Food Microbiology 26 (2009) 573–577

Contents lists available at ScienceDirect

Food Microbiology

journal homepage: www.elsevier.com/locate/fm

Assessment of the microbiological safety of salad vegetables and sauces from kebab take-away restaurants in the United Kingdom

R.J. Meldrum [a], C.L. Little [b,*], S. Sagoo [b], V. Mithani [b], J. McLauchlin [c], E. de Pinna [b]

[a] National Public Health Service for Wales, Microbiology Laboratory, Llandough Hospital, Penarth, Vale of Glamorgan, CF64 2XX, UK
[b] Department of Gastrointestinal Emerging and Zoonotic Infections, Centre for Infections, Health Protection Agency, 61 Colindale Avenue, London NW9 5EQ, UK
[c] Health Protection Agency Regional Microbiology Network, London WC1V 7PP, UK

ARTICLE INFO

Article history:
Received 19 February 2009
Received in revised form
23 March 2009
Accepted 28 March 2009
Available online 5 April 2009

Keywords:
Salmonella
Bacillus cereus
Escherichia coli
Staphylococcus aureus
Salad vegetables
Sauces

ABSTRACT

The purpose of this study was to establish the microbiological safety of salad vegetables and sauces served in kebab take-away restaurants. Comparison with published microbiological guidelines revealed that 4.7% of 1213 salad vegetable samples were of unsatisfactory microbiological quality due to *Escherichia coli* and/or *Staphylococcus aureus* levels at $\geq 10^2$ cfu g^{-1}. Another 0.3% of salad samples were of unacceptable quality due to *S. aureus* at $\geq 10^4$ cfu g^{-1} (2 samples) or the presence of *Salmonella* Kentucky (1 sample). Cucumber was the most contaminated salad vegetable with regards to unsatisfactory levels of *E. coli* (6.0%) or *S. aureus* (4.5%). Five percent of 1208 sauce samples were of unsatisfactory microbiological quality due to *E. coli*, *S. aureus* at $\geq 10^2$ cfu g^{-1} and/or *Bacillus cereus* and other *Bacillus* spp. at $\geq 10^4$ cfu g^{-1}. A further 0.6% of sauce samples were of unacceptable quality due to *Bacillus* spp. (*Bacillus subtilis*, *Bacillus pumilus*, *Bacillus licheniformis*) at $\geq 10^5$ cfu g^{-1} or the presence of *Salmonella* Agbeni (1 sample). More samples of chilli sauce (8.7%) were of unsatisfactory or unacceptable microbiological quality than any other sauce types. The results emphasize the need for good hygiene practices in kebab take-away restaurants handling these types of ready-to-eat products.

1. Introduction

The 'kebab' is one of the fastest growing sectors in the fast food market in some parts of Europe, including in the UK (Mintel, 2002). Kebabs are generally served with a salad made from lettuce, tomatoes, onions, cabbage and cucumber. There is usually a choice between yoghurt, chilli, or garlic sauces. Although cooked kebab meat has been shown to be of good microbiological quality in previous UK studies (ACMSF, 2004; Meldrum et al., 2006; Nichols et al., 1996; Williamson et al., 2001), there have been a number of outbreaks of foodborne disease in recent years associated with kebabs and products served from take-away restaurants. Between 1992 and 2007, 13 such outbreaks were reported in England and Wales (ACMSF, 2004; Evans et al., 1999; Little, 2008). Eleven of these were caused by *Salmonella*, one by vero-cytotoxigenic *Escherichia coli* O157 and one by *Campylobacter*. There were 739 cases linked to these outbreaks, with 12.7% (94) hospitalised. The potential for large outbreaks to occur is illustrated by two recent outbreaks of infection associated with various foods from two take-away kebab restaurants (*Salmonella enteritidis* PT 56 in 2003, *S. enteritidis* PT 1 in 2005) (Little, 2008). At least 340 people were affected in the outbreak of *S. enteritidis* PT 56 in 2003, with 19% of individuals hospitalised. The second outbreak in 2005 due to *S. enteritidis* PT 1 affected 195 people, 4% of whom were hospitalised. Evidence from these outbreaks indicates that cross-contamination risks due to poor hygiene during food handling and preparation within these premises is of importance (ACMSF, 2004; Evans et al., 1999; Synnott et al., 1993).

