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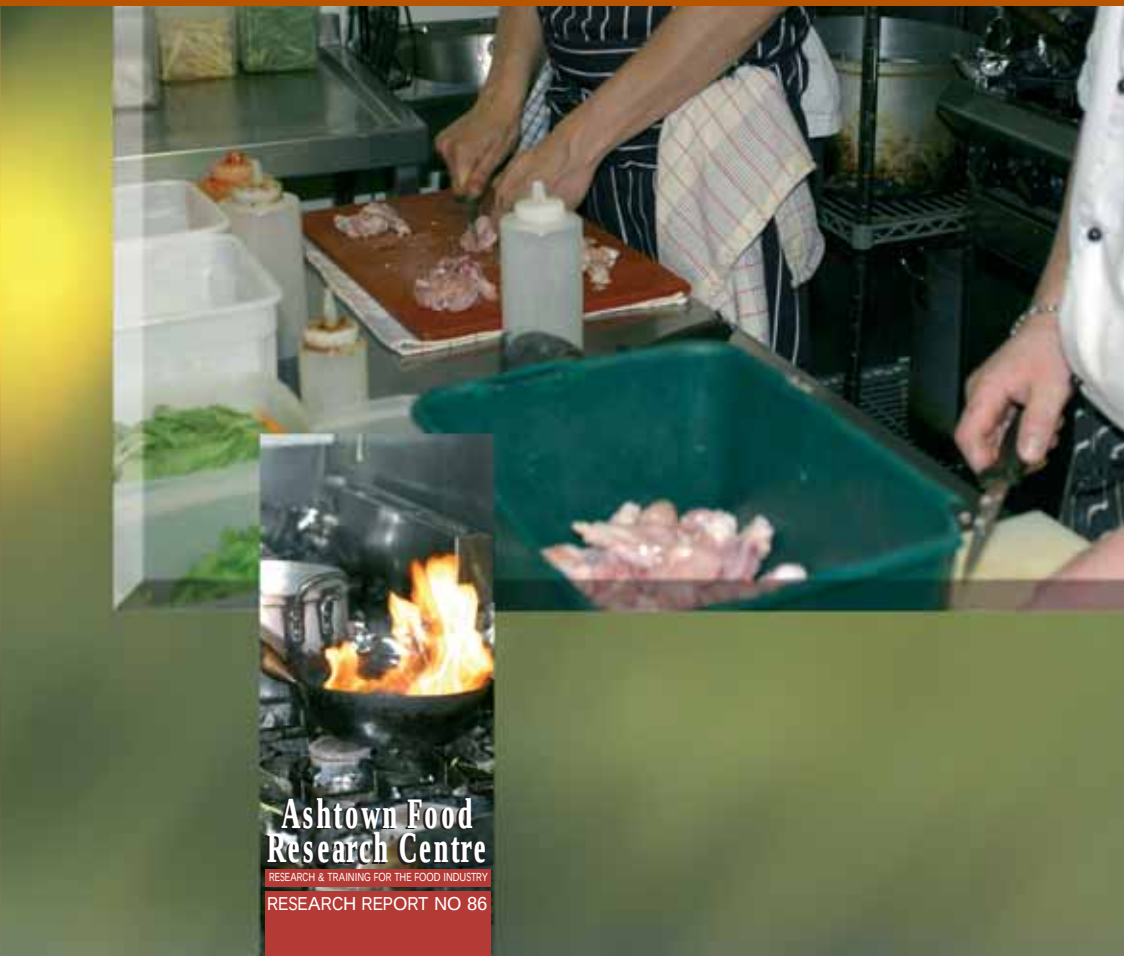
A Risk Assessment and Hazard Analysis and Critical Control Point (HACCP) Study for the Irish Catering Industry



