

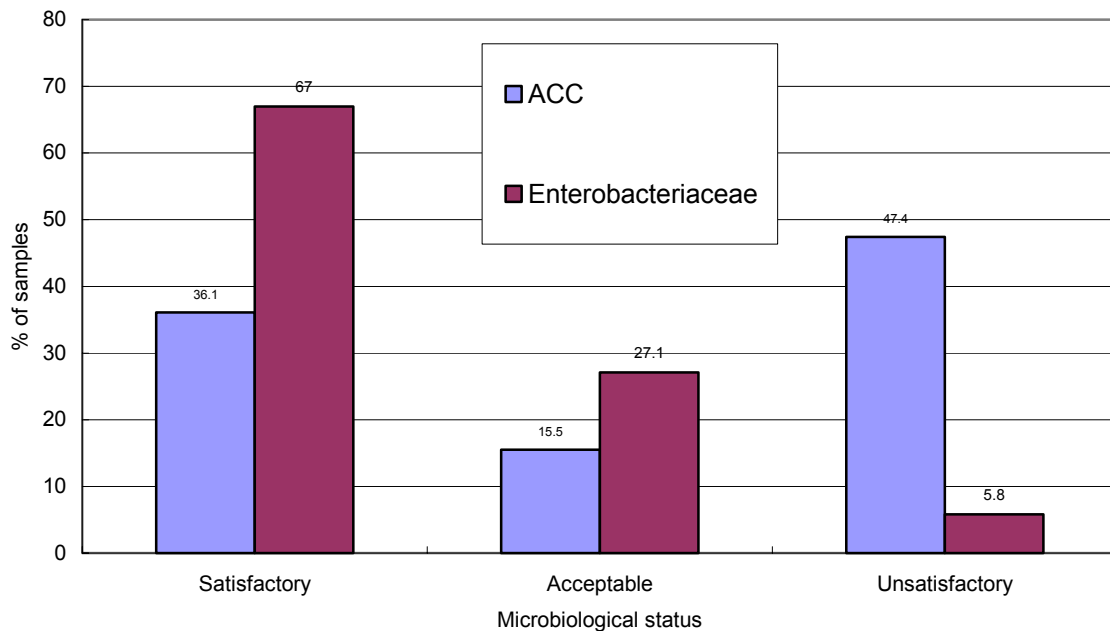
3rd Quarter National Survey 2001 (NS3):

Soft Ice Cream

Executive Summary

- Samples of soft ice cream were tested for levels of aerobic bacteria (aerobic colony count - ACC) and *Enterobacteriaceae*. These bacteria were chosen as indicators of i) the cleanliness of the machine and ii) the pasteurisation processes in the case of self pasteurising machines.
- A total of 552 samples were examined and of these 51.1% and 6.5% were unsatisfactory for ACC and *Enterobacteriaceae* respectively.
- This survey included a questionnaire from which there was a 52.7% response rate (i.e. questionnaires were returned with 291 samples). The following figure outlines the microbiological results of these samples:

Figure 1: Microbiological results of ice cream samples returned with a questionnaire (n=291)



- The questionnaire obtained information on the type of premises sampled, the type of ice cream machine (self-pasteurising/non-self pasteurising machines), the machine brand, the temperature of the machine and the type of staff training. Correlations were made between this information and the microbiological results.
- This survey indicated a poor overall level of hygiene in the service of soft ice cream and highlights the need for improvements in the overall level of hygiene. A number of recommendations to retailers are made in the report.

Report of 3rd Quarter National Survey 2001 (NS3):

Soft ice cream

Summary

This was a study of the microbiological quality of soft ice cream. Sampling took place from July to September 2001. The Aerobic Colony Count (ACC, i.e. total aerobic bacteria) and *Enterobacteriaceae* numbers were determined in a total of 552 samples. 51.1% and 6.5% were found to be unsatisfactory for ACC and *Enterobacteriaceae* respectively.

This was the first national survey to include a questionnaire. 52.7% (n=291) of samples were returned with a questionnaire. Of these samples, 47.4% and 5.8% were unsatisfactory for ACC and *Enterobacteriaceae* respectively. The questionnaire obtained information on the type of premises sampled, the type of ice cream machine (self-pasteurising/non-self pasteurising machines), the machine brand, the temperature of the machine and the type of staff training. Correlations were made between this information and the microbiological results, the following were the main findings:

- i) The most common type of ice cream machine identified was self-pasteurising. Both the machine type (i.e. self-pasteurising/non-self pasteurising) and the temperature recording on the monitor of the machine had a significant effect on the microbiological results (however, the accuracy of the temperature monitor was not assessed).
- ii) Examining the 4 most common machine brands it was found that machine brand had a significant effect on the microbiological results for ACC, but not *Enterobacteriaceae*.
- iii) Unsatisfactory ACC results were greatest in premises sampled where staff received no food hygiene training, however, the relationship between food hygiene training and microbiological results was not significant.