The European Commission Regulation No. 852/2004 on the hygiene of foodstuffs provides a risk-based approach to controlling food hygiene (EC, 2004). The Regulation requires businesses to implement a written food safety management system based on hazard analysis and critical control point (HACCP) principles, to keep clean and maintain premises in good repair and condition, and to ensure food handlers are trained or instructed in good hygiene practices. Despite the legal requirements, cross-contamination remains an important contributory factor in outbreaks associated with kebab take-away restaurants in England and Wales (ACMSF, 2004; Evans et al., 1999; Synnott et al., 1993) and highlights the continuing importance of good hygiene practices and adequate training for food handlers.

The purpose of this study was to establish the microbiological safety of salad vegetables and sauces served in kebab take-away restaurants in order to estimate the risk these particular ready-to-eat food products presented to the consumer. The study was also

* Corresponding author.: Tel.: +44 20 8327 7931; fax: +44 20 8327 7112.
E-mail address: christine.little@hpa.org.uk (C.L. Little).

0740-0020/$ – see front matter
doi:10.1016/j.fm.2009.03.013

designed to examine the extent to which kebab take-away restaurants complied with the legal requirements.

2. Materials and methods

2.1. Sample collection

A total of 1213 salad vegetable and 1208 sauce samples were collected from 1277 take-away kebab restaurants that served these foods as an accompaniment to kebab meat. Samples were collected between 1 June and 31 July 2007 by sampling officers from 238 Local Authority Environmental Health Departments in the UK. All sample details were recorded on a standard questionnaire. Premises were randomly selected by either taking every fifth suitable kebab take-away premises on the Local Authority food business database or by using a random number generator.

All samples collected weighed at least 100 g and were "in use" at the time of sampling. Aseptic technique was used to transfer the sample into a sterile plastic container, using single use sterile utensils. Samples were collected and transported to the laboratory in accordance with the Food Law Code of Practice and Guidance issued by the Food Standards Agency (FSA, 2006b) and the Local Authorities Co-ordinators of Regulatory Services (LACORS) guidance on microbiological food sampling (LACORS, 2006).

2.2. Sample preparation and examination

Samples were examined by 25 Official Control Laboratories using Health Protection Agency (HPA) Standard Microbiological Methods (HPA, 2004a,b, 2005a,b). The presence of *Salmonella* spp., and *E. coli* and *Staphylococcus aureus* were enumerated for salad vegetable and sauce samples. Sauce samples were also examined for *Bacillus cereus* and other *Bacillus* spp. All *B. cereus* and other *Bacillus* spp. isolates from counts of $\geq 10^4$ cfu g^{-1} were sent to the Laboratory of Gastrointestinal Pathogens (LGP), HPA Centre for Infections, for further confirmation (Ash et al., 1991; Blackwood et al., 2004). All isolates confirmed as *Salmonella* were sent to the LGP for further characterization (Bale et al., 2007; Grimont and Weill, 2007).

Microbiological results were interpreted in relation to microbiological criteria in the HPA guidelines for the microbiological quality of some ready-to-eat foods (Table 1) (Gilbert et al., 2000).

2.3. Statistical analysis

Descriptive and statistical analysis of the data, including the evaluation of risk factors, was undertaken using Microsoft Excel and the Epi Info version 6.04d. Relative proportions were compared using the chi-squared (χ^2) and Fisher's exact tests. A probability value of less than 5% was deemed to be significant.

Table 1
Microbiological criteria for ready-to-eat salad vegetables and sauces.

Micro-organism	Results (cfu g^{-1} unless otherwise specified)	Interpretation of microbiological quality[a]
Escherichia coli	$\geq 10^2$	Unsatisfactory
Staphylococcus aureus	10^2 to $<10^4$	Unsatisfactory
	$\geq 10^4$	Unacceptable[b]
Bacillus cereus and other pathogenic *Bacillus* spp.[c]	10^4 to $<10^5$	Unsatisfactory
	$\geq 10^5$	Unacceptable[b]
Salmonella spp.	Detected in 25 g	Unacceptable[b]

[a] Gilbert et al., 2000.
[b] Potentially injurious to health and/or unfit for human consumption (contravenes Article 14 Food Safety Requirements of Regulation (EC) No. 178/2002, the General Food Law Regulation).
[c] Sauce samples only.