Ashtown Food Research Centre

RESEARCH & TRAINING FOR THE FOOD INDUSTRY

RESEARCH REPORT NO 86

A RISK ASSESSMENT AND HAZARD ANALYSIS AND CRITICAL CONTROL POINT (HACCP) STUDY FOR THE IRISH CATERING INDUSTRY

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Teagasc Oak Park Carlow Co. Carlow

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SUMMARY

This report provides details of a food safety knowledge survey, a microbiological survey, a chilled temperature survey and an audit conducted in 200 restaurants throughout the island of Ireland. The results suggest a low incidence of several bacterial pathogens (including *Salmonella enterica*) and identify areas in which food safety knowledge, procedures and practices should be improved. *Salmonella enterica* isolates were characterised and the results suggested distinct pockets of different serotypes. Growth curves for *L. monocytogenes* isolates suggest considerably reduced shelf-life for a variety of foods. For example, lettuce should not be stored at room temperature or the shelf-life is reduced from 6.5 days (chilled storage) to 3.3 days. The predicted shelf-life for fresh milk was 4.5 days (chilled storage). Chlorine (sodium hypochlorite, 5 ppm), 1-monolauroyl-rac-glycerol and a laurate ester (ester-glucoside laurate) were also tested for application as vegetable decontaminating agents in restaurant kitchens. The report concludes with recommendations for improved food safety and hygiene in Irish restaurants.

INTRODUCTION

Foodborne illness is an unacceptable threat to public health and a major economic loss to the Irish economy in terms of lost working days and health sector costs. Although there are no figures available for Ireland, the annual cost of foodborne illness in the United States is estimated to be $6.7 billion, up to $100 million in New Zealand and $123 million in Sweden. Individual outbreaks are also costly; the *Escherichia coli* O157 outbreak, associated with a school canteen in Japan in 1996, cost the equivalent of €7.2 million.

It is estimated that approximately half of all food-borne infections are associated with the food services industry (Anon., 2000a). The Food Safety Authority of Ireland (FSAI) have identified the following main contributory factors; infected food handlers, cross-contamination, inadequate cooking, inadequate storage, inadequate reheating and delayed serving (Anon., 2000a). All of these factors could and should be controlled through education campaigns, training and the

development of food safety systems such as hazard analysis and critical control point (HACCP). However, the development of effective educational and motivational catering food safety programmes requires background information about current food safety knowledge and food safety / microbiological conditions within the food service industry.

The objectives of this study were as follows:

1. To establish the areas where food safety knowledge is lacking among head chefs and catering kitchen managers

2. To assess hygiene within restaurant kitchens and to determine the incidence of bacterial pathogens in the catering kitchen environment

3. To establish the real refrigeration temperature in restaurant refrigerators

4. To identify key areas where restaurants may improve hygiene / food safety

In order to achieve these, 200 restaurants were visited throughout the island of Ireland and the head chef, catering manager or other person responsible for food safety was interviewed (knowledge survey). The data obtained was analysed using the Statistical Package for the Social Sciences (SPSS). Furthermore, at each establishment the refrigerator, work top, cutting boards and knives were swabbed and the dish cloth sampled; total viable counts (TVC), total coliform count (TCC) and the presence or absence of *Escherichia coli*, *Salmonella*, *Campylobacter*, *Listeria monocytogenes*, *Yersinia enterocolitica*, *Staphylococcus aureus* and *Escherichia coli* O157 were established using standard ISO microbiological methods (ISO, 1991). The *Salmonella* isolates were serotyped and characterised using pulsed field gel electrophoresis. Antibiotic resistance profiles were also established.

Chlorine, 1-monolauroyl-rac-glycerol and a laurate ester (ester-glucoside laurate) were tested for anti-microbial properties, specifically their potential application in the decontamination of vegetables in the catering kitchen. Refrigeration temperatures were determined in 10 randomly selected restaurant refrigerators using temperature data loggers while the growth of *L. monocytogenes* and *Salmonella* catering isolates under the recorded temperature

conditions was investigated. Data generated were used to estimate the shelf-life of meat, dairy and vegetable foods. Fifty randomly selected restaurants were also inspected using a procedure based on 'Hygiene for the Catering Sector' (IS 340: 1994) published by the National Standards Association of Ireland (NSAI).

