{o}C and 5.09 respectively).

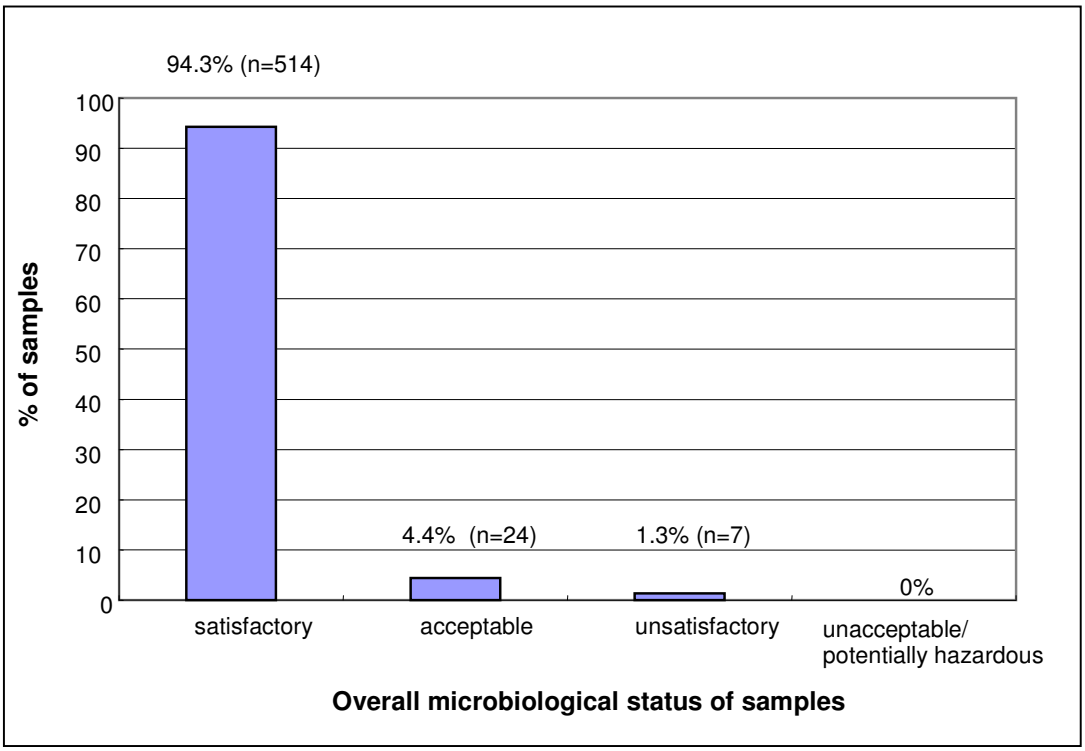
4.2 Questionnaire data

A total of 545 questionnaires were returned, this represented a response rate of 71.5% (545/762).

4.2.1 Overall microbiological status of samples returned with a questionnaire

The overall microbiological status of the 545 samples which were returned with a questionnaire are presented in Figure 4.

Figure 4: Overall microbiological status of samples returned with a questionnaire (n=545)



The overall status of these 545 samples is similar to that presented in Figure 2.

4.2.2 Effect of individual parameters on the microbiological status

Information recorded on the questionnaire included: i) sample source, ii) sample type (fermented sausage/fermented whole meat), iii) nature of product (sliced/whole) and iv) the type of storage (refrigerated, ambient, frozen). The response rate to each question is outlined in Table 12.

Table 12: Response rate to individual questions on the questionnaire

Question posed on the questionnaire	No. of questionnaires with a completed answer	Response rate to the question (%)[r]
Sample source	544	99.8
Sample type	531	97.4
Nature of sample	531	97.4
Type of storage	540	99.1

[r] Total number of questionnaires returned = 545

In relation to sample source almost two thirds of the samples (63%, 345/544) were obtained from supermarkets. The remainder of samples were obtained primarily from catering premises and butchers. In relation to sample type and nature of product, almost 80% (422/531) of the samples were fermented sausages and almost 85% (450/531) of samples submitted were sliced as opposed to whole. The predominant storage condition was refrigeration (95.6%, 516/540) (Figures 5-8).

