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# Microbiological examination of cold ready-to-eat sliced meats from catering establishments in the United Kingdom

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I. GILLESPIE, C. LITTLE AND R. MITCHELL. 2000. A microbiological study of cold, ready-to-eat sliced meats from 2579 catering establishments (public houses, hotels, cafés, restaurants, residential homes and other catering premises) found that 2587 of 3494 samples (74%) were of acceptable quality, 892 (26%) were of unsatisfactory quality and 15 (<1%) were of unacceptable quality. Unacceptable results were due to high levels of *Escherichia coli*, *Staphylococcus aureus*, *Listeria* species and/or *Clostridium perfringens*. Unsatisfactory results were mostly due to high Aerobic Plate Counts. The microbiological quality of cold, ready-to-eat meats was associated with meat type, premises type, management training, hygienic practices, meat supplier and length of storage. The relationship between food hygiene training and microbiological quality is discussed.

## INTRODUCTION

This study was the first of two surveys that formed the 1998/1999 Local Authority Co-ordinating Body on Food and Trading Standards (LACOTS)/Public Health Laboratory Service (PHLS) Co-ordinated Food Liaison Group Microbiological Sampling Programme. Commercial catering premises (restaurants, hotels, public houses, canteens and caterers) accounted for 19% (293/1568) of general outbreaks of infectious intestinal disease during 1995–1996, 62% (183/293) of which were food-borne. Residential homes for the elderly also figured prominently (30% of outbreaks), although person-to-person (83%) transmission was more common in these settings (Evans *et al*. 1998). Meat or poultry eaten cold or pre-warmed was a predominant vehicle of food poisoning. Key contributing factors included inadequate cooking, inappropriate storage and/or cross-contamination. Infected food handlers were also identified in some outbreaks (POST 1997; Evans *et al*. 1998). Between 1992 and 1997 in England and Wales, there were 20 reported outbreaks of food poisoning attributed to consumption of contaminated cold meats from catering premises, with 573 people affected, most (55%) of which occurred between the months of June and August (CDSC, unpublished). Large outbreaks of salmonellosis in the UK have also implicated catering premises where cold meats were consumed at social functions (CDSC 1992a, b; Davies *et al*. 1996). Furthermore, cold meats from these premises have been identified as a risk factor for sporadic infections of *Escherichia coli* O157 infection in the UK (Parry *et al*. 1998).

Catering is one of the largest industries in the UK, with over 300 000 outlets of different establishments (JHIC 1998). Eating out has increased considerably over recent years, and *per capita* consumption of meat and meat products outside the home has also recovered from 1996 when the main BSE crisis occurred (MAFF 1998). In addition, many changes in styles of catering have been developed, such as the serving of foods in public houses and an increase in the number and type of international cuisine restaurants to name but a few (Committee on the Microbiological Safety of Food 1991). While some of these developments may permit improvements in food handling practices, others may introduce new problems for food safety (Committee on the Microbiological Safety of Food 1991). The Food Safety (General Food Hygiene) Regulations 1995 implements the European Community's Directive on Food Hygiene (93/43/EEC). Caterers must now apply the principles of hazard analysis to their own businesses. Food hygiene training and instruction for all staff handling food is also a new legal requirement. The Joint Hospitality Industries Congress (JHIC), which represents all sectors of the catering industry, produced the UK Catering Industry Guide (JHIC 1997) to advise catering businesses of

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how to comply with their legal obligations and to ensure food safety.

Catering premises and residential homes throughout the UK were surveyed in this study to determine the extent to which they comply with the legal requirements. In addition, cold ready-to-eat meats were examined for the presence of *Salmonella* spp. and *E. coli* O157. *Listeria monocytogenes*, *Listeria* spp., *Staphylococcus aureus*, *E. coli*, *Clostridium perfringens* and Enterobacteriaceae were enumerated and the Aerobic Plate Count (APC) was determined to obtain an indication of hygiene and levels of contamination.

## MATERIALS AND METHODS

### Sample collection

Cold, sliced, ready-to-eat meats collected from hotels, public houses, restaurants, cafés and residential care homes were examined in PHLS and non-PHLS laboratories in the United Kingdom (UK), between 1 June and 31 July 1998, using a standardized protocol and reporting system. Samples (100 g) consisted of cooked meats cut or sliced on or off the premises. Fermented meats and fish were specifically excluded from this study. Samples were collected by staff from local Environmental Health Departments in accordance with the Food Safety Act 1990, Code of Practice No. 7.