FOOD SAFETY KNOWLEDGE SURVEY IN IRISH RESTAURANTS

The key findings of the catering food safety knowledge survey were as follows:

- Of those interviewed, 28.5% had a certificate in food preparation, 15% had a diploma, 5% had a degree, 25% had attended a *City and Guilds* course, 6.5% had completed a *CERT* course and 20% had no formal but on-the-job training.

- Of the head chefs, catering managers or other persons responsible for food safety in the catering kitchen, 78% were unaware of the current legislation covering catering food safety.

- HACCP meant different things to different caterers. Responses included; food safety system (10%); process control system (5.5%); temperature control system (8%); documentation procedures (4.5%); hazard analysis and critical control point (60.5%). Other answers accounted for 3.5% while 8% did not know about HACCP.

- In 70% of catering establishments, the suppliers were audited by the head chef. This task was undertaken by the catering manager in 14% of restaurants, by another member of staff in 10.5%, by an external auditor / consultant in 2% while the health board was mentioned in 2.5% of cases, with others accounting for 1%.

- Suppliers were audited by spot checks (13%); at every delivery (42%); daily (10%); weekly (16%); monthly (3%) and yearly (2%).

- When asked what standards were used on which to base supplier audits, 59% of establishments based the audit on a standard developed in-house, 8% cited ISO standards, 7% sought guidance from environmental health

officers, 5.5% from the regional health board, 5% used an FSAI guide while 12.5% were unsure and 3% cited other standards.

- The interviewee knew the recommended refrigeration temperature in 97% of establishments and 91.5% claimed to have a thermometer in refrigeration units, 68.5% in the chill rooms and 79.5% in the freezer unit.

- In 20% of establishments, the thermometer in the low temperature unit (refrigerator, chill room or freezer) was used as the sole source of temperature readings and the temperature of the foods stored in these units was never checked.

- Raw meat was stored on the middle shelf (1%); bottom shelf (30%); in a separate fridge (43%); or in a separate cold room (19%).

- Almost all (99.5%) catering establishments had a designated sink(s) for washing hands and the majority (99%) provided hot water and soap. However, very few (7.5%) provided a scrubbing brush. When asked about cleaning hands after handling raw meat, the majority washed their hands with bactericidal soap (92%) or ordinary soap (2%) while 0.5% (or one respondent) wiped his/her hands with a cloth instead of washing; 5.5% cited other practices.

- In 67.5% of establishments, the interviewee knew that the current recommendation for food held in a bain marie is 63°C or higher while 26.5% of establishments cited this question as not applicable as they did not use a bain marie. Of those that did use this hot holding device, 73.8% checked the temperature of the food, 14.9% relied on the dial reading and 11.3% monitored the temperature of the water.

- When asked about practices to ensure that knives used to cut raw food were not subsequently used on cooked foods, 35.5% of respondents claimed they used a two knife system, 27.5% always washed the knife immediately after use, 25% used colour-coded knives while 12% cited other practices. All respondents (100%) washed the knives with hot water and detergent or mild bleach either manually or using a dishwasher.

- When the same question was asked about cutting boards, 82.5% of respondents used a colour coded system and 8% washed the board.

- In 65% of establishments, a sanitiser was used to clean the refrigerator while 27% used a detergent, 6.0% washing-up liquid and 2% applied a baking soda solution. A sanitiser was also most commonly used (78.5%) when cleaning work tops. Detergent and washing-up liquid were used in 19.5% and 2% of establishments respectively. Most establishments (45.5%) used a dishcloth to clean the refrigerator and work top, with J cloths being used in 26%, blue roll or paper towels in 22% and a sponge in 6.5%.