The relationship between each of these parameters and microbiological status is outlined in Table 13. No parameter had a significant effect (95% confidence limit) on microbiological status.

Figure 5: Sample source (n=544)

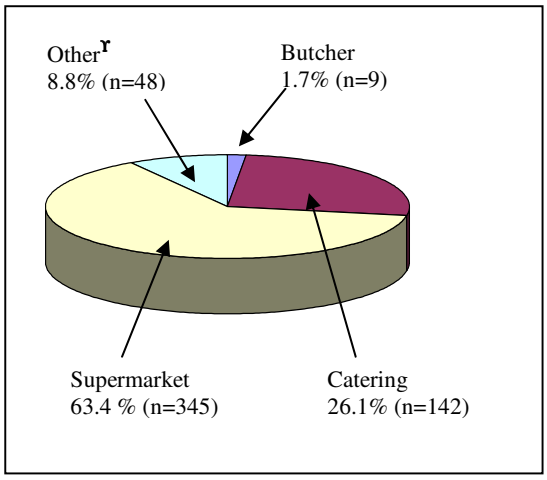
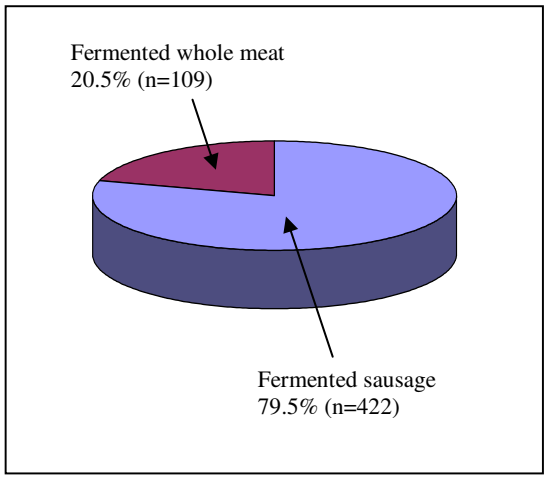


Figure 6: Type of sample (n=531)



[r] Other includes premises such as café, delicatessen, pizzeria etc

Figure 7: Nature of sample (n=531)

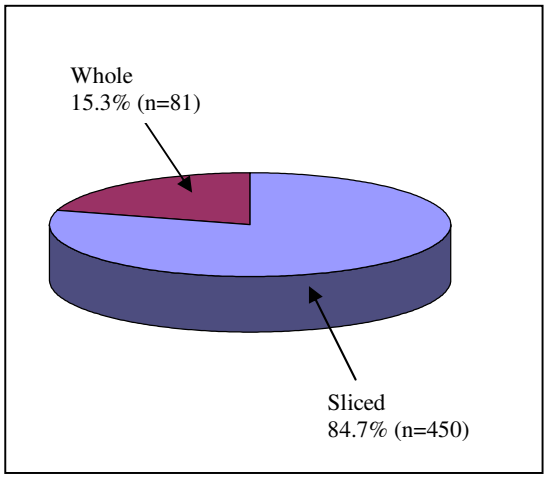
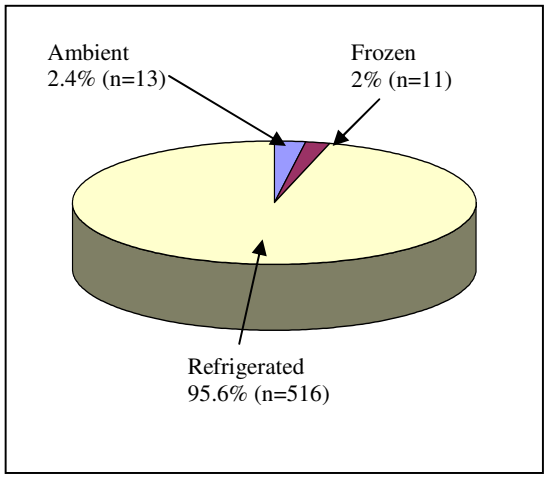