3. Results

Amongst the 2421 salad vegetable and sauce samples tested, 2299 (94.9%) were of satisfactory or acceptable microbiological quality, 112 (4.7%) were unsatisfactory, and 10 (0.4%) were of unacceptable quality.

3.1. Microbiological quality of salad vegetables

Of the 1213 salad vegetables sampled, 4.7% (57) were of unsatisfactory microbiological quality due to *E. coli* ($\geq 10^2$ cfu g^{-1}, 3.7%), *S. aureus* ($\geq 10^2$ to $<10^4$ cfu g^{-1}, 0.8%) or both organisms (0.2%) (Table 2). Cucumber samples had the highest proportion of unsatisfactory results for both *E. coli* (6.0%) and *S. aureus* (4.5%). Tomato samples had the lowest unsatisfactory rates for these organisms (*E. coli*, 1.0%, *S. aureus*, 0%).

Three samples were of unacceptable microbiological quality due to high levels of *S. aureus* at $\geq 10^4$ cfu g^{-1} (2 samples, 0.4%) or the presence of *Salmonella* Kentucky (1 sample, 0.2%). The sample contaminated with *Salmonella* Kentucky was shredded lettuce. Follow-up investigations by the local authority at the premises from which the sample was taken revealed the presence of *Salmonella* Kentucky in further prepared salad vegetable items, food preparation surfaces, cleaning materials (including cloths) and mouse droppings. A number of corrective measures were taken to address hygiene within the premises, including closure for professional cleaning and refurbishment (Willis and Jones, 2008). No cases of human infection of *Salmonella* Kentucky were reported in the area at the time of the study.

3.2. Microbiological quality of sauces

Of the 1208 sauce samples examined, 4.7% (57) were of unsatisfactory microbiological quality due to *E. coli* ($\geq 10^2$ cfu g^{-1}, 0.7%), *S. aureus* ($\geq 10^2$ to $<10^4$ cfu g^{-1}, 0.2%) or *B. cereus* and/or other pathogenic *Bacillus* species ($\geq 10^4$ to $<10^5$ cfu g^{-1}, 3.8%) (Table 3). A further seven samples (all chilli sauce) were found to be of unacceptable microbiological quality due to high levels of *B. cereus* and/or other pathogenic *Bacillus* species ($\geq 10^5$ cfu g^{-1}, 6 samples, 0.4%) or presence of *Salmonella* Agbeni (1 sample, 0.1%).

Table 2
Microbiological quality of ready-to-eat salad vegetables.

Micro-organism	Salad type	No. samples $n = 1213$ (%)	No. samples of unsatisfactory or unacceptable quality (%)	
			Unsatisfactory	Unacceptable
E. coli	Cabbage	123 (10.1)	4 (3.2)	n/a[b]
	Cucumber	67 (5.5)	4 (6.0)	n/a
	Lettuce	454 (37.5)	21 (4.6)	n/a
	Onion	111 (9.2)	3 (2.7)	n/a
	Tomato	102 (8.4)	1 (1.0)	n/a
	Mixed[a]	356 (29.3)	14 (3.9)	n/a
S. aureus	Cabbage	123 (10.1)	2 (1.6)	0 (0.0)
	Cucumber	67 (5.5)	3 (4.5)	0 (0.0)
	Lettuce	454 (37.5)	3 (0.7)	2 (0.4)
	Onion	111 (9.2)	0 (0.0)	0 (0.0)
	Tomato	102 (8.4)	0 (0.0)	0 (0.0)
	Mixed[a]	356 (29.3)	4 (1.1)	0 (0.0)
Salmonella spp.	Cabbage	123 (10.1)	n/a	0 (0.0)
	Cucumber	67 (5.5)	n/a	0 (0.0)
	Lettuce	454 (37.5)	n/a	1 (0.2)
	Onion	111 (9.2)	n/a	0 (0.0)
	Tomato	102 (8.4)	n/a	0 (0.0)
	Mixed[a]	356 (29.3)	n/a	0 (0.0)

[a] Mixed: cabbage, lettuce, tomato.
[b] Not applicable.