This survey highlights the need for improvements in the overall level of hygiene in the service of soft serve ice cream. A number of recommendations to retailers are made in the report.

Introduction

Soft ice cream is a congealed dairy product produced by freezing a heat treated mixture of milk, cream, milk solids, sugars, stabilisers, emulsifiers and flavourings. In the past the microbiological quality of soft ice-cream has been less than satisfactory, however, microbiological quality should have improved considerably since the advent of self-pasteurising machines and due to increased awareness of the importance of good food handling and hygiene practices.

Two microbiological tests were used in the survey, ACC and *Enterobacteriaceae*. Both tests were chosen as tools to determine the hygienic quality of soft ice cream and the standard of hygiene practised in its preparation and service. The aerobic colony count quantifies the total number of aerobic bacteria present in the foodstuff. The *Enterobacteriaceae* are heat sensitive microorganisms which will not survive a thorough pasteurisation process. Their numbers therefore are a good estimate of the effectiveness of cleaning and pasteurisation processes. Traditionally the coliform group has been used for this purpose. The *Enterobacteriaceae* and the coliform group overlap substantially, however the *Enterobacteriaceae* family include a broader range of microorganisms and their numbers therefore provide more detailed information.

Specific Objectives

- To examine the microbiological quality of soft ice cream
- To test the usefulness of a short questionnaire in addition to the microbiological analysis
- To improve national survey methodology.

Method

Sample source: Samples were collected from retail premises including:

- Vans (e.g. mobile ice cream vans) and stalls (e.g. temporary structures at outdoor events) and
- Shops (e.g. corner shops and supermarkets).

Sample Description: Soft ice cream from ice cream machines, excluding all other elements such as ice cream cones and toppings. The type of ice cream used in machines is a packaged mix which has been either Pasteurised (PT) or Ultra High Temperature (UHT) treated.

Sample collection and analysis: Environmental Health Officers (EHOs) from the various health boards (Appendix 2) collected samples. The samples were analysed for ACC and *Enterobacteriaceae* in one of the 7 Official Food Microbiology Laboratories (OFMLs – Appendix 3) using an approved / standard method (methods accredited by the National Accreditation Board). Results were interpreted using the FSAI microbiological guidelines ⁽¹⁾.

Results and Discussion

A. Results of Samples Submitted for Microbiological Testing

A total of 552 samples were returned with 61%, 24% and 16% of samples collected in July, August and September respectively and the greatest sampling taking place on July 16th with 53 samples (9.6%). All 10 health boards returned results (Table 1) analysed by the 7 official food microbiology laboratories.

Of the 552 samples submitted for microbiological testing, 34.1% and 64.3% of samples were satisfactory for ACC and *Enterobacteriaceae*, while 51.1% and 6.5% of samples were unsatisfactory for ACC and *Enterobacteriaceae* respectively (Table 2). All samples unsatisfactory for *Enterobacteriaceae* were also unsatisfactory for ACC. Table 3 details the microbial counts for ACC and *Enterobacteriaceae*.

Table 1: Number of samples from each health board (n = 552)

Health board [Ⓜ]	Number of samples collected
SHB	84
SEHB	75
NWHB	72
WHB	66
MWHB	50
SWAHB	47
NAHB	46
MHB	43
NEHB	42
ECAHB	27

Table 2: Microbiological quality (ACC & *Enterobacteriaceae*)[Ⓢ] of samples (n = 552)

Microbiological quality	ACC (%) [Ⓢ]	<i>Enterobacteriaceae</i> (%) [Ⓢ]
Satisfactory	34.1	64.3
Acceptable	13.2	27.9
Unsatisfactory	51.1	6.5

[Ⓜ] See appendix 2 for details of health boards

[Ⓢ] Microbiological quality was interpreted using the FSAI microbiological guidelines ⁽¹⁾

