2nd Quarter National Microbiological Survey 2002 (NS2):

Microbiological quality of pre-prepared and left over gravy

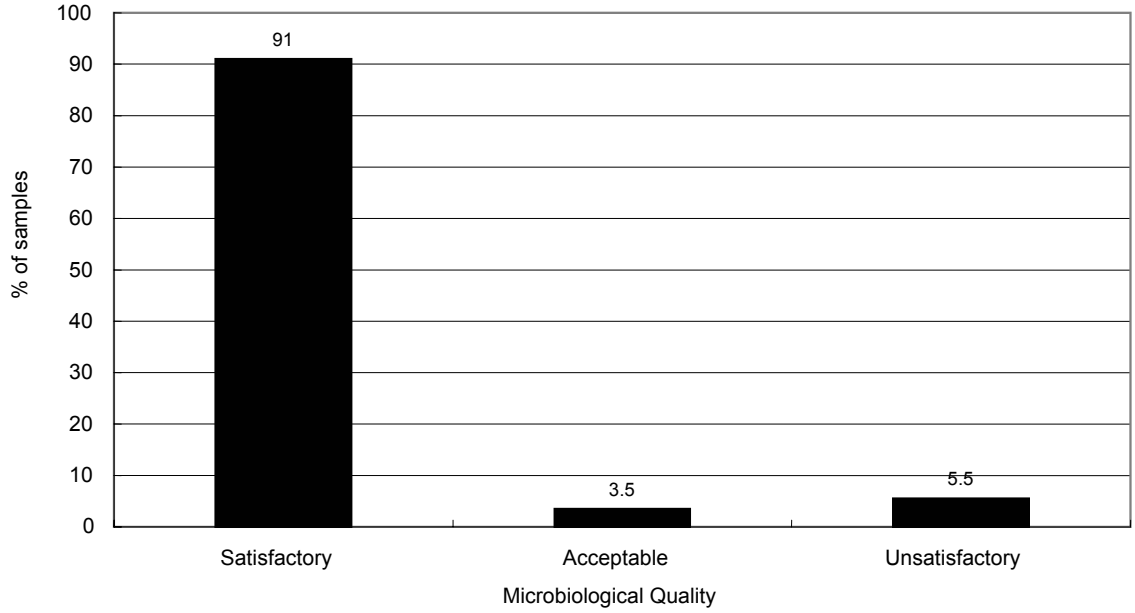
Executive Summary

Background

- Pre-prepared and left over gravy samples were obtained from catering premises and were analysed for *Clostridium perfringens* and Aerobic Colony Count (ACC).
- Samples were analysed for *C. perfringens* to determine the effectiveness of the time-temperature controls during the cook chill process. The ACC of the samples was analysed to determine the overall microbiological quality (parameters affecting ACC levels include the microbiological quality of the ingredients, temperature control during the cook-chill process and post process contamination).
- Sampling took place during April, May and June 2002. A total of 454 samples were analysed.

Results

- All samples were satisfactory for *C. perfringens* (i.e. <20cfu/g).
- 91% (n=413) of samples were satisfactory (<10^4 cfu/g), 3.5% (n=16) were acceptable (10^4-<10^5 cfu/g) and 5.5% (n=25) were unsatisfactory (≥10^5 cfu/g) for ACC (Figure 1).



Conclusions:

- The finding that all gravy samples were satisfactory for *C. perfringens* is very encouraging and suggests that adequate controls for cooking and chilling are in place to prevent the growth of this pathogen.
- The finding that 5.5% of samples were unsatisfactory for ACC highlights the need for continued emphasis to be placed on the microbiological quality of the ingredients, temperature control and/or post-process contamination.

Report of 2nd Quarter National Survey 2002 (NS2):

Microbiological Quality of Pre-Prepared and Leftover Gravy

Summary

The microbiological quality (*Clostridium perfringens* and Aerobic Colony Count (ACC)) of pre-prepared and left over gravy (n=454) was assessed during April, May, and June 2002.