Table 3
Microbiological quality of ready-to-eat sauces.

Micro-organism	Sauce type	No. samples $n = 1208$ (%)	No. samples of unsatisfactory or unacceptable quality (%)	
			Unsatisfactory	Unacceptable
E. coli	Chili	548 (45.4)	5 (0.9)	n/a[b]
	Garlic	493 (40.8)	1 (0.2)	n/a
	Yoghurt based	82 (6.8)	1 (1.2)	n/a
	Other[a]	85 (7.0)	1 (1.2)	n/a
S. aureus	Chili	548 (45.4)	2 (0.4)	0 (0.0)
	Garlic	493 (40.8)	1 (0.2)	0 (0.0)
	Yoghurt based	82 (6.8)	0 (0.0)	0 (0.0)
	Other[a]	85 (7.0)	0 (0.0)	0 (0.0)
B. cereus and other pathogenic *Bacillus* spp.	Chili	548 (45.4)	34 (6.2)	6 (1.1)
	Garlic	493 (40.8)	9 (1.8)	0 (0.0)
	Yoghurt based	82 (6.8)	3 (3.7)	0 (0.0)
	Other[a]	85 (7.0)	0 (0.0)	0 (0.0)
Salmonella spp.	Chili	548 (45.4)	n/a	1 (0.2)
	Garlic	493 (40.8)	n/a	0 (0.0)
	Yoghurt based	82 (6.8)	n/a	0 (0.0)
	Other[a]	85 (7.0)	n/a	0 (0.0)

[a] Curry, sweet and sour, mango and tomato sauces.
[b] Not applicable.

The proportion of chilli sauce samples of unsatisfactory or unacceptable microbiological quality (8.7%) was significantly higher than all other sauce types (yoghurt; 4.8%, garlic; 2.2%, other types; 1.1%) ($p < 0.0001$). The chilli sauce sample contaminated with *Salmonella* Agbeni was made at the take-away premises and stored uncovered at a temperature of 11.8 °C and staff in this premises reported not usually discarding sauce at the end of the trading day. *Salmonella* Agbeni infection is very rare in England and Wales, with only 26 cases having been identified between 2004 and 2006. There were no cases of *Salmonella* Agbeni reported during 2007, the year that this study took place.

3.3. *Bacillus spp. and B. cereus isolated at $\geq 10^4$ cfu g^{-1} from sauces*

Of the 59 *Bacillus* spp. and *B. cereus* isolates at $\geq 10^4$ cfu g^{-1} (obtained from 52 samples; levels ranged from 1.0×10^4 to 8.6×10^5 cfu g^{-1}) referred for characterisation, 40 (67.8%) were *Bacillus subtilis*, and the remaining 19 were *Bacillus pumilus* (11), *B. cereus* (4) and *Bacillus licheniformis* (4).

3.4. *Microbiological quality of salad vegetables and sauces in relation to premises and product details*

The supply, storage, and service details and hygiene factors at the kebab take-away premises (presented below) had no significant statistical effect on the microbiological quality of the vegetables and sauces with regard to samples of unsatisfactory or unacceptable quality (Tables 4 and 5).

Forty-eight percent of samples were collected from premises serving a Turkish cuisine (Table 4) and 85.9% of samples were from premises that had staff who had received some form of food hygiene training. However, 10.0% of samples were from premises where staff had received no training in food hygiene (Table 4). Only half (50.9%) of the samples collected were from premises that complied with HACCP requirements as provided in Article 5 of Regulation (EC) No. 852/2004 (EC, 2004) (Table 4).

Most salad vegetables were supplied to the kebab take-away premises in a loose and unprepared format (i.e. open, unwashed)

Table 4
Microbiological quality of salads and sauces in relation to premises details.