[Ⓣ] 1.6% of ACC and 1.3% of *Enterobacteriaceae* results were missing

Table 3: ACC and *Enterobacteriaceae* colony counts

Aerobic Colony Count (ACC)		Enterobacteriaceae	
cfu/g	Percent (%)	cfu/g	Percent (%)
<10 ³	5.4	<10 ²	64.3
10 ³ -10 ⁴	28.6	10 ² -10 ³	13.6
10 ⁴ -10 ⁵	13.2	10 ³ -10 ⁴	14.3
10 ⁵ -10 ⁶	24.5	10 ⁴ -10 ⁵	5.1
10 ⁶ -10 ⁷	17.8	10 ⁵ -10 ⁶	1.1
10 ⁷ -10 ⁸	8.3	≥ 10 ⁶	0.4
≥ 10 ⁸	0.5	Missing Results ‡	1.3
Missing Results ‡	1.6		

ACC and *Enterobacteriaceae* can be used to reflect the hygienic nature of soft ice cream and the effectiveness of hygiene practice in its production. Unsatisfactory results for ACC and/or *Enterobacteriaceae* can reflect poor hygiene practices in premises surveyed.

A previous Irish survey carried out in 1992 with 106 samples indicated that 69.8% of samples surveyed were satisfactory for all parameters tested (ACC, coliforms, *Salmonella* and *Staphylococcus aureus*) with only 3.8% of samples failing to meet the guidelines for ACC ⁽²⁾. This survey did not test for *Enterobacteriaceae*, in addition, the guidelines used for the assessment of ACC ⁽³⁾ (not to exceed 1.0 × 10⁶ cfu/g) were less stringent than the current guidelines ⁽¹⁾ (unsatisfactory: ≥ 1.0 × 10⁵ cfu/g). However, even by applying the less stringent guidelines to the results of this current survey, 26.2% still fail to be categorised as satisfactory.

Analysis of the results of a survey conducted in the UK ^(4,5) using 1246 samples of soft ice cream shows that 40% of these samples would be considered unsatisfactory for ACC and 15% unsatisfactory for *Enterobacteriaceae* using the Irish 2001 guidelines (≥ 1.0 × 10⁵ cfu/g and ≥ 1.0 × 10⁴ cfu/g respectively) ⁽¹⁾.

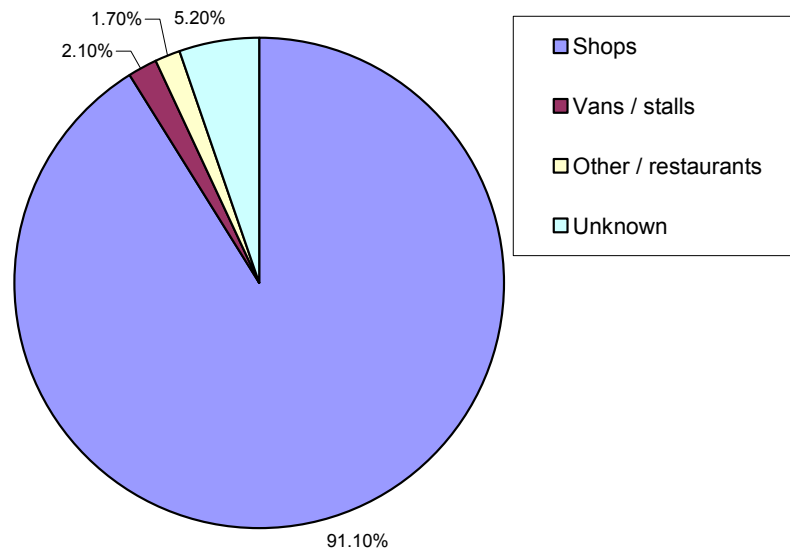
An aerobic colony count in the range of ≥ 1 × 10⁵ to < 1 × 10⁶ cfu/g was found in 47% of ice cream samples (n=150) tested in a Spanish study ⁽⁶⁾. According to the Irish microbiological guidelines ⁽¹⁾ these samples would be classified as unsatisfactory.

‡ Results not returned

B. Results from Samples Returned with a Questionnaire

Approximately half of the 552 samples (291 samples i.e. 52.7%) were returned with the provided questionnaire. Therefore, the remainder of the discussion will refer to these 291 samples unless otherwise indicated. The 291 samples were obtained from a variety of different sources as illustrated in Figure 1.

Figure 1: Distribution of sample source.



Of the 291 results, 36.1% and 67.0% of samples were satisfactory for ACC and *Enterobacteriaceae* while, 47.4% and 5.8% of samples were deemed unsatisfactory for ACC and *Enterobacteriaceae* respectively (Table 4).