Information on the catering premises was recorded on a standard proforma by observation and enquiry. This included information on the premises and practices, with regard to food safety legislation (Food Safety Act 1990, Code of Practice No. 9), slicing and storage of cooked meats, documentation of a hazard analysis system, and the level of food hygiene training received by the manager.

### Isolation of bacteria

Aerobic Plate Counts were determined according to British Standard (BS) 5763: Part 5 (1991) by spiral- or surface-plating (Roberts *et al*. 1995). Plates were incubated at 30 °C for 48 h. Enterobacteriaceae were enumerated using BS 5763: Part 10 (1993b). *Escherichia coli* was enumerated by spiral- or surface-plating onto BCIG agar (tryptone bile agar containing 5-bromo-4-chloro-3-indolyl-$\beta$-D-glucuronic acid; Oxoid). Plates were incubated at 30 °C for 4 h and then at 44 °C for $18 \pm 2$ h. Identification was confirmed as the growth on BCIG agar at 44 °C with a positive $\beta$-glucuronidase reaction (Frampton and Restaino 1993). Isolation and enumeration of *Staph. aureus* was in accordance with BS 5763: Part 7 (1983) by spiral- or surface-plating (Roberts *et al*. 1995). Isolation and enumeration of *Listeria* spp. and *L. monocytogenes* were by US Food and Drugs Administration (FDA) methods (Roberts *et al*. 1995). *Listeria* spp. at levels $\geqslant 10^3$ cfu $g^{-1}$ were sent to the Food Hygiene Laboratory (FHL), Central Public Health Laboratory (CPHL) for further characterization and typing. *Clostridium perfringens* was enumerated using BS 5763: Part 9 (1993a). *Salmonella* spp. were detected in accordance with BS EN 12824 (1998). *Escherichia coli* O157 was detected by enrichment in pre-warmed (42 °C) modified tryptone soya broth (MTSB) with novobiocin (20 mg $l^{-1}$) for up to 24 h. Either 100 $\mu$l were sub-cultured to Cefixime Tellurite Sorbitol MacConkey (CT-SMAC) agar, or immunomagnetic separation was performed after 6 and 24 h, and 50 $\mu$l of resuspended beads were inoculated onto a plate of CT-SMAC after 6 and 24 h. Plates were incubated at 37 °C for 20–24 h (Bolton *et al*. 1995, 1996).

## RESULTS

A total of 3494 cold, ready-to-eat sliced meat samples were collected and examined from 2579 catering establishments in the UK. Samples were submitted by 58 Local Authority Food Liaison Groups, involving 372 Local Authorities, for examination by 50 laboratories (38 PHLS and 12 non-PHLS).

### Micro-organisms isolated from cold, ready-to-eat sliced meats

*Cold sliced meats.* Of the 3494 samples examined, 1658 were ham and tongue (food category 4 (Gilbert *et al*. 1996)) and of these, 269 (8%) samples had APCs of $10^7$ cfu $g^{-1}$ or more (Table 1). Of the 1821 other meat samples (food category 3 (Gilbert *et al*. 1996)), 444 (13%) had APC levels in excess of $10^6$ cfu $g^{-1}$. Enterobacteriaceae ($\geqslant 10^4$ cfu $g^{-1}$) were present in 296 (8%) samples. *Escherichia coli* ($\geqslant 10^2$ cfu $g^{-1}$) was present in 114 (3%) samples. *Staphylococcus aureus* ($\geqslant 10^2$ cfu $g^{-1}$) was present in 52 (1%) samples. *Clostridium perfringens* ($\geqslant 10^2$ cfu $g^{-1}$) was present in 12 (0·3%) samples. *Listeria* spp. and *L. monocytogenes* ($\geqslant 10^2$ cfu $g^{-1}$) were present in 13 (0·3%) and 5 (0·1%) samples, respectively. *Listeria seeligeri* found in excess of $10^3$ cfu $g^{-1}$ was isolated from two of the samples (ham). Neither *E. coli* O157 nor *Salmonella* spp. were detected from any of the samples (Table 1).