Figure 8: Type of storage[✦] (n=540)



Average core temperatures of samples:
Storage under ambient conditions = 9.92 °C
Storage under frozen conditions = -15.13 °C
Storage under refrigeration = 4.53 °C

Table 13: Effect of various parameters on microbiological status

Parameter	Parameter details	Overall microbiological status[r]				Total
		S	A	U	U/PH	
Premises Type	**Supermarket**	330	12	3	0	**345**
	Catering	131	8	3	0	**142**
	Butcher	8	1	0	0	**9**
	Other	44	3	1	0	**48**
	Total	**513**	**24**	**7**	**0**	**544**
Sample type	**Fermented sausage**	400	18	4	0	**422**
	Fermented whole meat product	100	6	3	0	**109**
	Total	**500**	**24**	**7**	**0**	**531**
Nature of sample	**Whole**	79	1	1	0	**81**
	Sliced	422	22	6	0	**450**
	Total	**501**	**23**	**7**	**0**	**531**
Storage conditions	**Ambient**	13	0	0	0	**13**
	Frozen	11	0	0	0	**11**
	Refrigerated	485	24	7	0	**516**
	Total	**509**	**24**	**7**	**0**	**540**

[r] S = Satisfactory, A = Acceptable, U = unsatisfactory, U/PH = Unacceptable/potentially hazardous

5. Conclusions

The findings of this study show that the majority of fermented meat samples (93.1%) had a satisfactory microbiological status. While this finding is very encouraging it is imperative that every effort is made to ensure the continued safety and quality of this product as it has been implicated in foodborne outbreaks.

Production of safe fermented meat products requires prevention of the growth of pathogens during the fermentation step and maximizing death of surviving pathogens [(5)]. Successful strategies for achieving this objective include:

- Proper selection of raw materials: To avoid problems during the fermentation process, (i) raw meat should have a low level of undesirable microorgansims [(3)] and (ii) the starter culture must be physiologically active [(18)].
- Good manufacturing and good hygiene practices.
- Good process control (temperature control, precise control of drying air parameters, control of water activity and pH).
- Operation of a food safety management system based on the principles of HACCP.

At retail level, it is imperative that good hygiene practices are undertaken. In relation to storage conditions, while the majority of samples examined in this study were stored under refrigerated conditions, the microbiological status of the samples was not adversely affected by storage under ambient conditions. However, retailers should comply with the storage conditions specified by the manufacturer (the storage conditions will vary between products). These recommendations should be incorporated into the retailers HACCP plan.

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7. Appendices

Appendix 1

List of health boards

Health board	***Abbreviation***
East-Coast Area Health Board	ECAHB
Midland Health Board	MHB
Mid-Western Health Board	MWHB
Northern Area Health Board	NAHB
North-Eastern Health Board	NEHB
North-Western Health Board	NWHB
South-Eastern Health Board	SEHB
Southern Health Board	SHB
South-Western Area Health Board	SWAHB
Western Health Board	WHB

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: Questionnaire

Questionnaire 04NS1
Microbiological safety and quality of fermented meat

Please note:
1) this questionnaire must be completed for <u>all</u> samples by EHOs
2) <u>all</u> fields are mandatory
3)<u>all</u> questionnaires should be returned to the FSAI by 31st May 2004 (at the latest).