- Approximately 60% of respondents defrosted meat in the refrigerator, 19% left the meat out at room temperature while 5% or less used a microwave, cold water or cooked the meat frozen.

- There was also a variety of tests used to check that red meat and poultry were fully cooked. For red meat, these included using a probe (40%), touch (27%), cooking for a stated time (13%) and experience (12%). For poultry, a probe was used by 57% of respondents. Less than 10% cited 'until the juice runs clear', visual inspection, when in the oven for a stated time, touch or experience.

- When asked what percentage of their customers prefer their meat rare, 50.5% said 1-10%, 14% said 11-20%, 9.5% said 21-30%, 6.0% said 31-40%, 7.5% said 41-50%, 3% said 51-60% with 5.5% suggesting that over 60% of their customers preferred rare beef and 4% in the 'don't know' category.

- Food that was cooked but not eaten was allowed to cool at room temperature and then placed in chilled storage in 72.5% of establishments, discarded in 9% of restaurants, allowed to cool at room temperature and placed in frozen storage in 1.5% of establishments, left out indefinitely on the counter top at room temperature in 0.5%, with 6% suggesting other practices; 10.5% stated that the question was not applicable.

- Food was reheated to above 70°C in 44% of restaurant kitchens, to below 70°C in 0.5%, served cold in 29.5% and the question was not applicable in 26% of establishments.

The levels of knowledge of microbial pathogens is summarised in Table 1. *Salmonella* (100%), *E. coli* O157 (97.5%), *L. monocytogenes* (84%) and *S. aureus* (78%) were familiar to most interviewees, although the source of these bacteria was less well known.

Table 1. Knowledge of bacterial contamination and pathogens

Bacterium	Had heard of the bacterium (%)	Associated bacterium with relevant food (% of those who had heard of the bacterium)		
Salmonella	100%	Poultry 72%	Pork 6.5%	Eggs 56%
Listeria monocytogenes	84%	Beef 3.5%	Soft cheese 38.5%	Vegetables 9%
Shigella	13%	Meat 2%	Water 4%	Salads 2%
E. coli O157	97.5%	Beef 43%	Raw milk 5%	Burgers 45%
Campylobacter	41.5%	Poultry 14%	Pork 3%	Eggs 2%
Bacillus cereus	47.5%	Rice 25%	Cream/milk 2%	Soup 5%
Staphylococcus aureus	78%	Milk 3.5%	Eggs 1%	People 59%
Clostridium perfringens	41.5%	Meat 10.5%	Spices 5%	
Clostridium botulinum	71%	Canned foods 44%	Meat 5.5%	
Yersinia enterocolitica	7%	Pork 6%		

The results of the microbiological survey are shown in Tables 2-6. The total viable counts (TVC) ranged from 94,904 bacteria per cm^2 on the countertops to 3,235,937 bacteria per ml in the dishcloth. The total coliform counts (TCC) ranged from 170 coliform bacteria per cm^2 in the refrigerator to 18,621 coliform bacteria per ml in the dish cloth. *S. aureus* was the most prevalent pathogen while *E. coli* O157 was not detected at any stage. Generic *E. coli*, *Salmonella*, *Campylobacter*, *L. monocytogenes* and *Y. enterocolitica* were detected in a low percentage of restaurant kitchens.

Table 2. Bacterial contamination in catering refrigeration systems

Bacterium	Bacterial count / Incidence
Total viable count	119,526 bacteria per cm^2
Total colifom count	170 coliform bacteria per cm^2
E. coli	4%
Salmonella	6%
Campylobacter	1%
L. monocytogenes	3%
Y. enterocolitica	1%
S. aureus	24%
E. coli O157	0%

Table 3. Bacterial contamination on catering work-tops

Bacterium	Bacterial count / Incidence
Total viable count	94,406 bacteria per cm^2
Total colifom count	473 coliform bacteria per cm^2
E. coli	2%
Salmonella	2%
Campylobacter	0%
L. monocytogenes	0%
Y. enterocolitica	0%
S. aureus	25%
E. coli O157	0%