### Microbiological quality of cold sliced meats

Based on the PHLS Microbiological Guidelines for some ready-to-eat foods sampled at point of sale (Gilbert *et al*. 1996), 48% of samples were satisfactory, 26% were borderline and 26% were unsatisfactory. Fifteen (0·4%) samples were of unacceptable quality (Table 2). This was due to high levels of *E. coli*, *Staph. aureus*, *Listeria* spp. and *Cl. perfringens*. The APC was the microbiological parameter most often associated with unsatisfactory results, accounting for 702 of the 892 (79%) unsatisfactory samples, 20% of which also had unsatisfactory ($\geqslant 10^4$ cfu $g^{-1}$) levels of Enterobacteriaceae. The remainder (21%) were due to the presence of Entero-

**Table 1** Microbiological results of cold ready-to-eat meats from catering premizes ($n = 3494$)

| | ND* in 25 g | D† in 25 g | ND | $<10^2$§ | $10^2$–$<10^3$ | $10^3$–$<10^4$ | $10^4$–$<10^5$ | $10^5$–$<10^6$ | $10^6$–$<10^7$ | $\geqslant 10^7$ | NE‡ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aerobic Plate Count | | | | | 513 | 742 | 688 | 596 | 433 | 511 | 11 |
| Enterobacteriaceae | | | 1902[a] | 393 | 556 | 339 | 171 | 90 | 27 | 8 | 8 |
| *E. coli* | | | 3276[b] | 89 | 78 | 23 | 8 | 3 | 2 | 0 | 15 |
| *Staph. aureus* | | | 3369[b] | 59 | 35 | 14 | 1 | 2 | 0 | 0 | 14 |
| *Listeria* spp.¶ | | | 3438[b] | 23 | 11 | 1 | 1 | 0 | 0 | 0 | 20 |
| *L. monocytogenes* | | | 3442[b] | 8 | 5 | 0 | 0 | 0 | 0 | 0 | 39 |
| *Cl. perfringens* | | | 3373[a] | 91 | 7 | 4 | 1 | 0 | 0 | 0 | 18 |
| *E. coli* O157 | 3349 | 0 | | | | | | | | | 145 |
| *Salmonella* spp. | 3435 | 0 | | | | | | | | | 59 |

* ND, Not detected.
† D, Detected.
‡ NE, Not examined (full set of microbiological parameters not performed on sample).
§ cfu $g^{-1}$.
¶ Not *L. monocytogenes*.
a, Lower detection limit $<10$ cfu $g^{-1}$; b, lower detection limit $<20$ cfu $g^{-1}$.

bacteriaceae ($\geqslant 10^4$ cfu $g^{-1}$) and/or *E. coli*, *Staph. aureus* and *Cl. perfringens* in excess of $10^2$ cfu $g^{-1}$.

Meat types sampled included ham (47%), beef (23%), turkey (10%), chicken (8%), pork (6%) and lamb (4%) (Table 2). Other samples (including corned beef, tongue, bacon, duck and gammon) made up 2%. In <1%, the type of meat was not specified. Significantly more samples of turkey (40%) were of unsatisfactory or unacceptable microbiological quality compared with beef (30%), pork (27%), chicken (24%), lamb (23%) and ham (22%) ($P < 0{\cdot}001$).

## Product history in relation to microbiological quality

*Place of cooking.* Approximately half (56%) of the cold meat samples were cooked on the premises, 43% were cooked elsewhere and of the remaining 1%, place of cooking was not specified. Significantly more samples that were cooked elsewhere (31%) were of unsatisfactory or unacceptable microbiological quality compared with those that were cooked on the premises (22%) ($P < 0{\cdot}001$).

Of the 1958 meat samples cooked on the premises, 21% had been cooked within 1 day, 39% over a day ago, 20% over 2 days ago, 9% over 3 days ago, and 6% over 4 days ago. For 6% of samples, the time since cooking was not known. Significantly more samples which had been cooked over 4 days ago were of unsatisfactory or unacceptable microbiological quality (28%) compared with those which had been cooked for less than this time (>3 days (25%), >2 days (27%), >1 day (23%), <1 day (14%)) ($P < 0{\cdot}001$).

Over a third (38%) of meat samples cooked elsewhere were supplied from wholesalers, approximately a quarter (26%) from butchers and a smaller proportion (5%) from supermarkets. Other suppliers (central distributors, delicatessens, poulterers, hotels, markets etc.) accounted for 2% of samples. For 29% of samples, the supplier details was not specified. Significantly more unsatisfactory or unacceptable samples (28%) were supplied from butchers and wholesalers than those supplied from supermarkets (19%) ($P < 0{\cdot}01$).