1. EHO Name: _____

2. EHO Sample Reference Number: _____
(i.e. EHO's own personal reference number for the sample)

3. Laboratory Reference Number (upon receipt of lab report): _____
(i.e. unique laboratory reference number)

4. Type of Premises
Supermarket (incl. Corner shops) □
Food stall (e.g. country market) □
Catering □
Butcher □
Other □ *Please specify*_____

5. Type of sample
Fermented sausage □
Fermented whole meat product □

6. Nature of product
Sliced □
Whole □

7. Brand name (if available): _____

8. Core temperature of fermented meat at time of sampling: _____°C

9. Storage condition of sample in premises
Refrigerated □
Ambient □
Other (Please specify) □ _____

9. Date of minimum durability
Best before date: _____
Not Available: □

APPENDIX 4

Details of sample numbers submitted from each health board and analysed in each OFML

	Official Food Microbiology Laboratory (OFML)							
Health Board	Cherry Orchard Hospital	St Finbarr's Hospital, Cork	University College Hospital, Galway	Mid-Western Regional Hospital	Sligo General Hospital	Public Analysts Laboratory, Dublin	Waterford Regional Hospital	**Total**
ECAHB	17	-	-	-	-	34	-	**51**
MHB	-	-	-	-	-	40	-	**40**
MWHB	-	-	-	71	-	-	-	**71**
NAHB	48	-	-	-	-	27	-	**75**
NEHB	49	-	-	-	-	-	-	**49**
NWHB	-	-	-	-	54	-	-	**54**
SEHB	-	-	-	-	-	-	137	**137**
SHB	-	105	-	-	-	-	-	**105**
SWAHB	90	-	-	-	-	9	-	**99**
WHB	-	-	81	-	-	-	-	**81**
Total	**204**	**105**	**81**	**71**	**54**	**110**	**137**	**762**

Appendix 5

Table 1: *Listeria monocytogenes* results by health board

	Qualitative analysis		Quantitative analysis	
Health Board	**No. of samples analysed**	**No. of samples in which *L. moncoytogenes* was detected**	**No. of samples analysed**	**No. of samples categorised as satisfactory (<20 cfu/g)**
ECAHB	51	1	51	51
MHB	39	2	40	40
MWHB	69	1	71	71
NAHB	75	0	75	75
NEHB	49	1	49	49
NWHB	53	2	54	54
SEHB	137	5	137	137
SHB	104	3	105	105
SWAHB	99	4	99	99
WHB	81	1	81	81
Grand Total	**757**[r]	**20**	**762**	**762**

[r] A total of 762 samples were submitted for analysis however 5 of these were not analysed qualitatively for *Listeria* spp [MHB (n=1), MWHB (n=2), NWHB (n=1), SHB (n=1)]

Appendix 6

Staphylococcus aureus results by health board

	Microbiological Status				
Health Board	**Satisfactory <20 cfu/g**	**Acceptable 20-<100 cfu/g**	**Unsatisfactory 100-<10^4 cfu/g**	**Unacceptable/ potentially hazardous ≥10^4 cfu/g**	**Grand Total [r]**
ECAHB	50	1	-	-	**51**
MHB	40	-	-	-	**40**
MWHB	69	1	1	-	**71**
NAHB	67	1	-	-	**68**
NEHB	49	-	-	-	**49**
NWHB	54	-	-	-	**54**
SEHB	135	2	-	-	**137**
SHB	103	1	1	-	**105**
SWAHB	97	1	-	-	**98**
WHB	81	-	-	-	**81**
Grand Total	**745**	**7**	**2**	**-**	**754**

[r] A total of 762 samples were analysed, however 8 of these were not analysed for *S. aureus* [NAHB (n=7) & SWAHB (n=1)].

Appendix 7

Enterobacteriaceae results by health board

	Microbiological Status			
Health Board	**Satisfactory <100 cfu/g**	**Acceptable 100-<10^4 cfu/g**	**Unsatisfactory > 10^4 cfu/g**	**Grand Total**
ECAHB	50	-	1	**51**
MHB	38	2	-	**40**
MWHB	67	4	-	**71**
NAHB	72	2	1	**75**
NEHB	45	2	2	**49**
NWHB	46	6	2	**54**
SEHB	124	9	4	**137**
SHB	103	2	-	**105**
SWAHB	90	9	-	**99**
WHB	81	-	-	**81**
Grand Total	**716**	**36**	**10**	**762**