Table 4: Microbiological quality (ACC & *Enterobacteriaceae*)^Φ of samples (n = 291)

Microbiological quality	ACC (%) [∅]	Enterobacteriaceae (%)
Satisfactory	36.1	67.0
Acceptable	15.5	27.1
Unsatisfactory	47.4	5.8

Seven samples were taken from ice cream dispensers and were not included in the report as this is a hard ice cream. Interestingly, only one (14.3%) of these

^Φ Microbiological quality was interpreted using the FSAI microbiological guidelines ⁽¹⁾

[∅] ACC results missing for 1% of samples

dispenser samples had unsatisfactory ACC results. All dispenser samples were acceptable for *Enterobacteriaceae*.

A wide variety of machine brands and models were identified in the survey. Machine brands are detailed in Table 5.

Table 5: Machine brands identified in this survey (n = 286)

Machine brand	Frequency	Percent of total
Carpigiani	218	73.1
Taylor	30	10.7
Coldelite	19	6.4
Cattabriga	14	4.7
OTT Swiss Freezer	4	1.3
Frigomat	1	0.3
Unidentified	5	1.7

A statistical examination of the microbiological results from the 4 most common machine brands using a non-parametric Kruskal-Wallis test, found that machine brand had a significant effect ($P < 0.003$) on the microbiological results for ACC, but not *Enterobacteriaceae*. This test did not differentiate between individual machine brands because of the variation in their frequency of usage.

At least 12 different models were identified for the most common brand “Carpigiani” but only 76 of these (34.9%) had model details.

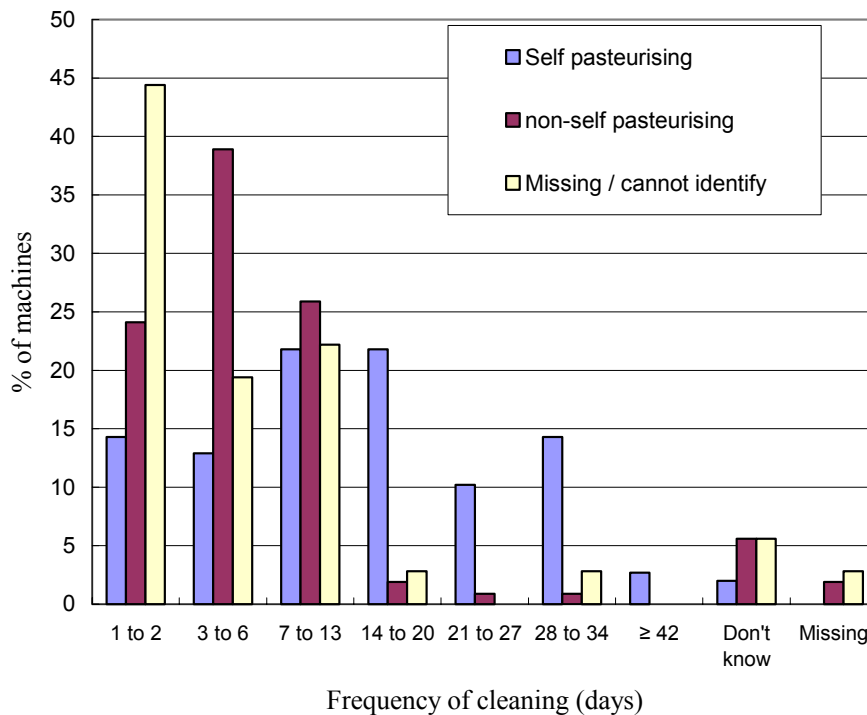
The most common type of ice cream machine identified was self-pasteurising. 147 of the 291 samples (50.5%) were taken from this type of machine, while 108 samples (37.1%) were from non-self pasteurising machines. The type of machine was unidentified or the data was not recorded for 36 samples (12.4%). A non-parametric Mann-Whitney test revealed that there was a significant difference for ACC ($P < 0.0005$) and *Enterobacteriaceae* ($P = 0.001$) on the type (i.e. self-pasteurising/non-self pasteurising) of machine used in soft ice cream preparation and microbiological quality results obtained (Table 6). The relationship between microbiological quality and type of dispensing machine (with or without a pasteurising facility) had previously been noted in a UK study ⁽⁵⁾.