Over half (51%) of the cold meat samples cooked elsewhere were transported to the catering premises vacuum-wrapped, 11% were wrapped in cling film and 2% were transported in open trays. Other methods of packaging (tins, boxes, closed trays, aluminium foil, greaseproof paper etc.) were used for 2% of samples. For a third (33%) of samples, the transportation packaging was not known. Cold meats packaged in vacuum wrap (29%) were more likely to be of unsatisfactory or unacceptable microbiological quality compared with those packaged in cling film (27%) or in open trays (27%).

*Slicing.* Approximately half (59%) of the 3494 cold meat samples collected were freshly sliced, 39% were pre-sliced and for 3%, this information was not specified. Significantly more pre-sliced samples (30%) were of unsatisfactory or unacceptable microbiological quality compared with those which were freshly sliced (24%) ($P < 0{\cdot}001$). Sixty-eight percent of freshly sliced meat samples were sliced using a knife and 32% by a meat slicing machine. Significantly more meats that had been sliced by machine (28%) were of unsatisfactory or unacceptable microbiological quality compared

**Table 2** Samples of cold ready-to-eat meats categorized by meat type, based on the 1996 PHLS microbiological guidelines (Gilbert *et al.* 1996)

| Meat type | Satisfactory (%) | Borderline–limit of acceptability (%) | Unsatisfactory (%) | Unacceptable/potentially hazardous (%) | Total |
|---|---|---|---|---|---|
| Ham | 828 (51) | 452 (28) | 346 (21) | 6 (<1) | 1632 |
| Beef | 343 (43) | 209 (26) | 234 (30) | 4 (<1) | 790 |
| Turkey | 129 (35) | 88 (24) | 145 (40) | 2 (<1) | 364 |
| Chicken | 149 (53) | 66 (23) | 67 (24) | 1 (<1) | 283 |
| Pork | 101 (47) | 56 (26) | 57 (27) | 1 (<1) | 215 |
| Lamb | 67 (52) | 33 (25) | 29 (22) | 1 (<1) | 130 |
| Other | 40 (61) | 13 (20) | 13 (20) | 0 | 66 |
| Not specified | 11 (79) | 2 (14) | 1 (7) | 0 | 14 |
| Total | 2668 (48) | 919 (26) | 892 (26) | 15 (<1) | 3494 |

Key to classification (Gilbert *et al.* 1996).

| | Microbiological quality (cfu $g^{-1}$ unless stated) | | | |
|---|---|---|---|---|
| Microbiological criterion | Satisfactory | Borderline–limit of acceptability | Unsatisfactory | Unaccetable/potentially hazardous |
| Aerobic Plate Count | | | | |
| Food category 3† | $<10^5$ | $10^5$–$<10^6$ | $\geqslant 10^6$ | N/A* |
| Food category 4‡ | $<10^6$ | $10^6$–$<10^7$ | $\geqslant 10^7$ | N/A |
| Enterobacteriaceae§ | $<10^2$ | $10^2$–$<10^4$ | $\geqslant 10^4$ | N/A |
| *E. coli* | $<20$ | $20$–$<10^2$ | $10^2$–$<10^4$ | $\geqslant 10^4$ |
| *Staph. aureus* | $<20$ | $20$–$<10^2$ | $10^2$–$<10^4$ | $\geqslant 10^4$ |
| *Listeria* spp.¶ | $<20$ | $20$–$<10^2$ | $10^2$–$<10^4$ | $\geqslant 10^4$ |
| *L. monocytogenes*¶ | $<20$ | $20$–$<10^2$ | $10^2$–$<10^3$ | $\geqslant 10^3$ |
| *Cl. perfringens* | $<10$ | $10$–$<10^2$ | $10^2$–$<10^4$ | $\geqslant 10^4$ |
| *E. coli* O157 | Not detected in 25 g | | | Detected in 25 g |
| *Salmonella* spp. | Not detected in 25 g | | | Detected in 25 g |

* N/A, Not applicable.
† Other meat (beef, pork, poultry, etc.).
‡ Ham and tongue.
§ Proposed categories in the revision of the PHLS microbiological guidelines (PHLS 1998).

with those sliced using a knife (22%) ($P < 0{\cdot}01$). Most (77%) freshly sliced samples were sliced using equipment dedicated to this task, 17% were sliced using shared equipment and for 6%, this information was not specified. Meat samples sliced using shared equipment (26%) were more likely to be of unsatisfactory or unacceptable microbiological quality compared with those which were sliced using dedicated equipment (23%).