Table 4. Bacterial contamination on cleaned catering cutting boards

Bacterium	Bacterial count / Incidence
Total viable count	602,559 bacteria per cm^2
Total colifom count	977 coliform bacteria per cm^2
E. coli	3%
Salmonella	9%
Campylobacter	1%
L. monocytogenes	2%
Y. enterocolitica	1%
S. aureus	23%
E. coli O157	0%

Table 5. Bacterial contamination on cleaned catering knives

Bacterium	Bacterial count / Incidence
Total viable count	109,648 bacteria per cm^2
Total colifom count	257 coliform bacteria per cm^2
E. coli	1%
Salmonella	3%
Campylobacter	0%
L. monocytogenes	1%
Y. enterocolitica	0%
S. aureus	13%
E. coli O157	0%

Table 6. Bacterial contamination in catering dish-cloths

Bacterium	Bacterial count / Incidence
Total viable count	3,235,937 bacteria per ml
Total colifom count	18,621 coliform bacteria per ml
E. coli	8%
Salmonella	9%
Campylobacter	2%
L. monocytogenes	2%
Y. enterocolitica	1%
S. aureus	28%
E. coli O157	0%

CHARACTERISATION OF *SALMONELLA* ISOLATES IN CATERING ESTABLISHMENTS

Salmonella isolates were serotyped and characterised using pulsed field gel electrophoresis; antibiotic resistance profiles were also established. The results demonstrated distinct pockets of *Salmonella* serotypes in different areas of the country. *Salmonella enterica* Typhimurium DT104 (R-type ACSSuT) was isolated from the cutting board and fridge in an establishment in Dingle. *Salmonella enterica* Agona was isolated in Tralee, Dingle and Clonakilty. PFGE suggested that the same strain was present in 3 different establishments in Tralee with a second strain being present in 2 Tralee restaurants, 1 establishment in Dingle and another in Clonakilty. *Salmonella enterica* Agona was not isolated anywhere else in the country. *Salmonella enterica* Virchow was only found in 2 restaurants, both of which were in Malahide in Dublin; PFGE confirmed that these were the same strain. *Salmonella enterica* Hadar appeared in Galway and Ennis but nowhere else in the country. However, the Galway and Ennis strains were different. The same strain of *Salmonella enterica* Dublin was isolated in restaurants in Cork city and Mallow only. Other serotypes included *Salmonella enterica* Infantis in Wexford and *Salmonella enterica* Derby in Dublin.

The *S.* Typhimurium were resistant to ampicillin, chloramphenicol, streptomycin, sulphonamide and tetracycline. Most of the *S.* Agona showed no antibiotic resistance but 2 isolates were resistant to streptomycin and nalidixic acid. The *S.* Virchow were susceptible to all antibiotics tested including sulphonamide, nalidixic acid, ampicillin, cefotaxime, chloramphenicol, ciproflaxacin, gentamycin, kanamycin, nitrofurantoin, streptomycin, tetracycline, trimethoprim, ceftazidine and minocycline. The *S.* Derby were resistant to sulphonamide, tetracycline, trimethoprim and minocycline; *S.* Hadar was resistant to streptomycin and tetracycline and the *S.* Dublin resistant to streptomycin and nalidixic acid. *S.* Infantis showed no resistance.

CHILLED TEMPERATURE SURVEY IN IRISH RESTAURANTS

Results from the temperature survey suggested that those restaurant refrigerators tested operated within the recommended temperature range of 1°C to 5°C.

INVESTIGATING THE POTENTIAL GROWTH OF *L. MONOCYTOGENES*

A cocktail of 5 different *L. monocytogenes* isolates was cultured in meat, dairy and vegetable dishes, incubated using the temperature profiles established in the catering technical survey (1°C to 5°C) and using a temperature abuse scenario (20°C). From the data obtained, generation times (g; the time required for the cultures to double in number) were calculated and maximum shelf-life was estimated allowing for 7 generations from 1 *L. monocytogenes* cell to a target of 128 cells (2 log) (Table 7).