Table 6: Microbiological quality^Φ (ACC & *Enterobacteriaceae*) based on machine type (n = 255)

Microbiological criteria	Microbiological test	Self pasteurising n = 147	Non-self pasteurising n = 108
		(%)	(%)
Satisfactory	ACC	54	19
Acceptable		12	21
Unacceptable		33	58
Results not available		1	1
Satisfactory	<i>Enterobacteriaceae</i>	77	56
Acceptable		20	36
Unacceptable		3	7

Frequency of internal cleaning of machines was considered a more useful indicator of cleaning practices than period since last cleaning. Non-self pasteurising and self-pasteurising machines were cleaned internally on average every 5 and 13 days, respectively (Figure 3).

Figure 2: Frequency of internal cleaning of machines



^Φ Microbiological quality was interpreted using the FSAI microbiological guidelines ⁽¹⁾

No correlation was made between the frequency of internal cleaning and the microbiological quality of the ice cream as it was felt that this question may have been misinterpreted in a number of cases.

External hygiene of machines (n = 291) was found to be exemplary in 17.9% of premises while 70.8% were adequate and 5.5% unclean. 5.8% of returned questionnaires had the external hygiene of machines missing from recorded data.

Of the 291 samples returned with questionnaires, 166 of those were from machines which had a temperature monitor, but only 161 of these had a temperature recorded. The temperature range recorded was between -10°C to +11°C. Details of the temperature recorded are as follows: $\leq -5^{\circ}\text{C}$ (1.4%), > -5 to 0°C (5.5%), 0 to 3°C (16.8%), 3 to 5°C (24.1%) and $>5^{\circ}\text{C}$ (7.6%). Nonparametric correlation using the Spearman's Rho test of the recorded monitor temperatures and the microbiological quality of the samples indicated that for both ACC ($P < 0.0005$) and *Enterobacteriaceae* ($P < 0.002$), as the temperature reading on the machine temperature monitor increased so did the microbiological counts. However, it should be noted that the accuracy of these readings can not be confirmed as it was not a requirement of this survey to check the efficacy of the temperature monitors. Further the actual temperature of the ice cream itself was not required in the survey. However, two questionnaires did return results for ice cream temperature which indicated large inaccuracies between the actual ice cream temperatures of -5°C and -4.6°C and the monitor temperatures of 10°C and 3°C , respectively.

Identified types of food hygiene training were in-house (38.9%), external (19.2%) and a combination of in-house and external (3.1%). 35.0% of respondents indicated no training at all. The most commonly trained personnel were owners (26.1%), managers (15.1%) and full time employees (14.8%). Unsatisfactory ACC microbiological results were greatest in premises sampled where staff received no food hygiene training (10.2%) or only in-house food hygiene training (8.4%). Where staff received both external and in-house training unsatisfactory ACC and *Enterobacteriaceae* microbiological results were 0.2% and 0% respectively. The relationship between food hygiene training and microbiological results however, was not found to be statistically significant - either when training categories were kept individually and treated as an ordered scale (i.e. none = worst to external and internal = best) or when treated as a dichotomous variable (i.e. any training versus no training).

Conclusions

The current survey has indicated a poor overall level of hygiene in the service of soft ice cream. 51.1% of all sample surveyed had unsatisfactory microbiological quality for ACC based on the FSAI microbiological guidelines⁽¹⁾. However, even

after applying the former less stringent 1992 guidelines ⁽³⁾, 26.2% of samples surveyed were still found to be unsatisfactory.

Good hygiene practices would improve the hygienic quality of soft ice cream especially in all steps post-pasteurisation, at retail level. An increased level of staff training and knowledge transfer, particularly in relation to food safety, handling and ice cream machine maintenance and cleaning would improve the situation. Further improvements should be sought in personnel hygiene and the general hygiene conditions of premises. The mandatory adoption of a food safety management system based on the principles of HACCP should improve the quality of soft ice-cream.

The gaps in the data collected in the survey are expected as this was the first survey used in national microbiological surveillance in Ireland to incorporate a questionnaire in addition to sampling. Subsequent surveys employing the use of questionnaires should provide improvements in the quality of data recorded.

Recommendations to Retailers

- A food safety management system based on the principles of HACCP should be developed.
- All staff should have basic training in food hygiene and safety.
- Retailers should consult manufacturers about the ease and efficacy of machine cleaning.
- Manufactures instructions regarding cleaning and sanitation of ice cream machines should be understood and adhered to by all responsible staff.
- Manufactures instructions regarding preparation, use and storage of ice cream mix should be understood and adhered to by all responsible staff.

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