*Storage/display.* The majority (89%) of catering premises stored/displayed cold, ready-to-eat meats at or below 8 °C, 9% stored meat above 8 °C and in 2%, the temperature was not specified. Samples which were stored above 8 °C (29%) were more likely to be of unsatisfactory or unacceptable microbiological quality compared with those stored at or below 8 °C (26%).

*Cleaning/disinfection.* The majority (92%) of catering premises used a food grade disinfectant/sanitizer for cleaning surfaces. Six percent of premises did not and in 2%, this information was not specified. Cold meat samples from premises that did not use a food grade disinfectant/sanitizer for cleaning (29%) were more likely to be of unsatisfactory or

unacceptable microbiological quality compared with those collected from premises that did (26%).

Approximately half (53%) the catering premises used re-usable dishcloths for cleaning, 41% used disposable dishcloths and in 4%, both were used. In 2% of premises, the type of cleaning cloth used was not specified. Premises which used re-usable cloths (28%) provided significantly more cold meat samples of unsatisfactory or unacceptable microbiological quality compared with premises that used either disposable cloths (24%) or both types of cloth (22%) ($P < 0{\cdot}05$).

## Catering premises in relation to microbiological quality

*Type of premises.* Among the 2579 premises visited, the majority of samples were collected from public houses (30%), hotels (25%), cafés (21%), restaurants (14%) and residential homes (7%). Other catering premises accounted for 2% and for 1%, the premises type was not specified. Significantly more samples from cafés (30%) and public houses (29%) were of an unsatisfactory or unacceptable microbiological quality compared with those from hotels (24%), restaurants (24%) and residential homes (18%) ($P < 0{\cdot}001$) (Table 3).

*Food hygiene inspections.* Food hygiene inspections are carried out on premises to assess their hygiene and the public health protection aspect of food law (Food Safety Act 1990, Code of Practice No. 9). Some food premises and businesses pose a greater risk to the consumer than others, and this is reflected by the frequency of inspection. Premises rated in Inspection Rating Category A pose the greatest risk and are visited at least once every 6 months, while premises rated in Inspection Rating Category F pose the least risk and are visited at least once every 5 years. The catering premises visited had an Inspection Rating Category A (13%), B (35%), C (44%), D (1%), E (<1%) and F (<1%). In 6%, the Category was not specified. Most catering premises had an Inspection Rating Category C, and these had proportionally less unsatisfactory or unacceptable samples (25%) than premises rated B (27%) or A (28%).

Inspectors consider the number of customers likely to be put at risk if there is a failure in food hygiene and safety procedures in a particular premises, and award a consumer at risk score accordingly (Food Safety Act 1990, Code of Practice No. 9). Scores range from 0 (very few at risk) to 15 (a substantial number at risk). An additional score of 20 exists for premises serving vulnerable groups (the elderly, the sick, young children and the immunocompromised). The catering premises visited had consumer at risk scores of 0 (1%), 5 (62%), 10 (22%), 15 (4%) and 20 (<1%). In 11%, the consumer at risk score was not specified. Seven of the 146 residential homes (5%) were categorized as having a consumer at risk score of 20. Most catering premises visited had a consumer at risk score of 5, and these had significantly more unsatisfactory or unacceptable samples (28%) than those premises with higher consumer at risk scores (2%) ($P < 0{\cdot}001$).

Inspectors assess the management food hygiene performance and score accordingly (Food Safety Act 1990, Code of Practice No. 9). Confidence in management scores range from 0 (highly confident) to 30 (no confidence). Catering premises visited had confidence in management scores of 0 (3%), 5 (25%), 10 (46%), 20 (16%) and 30 (1%). In 9%, the scores were not specified. Significantly more unsatisfactory or unacceptable samples were from premises with a confidence in management score of 20 or above (32%) compared with those with lower scores (24%) ($P < 0{\cdot}001$).