Table 7. Generation times and estimated shelf-life for a variety of foods.

Food	Generation time at 20°C (hours)	Estimated shelf-life at 20°C (days)	Generation time at 1-5°C (hours)	Estimated shelf-life at 1-5°C (days)
Minced beef	10.6	3.1	20.2	5.9
Vegetable soup	16.6	4.8	36.8	10.7
Oxtail soup	15.9	4.6	28.8	8.4
Fresh milk	8.9	2.6	15.3	4.5
Lettuce	11.3	3.3	22.4	6.5

INVESTIGATING THE POTENTIAL APPLICATION OF ANTI-MICROBIAL AGENTS IN CATERING FOOD PREPARATION

Lettuce, radishes and celery were inoculated with *L. monocytogenes*. Each was then treated with water (control), chlorine (sodium hypochlorite, 5 ppm), 1-monolauroyl-rac-glycerol and a laurate ester (ester-glucoside laurate). The latter reduced total viable counts on each vegetable by an average of 2 log

values while the other treatments had no effect. Both the 1-monolauroyl-rac-glycerol and the laurate ester reduced the average *L. monocytogenes* count on each vegetable by approximately 1 log while the chlorine had no affect.

FOOD SAFETY / HYGIENE AUDIT OF IRISH RESTAURANTS

The top ten food safety / hygiene audit failings in Irish restaurants were as follows:

1. dishcloths were a potential vehicle for cross-contamination (96% failed)
2. air/airflow was a potential vehicle for contamination (72% failed)
3. the layout did not protect against accumulation of dirt (68% failed)
4. delivery checklists did not include an inspection of the hygiene of the delivery person (63% failed)
5. ceilings and overhead fixtures were not designed and finished to prevent the accumulation of dirt, to prevent condensation, to prevent the growth of moulds and the shedding of particles (63% failed)
6. delivery checklists did not include an inspection of the packaging (56% failed)
7. the hygiene / HACCP prerequisite manual did not include hygiene training and job description (56%)
8. washing procedures for knives and other tools or designated knives did not protect against cross-contamination (50% failed)
9. horizontal sills and ledges had not been avoided (50% failed)
10. doors were not in good repair and condition (47% failed)

The complete audit list is provided in Annex A to allow restaurant owners and chefs to undertake their own internal audit.

CONCLUSIONS AND RECOMMENDATIONS

In summary, based on the findings of the studies reported in this document, Irish restaurants could improve food safety within their establishments by taking a number of key steps. It is therefore recommended that the following be implemented:

1. provide information and a food safety warning on the menu regarding undercooking of meat for consumers who prefer their meat rare
2. use a temperature probe to establish that meat and poultry are properly cooked
3. slice / portion cooked foods to facilitate cooling and placing the same in chilled storage as soon as possible
4. review premises and procedures as potential sources of cross-contamination
5. replace the dishcloth with a disposable equivalent or store the dishcloth in a bucket of disinfectant when not in use
6. provide personal hygiene training and include a scrubbing brush as a standard hand washing tool
7. review and upgrade food delivery inspections
8. develop, document and implement HACCP prerequisite and HACCP food safety systems.