All samples were found to be satisfactory for *C. perfringens* (<20cfu/g) suggesting that in the premises tested, adequate controls were in place to prevent the growth of this pathogen. Also, the majority of samples (94.5%) were either satisfactory/acceptable for ACC, however, the detection of samples unsatisfactory for ACC (5.5%) highlights the need for continued emphasis to be placed on the microbiological quality of the ingredients, temperature control and/or post-process contamination.

Introduction

Clostridium perfringens has been identified as the etiological agent in numerous incidents of food poisoning [(1)]. *C. perfringens* is ubiquitious in the environment (soil, dust, vegetation) and is part of the normal intestinal tract of humans and animals, therefore, most foods can be considered as vehicles for this pathogen [(2)].

C. perfringens is an anaerobic (i.e. is capable of growing in the absence of oxygen) spore forming bacteria. Its ability to multiply relatively rapidly in warm conditions is an important characteristic (its generation time[ϖ] is less than 10 minutes in meat between 43 ^{o}C and 47^{o}C) [(3)]. This characteristic has particular significance for foods prepared using a cook-chill process.

During cooking, the heat generated rapidly kills the heat sensitive vegetative cells but not the heat resistant spores (spores of *C. perfringens* are only destroyed by a severe heating process, e.g. the D-value[¥] for spores in beef gravy is 31.4 minutes at 98.9^{o}C or 6.6 minutes at 104.4^{o}C [(3)]), however, cooking can provide the shock required to initiate spore germination. If temperature abuse subsequently occurs during the cooling phase, conditions suitable for the rapid multiplication of the germinated cells may follow. Ingestion of food contaminated with large numbers of vegetative cells ($\geq$ 5x10^{5}/g of food) can cause illness (incubation period 6-24 hours)[(4)]. The vegetative cells which survive the acidic conditions in the stomach, sporulate and release an enterotoxin which cause symptoms including abdominal pain, nausea and acute diarrhoea.

[ϖ] The generation time is the time necessary to double a given bacterial population.

[¥] The D value is the 'decimal reduction' time. This is the time required at any given temperature to reduce the viable count by 90%.

Gravy is of particular concern as a vehicle for this pathogen because:

1) *C. perfringens* may be present in the gravy base (it has been detected in both commercially available dehydrated gravy mixes and in meat stock) and
2) gravy is commonly prepared using a cook-chill process.

There have been a number of food poisoning outbreaks associated with gravy. In 1971 an outbreak due to *C. perfringens* occurred in several Finnish schools [5] and in 1985 a *C. perfringens* outbreak occurred in a factory in Connecticut affecting 44% of the 1,362 employees. In this outbreak the gravy was pre-prepared (12-24h before serving), improperly cooled and insufficiently reheated before serving [2].

This study was carried out to determine the incidence of *C. perfringens* in gravy samples prepared using a cook-chill process. In addition, the overall microbiological quality of the gravy was assessed by determining the levels of ACC.

Specific Objectives

The specific objective of this survey was to assess the microbiological quality of pre-prepared and leftover gravy.

Method

Sample source:

Samples were obtained from any premises serving food and in particular from large catering establishments which were more likely to pre-prepare gravy.

Sample description:

Only cooled pre-prepared or cooled leftover gravy was sampled in this survey (the cooled gravy was sampled either pre-refrigeration or during refrigeration). Samples included meat sock and gravy made from either homemade stock (including gravy from poultry meat), packet stock or a combination of both. Hot samples or freshly made gravy were excluded.

Sample collection and analysis:

Environmental Health Officers from the 10 health boards (Appendix 1) collected samples (minimum of 60 ml or 60g) during April, May and June of 2002. Where possible, either the temperature of the sample or of a control sample was measured aseptically. Ideally, only one sample was submitted per premises and if a repeat sample was deemed necessary for further investigation it was not included in the survey.