Premises factor	No. samples		No. samples of unsatisfactory/ unacceptable quality (%)	
	Salad $n = 1213$ (%)	Sauce $n = 1208$ (%)	Salad	Sauce
Type of cuisine				
Greek	66 (5.4)	68 (5.6)	5 (7.6)	1 (1.5)
Indian	151 (12.5)	153 (12.7)	8 (5.3)	10 (7.2)
Middle Eastern	85 (7.0)	84 (6.9)	3 (3.5)	2 (2.4)
Turkish	590 (48.6)	582 (48.2)	24 (4.1)	34 (5.8)
Other[a]	292 (24.1)	290 (24.0)	16 (5.4)	14 (4.8)
Not recorded	29 (2.4)	31 (2.6)	4 (13.7)	1 (3.2)
Food hygiene training				
Total yes	1043 (86.0)	1037 (85.9)	51 (4.9)	57 (5.5)
Foundation	929 (89.1)	920 (88.7)	47 (5.0)	45 (4.8)
Intermediate	37 (3.5)	38 (3.7)	1 (2.7)	6 (15.8)
Advanced	7 (0.7)	7 (0.7)	0 (0.0)	0 (0.0)
Other[b]	19 (1.8)	19 (1.8)	1 (5.3)	0 (0.0)
Yes, but not recorded	51 (4.9)	53 (5.1)	2 (3.9)	6 (11.3)
No	121 (10.0)	121 (10.0)	4 (3.3)	4 (3.3)
Not recorded	49 (4.0)	50 (4.1)	5 (10.2)	1 (4.0)
Compliance with HACCP				
Yes	617 (50.8)	616 (51.0)	36 (5.9)	36 (5.9)
No	479 (39.5)	475 (39.3)	8 (3.3)	22 (4.6)
Not recorded	117 (9.7)	117 (9.7)	16 (6.8)	4 (4.3)
Salad-format supplied to premises				
Loose & unprepared	1071 (88.3)	n/a[c]	53 (5.0)	n/a
Pre-packed pre-cut (unwashed)	41 (3.4)	n/a	1 (2.4)	n/a
Pre-packed pre-cut (washed)	58 (4.8)	n/a	4 (6.9)	n/a
Not recorded	43 (3.5)	n/a	2 (4.6)	n/a
Sauce-place of manufacture				
Commercial	n/a	390 (32.3)	n/a	20 (5.2)
On premises	n/a	579 (47.9)	n/a	38 (6.7)
Not recorded	n/a	239 (19.8)	n/a	4 (1.6)

[a] Cypriot, Pakistani, Portuguese.
[b] In house training, RIPH qualification.
[c] Not applicable.

(88.3%). Sauces sampled were in the main made at the take-away premises (47.9%) or otherwise commercially manufactured (32.3%) (Table 4).

In 60.4% of kebab take-away premises salad vegetables and sauces were displayed or stored at above 8 °C. The majority (67.8%) had been in the service area for four or less hours (Table 5). Salad vegetables were mainly served/handled using a designated (61.5%) or shared (31.4%) serving utensil (Table 5). Ninety-four percent of sauces were served by the food handler rather than self-service (3.2%) (Table 5). In 72.7% of food service/preparation areas visited to collect samples, salad vegetables were not covered. By contrast, 78.1% of sauces were covered (Table 5). In 75.3% of kebab take-away premises the salad vegetables were discarded at the end of the serving period, but most sauces were not (70.6%) (Table 5).

The food preparation area in most premises (91.5%) was judged to be visibly clean by the sampling officer, in 6.3% it was unclean and for 2.2% of premises, this information was not recorded. A sanitiser or disinfectant was used for cleaning in the majority of premises (81.2%), in 16.6% these cleaning materials were not used and for 2.2% of premises, this information was not recorded. The majority of premises (63.2%) used only re-useable cleaning cloths, 30.2% used disposable cloths and a further 2.8% used both re-useable and disposable cloths. For 3.8% of premises, this information was not recorded. Most premises did not use a dishwasher (84.8%), although 12.3% did, and for 2.8%, this information was not

Table 5
Microbiological quality of salads and sauces in relation to storage and service details.