PUBLICATIONS FROM THIS PROJECT

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ANNEX A

The audit queries were as follows:

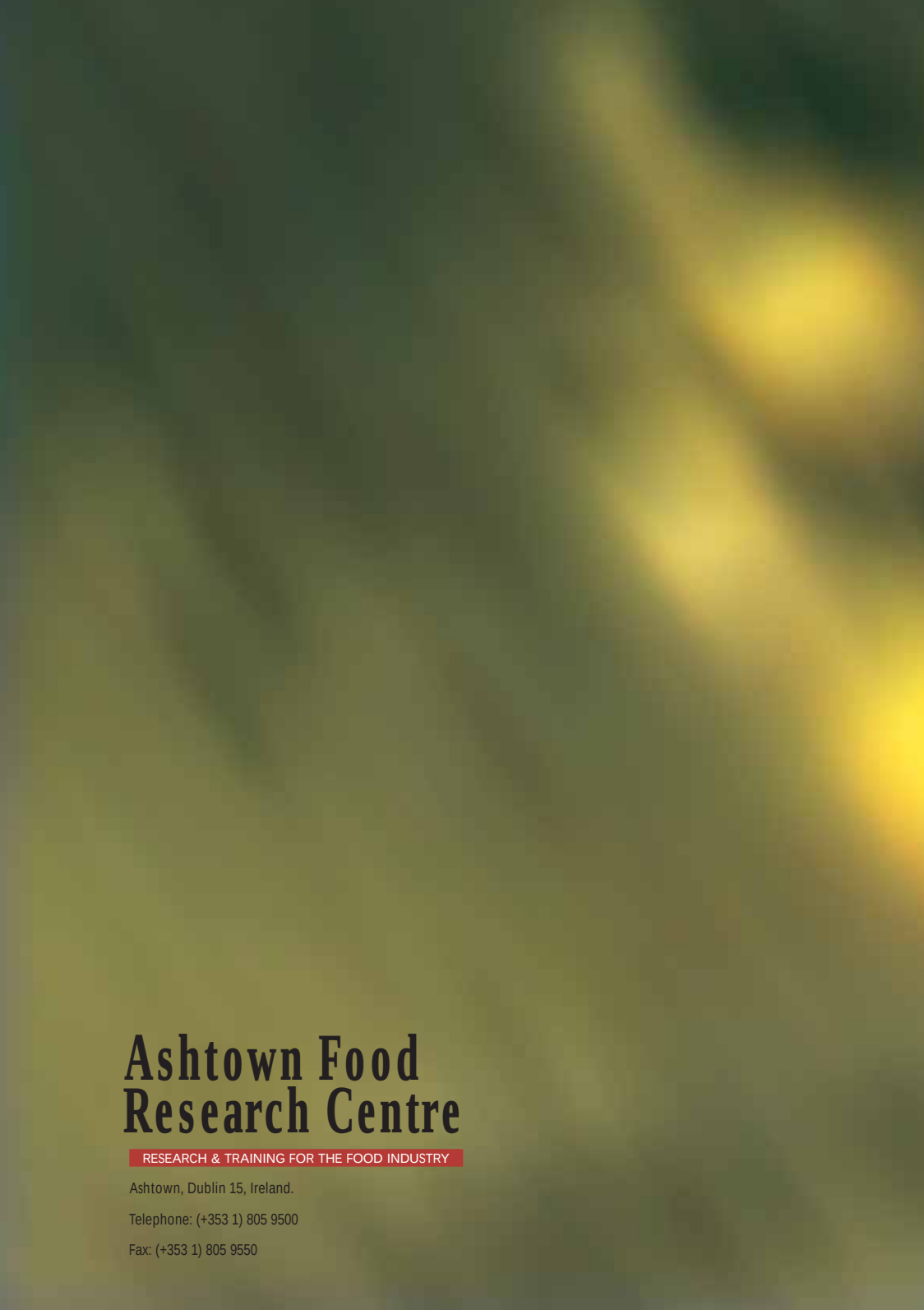
1. were the floors in good repair and condition?
2. were the counter / tables in good repair and condition?
3. were the walls in good repair and condition?
4. were the ceilings in good repair and condition?
5. were the doors in good repair and condition?
6. were the sinks in good repair and condition?
7. were window and door openings to the outside fitted with a fly screen or equivalent protection?
8. have horizontal sills and ledges been avoided?
9. does the layout permit adequate cleaning and sanitation?
10. does the layout protect against the accumulation of dirt?
11. does the layout protect against condensation?
12. does the layout protect against food contact with toxic materials?
13. does the layout protect against the formation of moulds?
14. are ceilings and overhead fixtures designed and finished to prevent the accumulation of dirt, to prevent condensation, to prevent the growth of moulds and the shedding of particles?
15. are surfaces that come in contact with food easy to clean and sanitise?
16. is there adequate provision for washing tools?
17. is there adequate provision for the washing of food?
18. are colour coded cutting boards used to protect against cross-contamination?
19. are there washing procedures for knives and other tools or designated knives to protect against cross-contamination?
20. is there correct storage of raw meat to protect against cross-contamination?
21. are there designated sinks for washing food to protect against cross-contamination?
22. is all equipment in good working order and easily cleaned?