The microbiological quality of the gravy was 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. Aerobic colony count (ACC) at 30^{o}C
2. *Clostridium perfringens*

Gravy is not currently classified under the ACC categories of the Irish microbiological guidelines [6]. However, for the purposes of this survey it was classified as food category B (Table 1), since meat products such as casseroles which may be prepared with a gravy base are currently classified in this category.

Table1: Microbiological quality of food category B[¥]

Parameter	Microbiological quality (cfu/g)			
	Satisfactory	**Acceptable**	**Unsatisfactory**	**Unacceptable potentially hazardous**
Aerobic Colony Count	$<10^4$	10^4-$<10^5$	$\geq 10^5$	N/A
C. perfringens	<20	20-<100	100-$<10^4$	$\geq 10^4$

Results and Discussion

A total of 454 samples of cooled gravy were obtained in each of the 10 health boards (Table 2).

Table 2. Number of samples from each health board (n=454)

Health board	No. of survey samples
ECAHB	25
MHB	35
MWHB	43
NAHB	38
NEHB	34
NWHB	45
SEHB	53
SHB	94
SWAHB	40
WHB	47
Total	**454[✪]**

All of the samples submitted for analysis were satisfactory for *C. perfringens* (<20cfu/g) (Table 3).

[¥] Microbiological quality as outlined in the Irish microbiological guidelines [6]

[✪] A total of 459 samples were submitted as survey samples, however 5 samples (3 from the NWHB and 1 from both the MWHB and SEHB) were excluded because they did not meet the survey criteria.

Table 3. *Clostridium perfringens* results by health board (n = 454)

Health board	No. of samples	Microbiological quality (cfu/g)			
		Satisfactory (%)	Acceptable	Unsatisfactory	Unacceptable potentially hazardous
		<20	20-<10^2	10^2- <10^4	≥10^4
ECAHB	25	25 (100)	0	0	0
MHB	35	35 (100)	0	0	0
MWHB	43	43 (100)	0	0	0
NAHB	38	38 (100)	0	0	0
NEHB	34	34 (100)	0	0	0
NWHB	45	45 (100)	0	0	0
SEHB	53	53 (100)	0	0	0
SHB	94	94 (100)	0	0	0
SWAHB	40	40 (100)	0	0	0
WHB	47	47 (100)	0	0	0
Total	**454**	**454 (100)**	**0**	**0**	**0**

To date microbiological surveillance studies have focused primarily on the incidence of *C. perfringens* in dehydrated gravy mixes rather than in prepared gravy. However, a Canadian survey [7] examined the bacterial content of both gravy bases/mixes (n=41) and gravies prepared in restaurants (n=44) and found that *C. perfringens* was not detected in either sample type. In a South African study, *C. perfringens* was detected in only one sample of street vended gravy (n=55) [8]. While the findings of both the Canadian study and this current survey would suggest that in the premises tested adequate controls are in place during the preparation of gravy to prevent the growth of this pathogen, epidemiological studies clearly show that problems can arise leading to food poisoning outbreaks.

In relation to ACC, 91% (n=413) of samples tested in this survey were satisfactory, 3.5% (n=16) were acceptable and 5.5% (n=25) were unsatisfactory for ACC (Table 4).

Table 4. Aerobic Colony Count (ACC) results by health board (n=454)

Health board	No. of samples	Microbiological quality (cfu/g)		
		Satisfactory (%)	Acceptable (%)	Unsatisfactory (%)
		$<10^4$	10^4 - $<10^5$	$\geq 10^5$
ECAHB	25	22 (88.0)	1 (4.0)	2 (8.0)
MHB	35	32 (91.4)	1 (2.9)	2 (5.7)
MWHB	43	40 (93)	0 (0)	3 (7.0)
NAHB	38	36 (94.7)	0 (0)	2 (5.3)
NEHB	34	30 (88.2)	2 (5.9)	2 (5.9)
NWHB	45	41 (91.1)	3 (6.7)	1 (2.2)
SEHB	53	48 (90.6)	2 (3.7)	3 (5.7)
SHB	94	84 (89.4)	5 (5.3)	5 (5.3)
SWAHB	40	37 (92.5)	2 (5.0)	1 (2.5)
WHB	47	43 (91.5)	0 (0)	4 (8.5)
Total	**454**	**413 (91)**	**16 (3.5)**	**25 (5.5)**

The ACC count of the majority (84%) of unsatisfactory samples (n=25) were in the range $\geq 10^5$ to $<10^7$ cfu/g (Table 5).