Inspectors will also consider whether there is a significant risk of food being contaminated with *E. coli* O157, other verocytotoxigenic *E. coli* (VTEC) or *Cl. botulinum* at the premises (Food Safety Act 1990, Code of Practice No. 9

**Table 3** Samples of cold ready-to-eat meats categorized by premises type, based on the 1996 PHLS microbiological guidelines (Gilbert *et al.* 1996)

| Premises type | Satisfactory (%) | Borderline–limit of acceptability (%) | Unsatisfactory (%) | Unacceptable/potentially hazardous (%) | Total |
|---|---|---|---|---|---|
| Public House | 437 (44) | 266 (27) | 277 (28) | 5 (<1) | 985 |
| Hotel | 476 (50) | 247 (26) | 228 (24) | 3 (<1) | 954 |
| Café | 315 (42) | 218 (29) | 222 (29) | 3 (<1) | 758 |
| Restaurant | 266 (52) | 124 (24) | 116 (23) | 4 (<1) | 510 |
| Residential home | 127 (60) | 48 (23) | 38 (18) | 0 | 213 |
| Other | 36 (72) | 9 (18) | 5 (10) | 0 | 50 |
| Not specified | 11 (46) | 7 (29) | 6 (25) | 0 | 24 |
| Total | 1668 (48) | 919 (26) | 892 (26) | 15 (<1) | 3494 |

Annex 11997). Although most (61%) of the catering premises visited were not considered to be a significant risk by Inspectors, over a quarter (28%) were. In 11%, this information was not specified. An equal portion of unsatisfactory or unacceptable samples were obtained from premises considered of significant risk (25%) and those that were not (26%).

*Hazard analysis system.* Forty-two percent of catering premises had a documented hazard analysis system in place, and a further 19% had an undocumented hazard analysis system in place. However, over a third (36%) of premises did not have a hazard analysis system in place and in the remaining 3%, this was not specified. Significantly more unsatisfactory or unacceptable samples were from premises where there was no hazard analysis system in place (30%) compared with those where an undocumented (27%) or a documented (22%) hazard analysis system was in place ($P < 0{\cdot}001$).

*Food hygiene training.* The manager in 88% of catering premises had received food hygiene training, in 9% he/she had received no food hygiene training and in 3%, this information was not specified. Of those with food hygiene training, 72% had attended a basic six-hour course, 14% had attended an intermediate course, 4% had attended an advanced course, 6% had attended another recognized course and in 4%, the type of training was not specified. Significantly fewer unsatisfactory or unacceptable samples were from premises where the manager had received advanced food hygiene training (14%) compared with those from premises where the manager had received intermediate (23%), basic (26%) or no (33%) food hygiene training ($P < 0{\cdot}001$).

Twice as many managers in premises with confidence in management scores of 20 and above (18%) had received no food hygiene training compared with managers from premises with lower scores (7%) ($P < 0{\cdot}05$). Significantly more managers of cafés (18%) had received no food hygiene training compared with managers of public houses (9%), restaurants (8%), hotels (5%) and residential homes (2%) ($P < 0{\cdot}001$). Significantly, where the manager of the premises had received some form of food hygiene training, food safety procedures (e.g. the presence of a hazard analysis system) were more likely to be in place (Table 4). A greater proportion of samples of lower microbiological quality from cafés and public houses were related to poorer management food hygiene training and practices compared with that found in other premises (Table 5).

## DISCUSSION

This study has shown that the majority (74%) of cold, ready-to-eat meats collected from catering premises in the UK were of acceptable microbiological quality. Fifteen (<1%) of the cold meats were unacceptable or were a potential risk to public health, and a further 26% were classified as unsatisfactory according to published microbiological guidelines (Gilbert *et al.* 1996), suggesting that improvements could be made in the hygienic handling of these meats. Unsatisfactory results were due mainly to high APC, Enterobacteriaceae and *E. coli* counts. Although high APC does not constitute a risk to health, it may sometimes indicate a general lack of hygiene. However, in the case of certain cured meats such as ham, a high APC could be due to the presence and growth of lactic acid bacteria, where a level of $10^8$ cfu $g^{-1}$ can be reached during shelf-life without detrimental effect to the product (IFST 1997). However, high Enterobacteriaceae, *E. coli* and *Staph. aureus* counts may indicate that the cooking process was inadequate, that post-cooking contamination had occurred, that the temperature of post-cooking storage was inadequate to prevent bacterial growth, or that a combination of these factors was involved.