23. are food transport containers clean to protect against cross-contamination?
24. are dishcloths a potential vehicle for cross-contamination?
25. is there an adequate number of designated wash-hand basins?
26. do designated wash-hand basins have hot and cold water?
27. do designated wash-hand basins have soap / antibacterial soap?
28. do designated wash-hand basins have hygienic drying facilities?
29. is there an adequate number of designated staff toilets?
30. does the layout ensure toilets do not open directly into the food preparation area?
31. is there adequate ventilation in the toilets?
32. are there adequate changing facilities for personnel?
33. is there air flow from clean to contaminated areas?
34. is the drainage system a potential source of bacterial pathogens?
35. is there food / other waste in the food preparation area?
36. are food waste containers easily cleaned, closed and located in a self-draining area?
37. does the waste bin area exclude pests?
38. is the water used potable?
39. are all personnel wearing suitable, clean protective clothing?
40. have the staff received food safety training?
41. have the staff received training in personal hygiene?
42. do you ensure that employees suffering from food poisoning, diarrhoea or other illness are not permitted to work in the food preparation area by requiring them to complete a medical questionnaire before the commencement of employment?
43. do you ensure that employees suffering from food poisoning, diarrhoea or other illness are aware they should not work in the food preparation area by covering this in a training course?
44. if an employee is out of work as a results of illness for more than 3 days, are they required to produce a certificate of fitness signed by a doctor to return to work?
45. do you ensure that employees suffering from cuts, boils and sores cover

them with a suitable dressing?

46. do you use electrocuters to control flying insects?
47. are there suitable screens to prevent insects gaining access to the food preparation area?
48. do you have a HACCP plan of some description?
49. if you have a HACCP plan, are cooking and chilling considered to be CCPs?
50. do you have a hygiene / HACCP prerequisite manual?
51. if you have a hygiene / HACCP prerequisite manual, does this include hygiene training and job description?
52. if you have a hygiene / HACCP prerequisite manual, does this include cleaning and maintenance schedules?
53. is the temperature of the refrigerator / chill room between 1°C and 5 °C?
54. is the temperature of the refrigerator / chill room monitored?
55. are there records of refrigerator / chill room temperatures?
56. is the temperature of the bain marie monitored?
57. are there records of bain marie temperatures?
58. do you have a hygiene policy and are you able to produce the same for inspection?
59. do you have audit checklist for self-auditing and are you able to produce these for inspection?
60. do you have a list of approved suppliers and are you able to produce these for inspection?
61. do you have checklists for inspection of deliveries and are you able to produce these for inspection?
62. if you have checklists for inspection of deliveries, do these include inspection of the suitability of the vehicle?
63. if you have checklists for inspection of deliveries, do these include inspection of the hygiene of the delivery person?
64. if you have checklists for inspection of deliveries, do these include inspection of the ‘best before’ or ‘use by’ dates?
65. if you have checklists for inspection of deliveries, do these include inspection of packaging?

66. if you have checklists for inspection of deliveries, do these include a check of the temperature of the food?
67. do you have a copy of the Irish Standard ‘Hygiene in the Catering Sector’?



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