Table 5. ACC range of the 25 unsatisfactory samples

Health board	Unsatisfactory Microbiological quality (cfu/g)					
	Total no. of samples $\geq 10^5$	$\geq 10^5$ – $<10^6$	$\geq 10^6$ – $<10^7$	$\geq 10^7$ – $<10^8$	$\geq 10^8$ – $<10^9$	$\geq 10^9$ – $< 10^{10}$
ECAHB	2	0	1	0	1	0
MHB	2	2	0	0	0	0
MWHB	3	2	0	0	0	1
NAHB	2	0	1	1	0	0
NEHB	2	1	1	0	0	0
NWHB	1	1	0	0	0	0
SEHB	3	0	3	0	0	0
SHB	5	1	4	0	0	0
SWAHB	1	0	1	0	0	0
WHB	4	0	3	0	1	0
Total	**25**	**7 (28%)**	**14 (56%)**	**1(4%)**	**2 (8%)**	**1 (4%)**

The ACC was measured to assess the overall microbiological quality of gravy samples. A high ACC maybe indicative of poor quality ingredients, poor temperature control in the cook-chill process and/or post process contamination. In this study, 5.5% of samples were classified as unsatisfactory for ACC ($\geq 10^5$ cfu/g) suggesting that more emphasis must be placed on control measures in some catering establishments. The findings of this study are comparable to the findings of a Canadian study [7]. In the Canadian study (n=44), ACC levels $\leq 10^4$ cfu/g were detected in 93% of all gravy samples and levels $>10^4$ cfu/g were detected in the remaining 7% of samples.

In this study it was impossible to link the unsatisfactory samples with information on their preparation and storage because insufficient information was recorded on the sample request forms. For example, information regarding product descriptions, storage conditions and sample temperatures were not available for 60%, 32% and 84% respectively, of the 25 samples unsatisfactory for ACC.

Conclusions

The finding that all gravy samples were satisfactory for *C. perfringens* is very encouraging and suggests that adequate controls are in place during cooking and chilling to prevent the growth of this pathogen. In any cook-chill process, control of *C. perfringens* relies primarily on the use of good time-temperature control measures [4]. Since spore germination may be initiated by the cooking process, rapid cooling particularly through the temperature range 55°C-15°C (to prevent spore germination and multiplication) is an essential control measure. Reheating of the food to a temperature >70°C (to kill any vegetative cells if present) immediately before consumption is also recommended as an additional control step. In a food premise this pathogen may also be spread through the environment, or by cross contamination from food handlers, equipment, utensils etc. Therefore, additional control measures include the use of good food hygiene and food handling practices.

ACC levels are affected by a number of factors including the microbiological quality of the ingredients, temperature control during the cook-chill process and post process contamination. The finding that 94.5% of samples tested in this survey were classified as either satisfactory or acceptable for ACC suggests that adequate controls are in place in most premises, however, there is room for improvement (5.5% of samples were unsatisfactory for ACC).

Currently gravy is not classified under the ACC categories of the Irish microbiological guidelines for ready-to-eat foods [6]. However, the classification (Category B) used in this survey appears appropriate as the majority of gravy samples (94.5%) were classified as satisfactory and this classification is currently used for meat products which may be prepared with a gravy base.

Control measures for *C. perfringens* and other pathogenic microorganisms should be incorporated into a food safety management system based on the principles of HACCP (implementation of HACCP has been a legal requirement in Ireland since 1998).

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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
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