There is little published literature regarding the microbiological quality of cold sliced meats from catering premises in the UK. One study of 45 samples, which included samples from retail premises, reported that 80% of samples contained *E. coli*, 47% *Staph. aureus* and 47% *Cl. perfringens* (Dempster *et al.* 1973). The incidences of these organisms in the study reported here (6%, 3% and 3%, respectively) are considerably lower and may reflect an improvement in food hygiene practices in the interim period. Eighty-four percent of 1500 cooked sliced meats from manufacturing butchers' premises (Little and de Louvois 1998) were of an acceptable microbiological quality according to published guidelines (Gilbert *et al.* 1996), a level significantly higher than that found in this present study where catering premises were supplied by butchers' premises (71%). Other studies have shown that during the preparation of raw meats in kitchens, numerous surfaces can become contaminated and, once contaminated, the contaminating micro-organisms can survive for considerable periods of time (de Wit *et al.* 1979; Scott and Bloomfield 1990). Tebbutt found that cross-contamination appeared to be greater in the kitchens of cafés, restaurants and hotels than in those of schools, hospitals and staff canteens. It was suggested that this was due to different work schedules and the formal training received in schools and hospital canteens. Furthermore, it was noted that daily disinfection of cloths was not sufficient, and the use of paper or disposable cloths for cleaning food surfaces was recommended (Tebbutt 1984). This is also supported by the findings of the present study.

Evidence from this study suggests that the lower microbiological quality of cold meats from cafés and public houses compared with those collected from other types of catering premises, such as hotels and restaurants, may reflect differences in management food hygiene training, the presence of a hazard analysis system, and food hygiene procedures

**Table 4** Management food hygiene training in relation to food safety procedures/activities present in catering premises

| Premise details | Food hygiene training received by the manager | | |
|---|---|---|---|
| | Yes | No | *P*-value* |
| Hazard analysis in place | 66% | 29% | <0·001 |
| Hazard analysis in place and documented | 69% | 42% | <0·001 |
| Meat cooked on premises and stored for over 4 days | 5% | 12% | <0·001 |
| Separate equipment used for slicing cooked meat | 82% | 74% | <0·05 |
| Storage/display of cold meats above 8 °C | 8% | 15% | <0·01 |
| Cold meats covered in storage/display | 13% | 18% | <0·05 |
| Food grade disinfectant/sanitizer used for cleaning surfaces | 95% | 82% | <0·001 |

* *P*-value derived from $\chi^2$ test.

**Table 5** Details of catering premises with cold meat samples of unsatisfactory or unacceptable microbiological quality

| Premises details | Catering premises | | |
|---|---|---|---|
| | Cafés and public houses | Other premises | *P*-value* |
| Meat cooked off the premises | 53% | 38% | <0·001 |
| Meat cooked on the premises more than 4 days ago | 8% | 5% | <0·01 |
| Pre-sliced samples collected | 48% | 36% | <0·001 |
| Premises categorized consumer at risk score 5 | 81% | 59% | <0·001 |
| Confidence in management scores of 20 and above | 23% | 14% | <0·001 |
| No hazard analysis system in place | 46% | 28% | <0·001 |
| Food hygiene training received by managers | 87% | 99% | <0·001 |
| Re-usable cloths used for cleaning | 59% | 47% | <0·001 |

* *P*-value derived from $\chi^2$ test.

(e.g. inappropriate slicing and storing). Legal requirements (Food Safety (General Food Hygiene) Regulations 1995) relating to food hygiene training apply only to food handlers. However, industry guidelines suggest that "senior supervisors who do not actually handle food, but who may have a direct influence on the hygienic operation of the business should also receive training as a matter of good practice" (JHIC 1997). Richmond noted that over 50% of the 2 million catering employees in 1987 worked part time, and many were agency or temporary staff (Committee on the Microbiological Safety of Food 1991). More recently, the House of Commons Agriculture Committee on Food Safety (1998) noted that medium- and smaller-sized businesses do not have access to the same level of food safety expertise as larger premises and, even when undertaken, training may not be of sufficient quality. It is possible that the dynamic nature of staffing levels in premises such as cafés and public houses causes a deficiency in management training, resulting in less stringent food hygiene procedures and a lower standard of microbiological quality of the products provided. Increased awareness, through improved training of all food handlers and managers, may lead to an improvement in hygienic practices.

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