Storage and service details	No. samples		No. samples of unsatisfactory/ unacceptable quality (%)	
	Salad $n = 1213$ (%)	Sauce $n = 1208$	Salad	Sauce
Storage temperature				
≤8 °C	462 (38.1)	417 (34.5)	29 (6.2)	24 (5.8)
>8 °C	709 (58.5)	753 (62.3)	30 (4.2)	37 (5.1)
Not recorded	42 (3.4)	38 (3.2)	1 (2.4)	1 (2.6)
How long in service area				
≤4 h	936 (77.2)	706 (58.4)	43 (4.6)	33 (4.8)
>4 h	159 (13.1)	313 (25.9)	10 (6.3)	18 (5.8)
Not known	118 (9.7)	189 (15.7)	7 (5.9)	11 (10.1)
Service of sauces				
Self-service	n/a	39 (3.2)	n/a	2 (7.7)
Served	n/a	1139 (94.3)	n/a	60 (5.2)
Not recorded	n/a	30 (2.5)	n/a	0.0
Service of salads				
Bare hands	36 (3.0)	n/a	1 (2.8)	n/a
Gloved/protected hand	24 (2.0)	n/a	1 (4.2)	n/a
Designated serving utensils	746 (61.5)	n/a	41 (5.5)	n/a
Shared utensils	381 (31.4)	n/a	16 (4.2)	n/a
Other	4 (0.3)	n/a	0 (0.0)	n/a
Not recorded	22 (1.8)	n/a	1 (4.5)	n/a
Food covered				
Yes	310 (25.6)	944 (78.1)	17 (5.4)	47 (4.9)
No	882 (72.7)	240 (19.9)	42 (4.7)	13 (5.8)
Not recorded	21 (1.7)	24 (2.0)	1 (4.8)	2 (8.3)
Discarded at end of day				
Yes	913 (75.3)	327 (27.1)	50 (5.4)	22 (7.0)
No	257 (21.1)	853 (70.6)	8 (3.1)	39 (4.6)
Not recorded	43 (3.6)	28 (2.3)	2 (4.6)	1 (3.6)

recorded. Adequate sanitary provision in food premises, with hand washing facilities for staff, is a legal requirement (EC, 2004). Although most premises (73.3%) had hand washbasins with hot water and soap available for their staff to use, 12.4% did not and for 14.3% of premises, this information was not recorded.

4. Discussion

This study has shown that the majority (95%) of prepared ready-to-eat salad vegetables and sauces sampled from kebab take-aways in the UK were of satisfactory/acceptable microbiological quality according to published microbiological guidelines (Gilbert et al., 2000). However, 5% of salad vegetable and sauces sampled were shown to be of unsatisfactory or unacceptable microbiological quality due to high levels of *E. coli*, *S. aureus* and *Salmonella* spp. and additionally for chilli sauces high levels of *B. cereus* and other *Bacillus* spp. Ready-to-eat foods contaminated with pathogens such as *Salmonella* spp. or with unacceptable levels of *S. aureus* or *B. cereus* are potentially unsafe. They are considered to be injurious to health and/or unfit for human consumption as they contravene the food safety requirements (Article 14) of Regulation (EC) No. 178/2002 (EC, 2002). The presence of *Salmonella* in salad vegetables and spices, which can be used to make sauces, has been linked to a number of recent outbreaks in the UK and elsewhere (Little and Gillespie, 2008; Little et al., 2003b). *B. cereus* may also be present in spices, usually at counts below 10^3 cfu g^{-1} but can multiply to high levels (10^5–10^6 cfu g^{-1}) in food to which it is added, such as sauces. This may be sufficient to cause food poisoning if the food is inappropriately handled or stored (Little et al., 2003b).

Microbial contamination of open food, including salad vegetables and sauces served with kebabs, can occur from the environment, from contact with contaminated containers, equipment and utensils, hands, aerosols, cleaning cloths or pests (Elson, 2007; Sagoo et al., 2003a). The presence of *S. aureus* in ready-to-eat salad vegetables (2.7%) and sauces (1.0%) found in this study is an indication of poor hygiene practices. The incidence of the faecal indicator organism *E. coli* at $\geq 10^2$ cfu g^{-1} in salad vegetables found in this study (3.7%) is slightly higher than that found in an earlier UK study of open prepared ready-to-eat salad vegetables from a range of different food service premises in 2001 (3.0%) (Sagoo et al., 2003b). A small proportion of sauces also contained *E. coli* at $\geq 10^2$ cfu g^{-1} (0.7%), and these levels in ready-to-eat salad vegetables and sauces should be avoided (Gilbert et al., 2000).

Smaller premises (such as take-away catering premises) have been highlighted as an area for concern with regard to microbiological quality of ready-to-eat food and food safety risks (Little et al., 2003a). A UK Food Standards Agency survey on consumer attitudes indicated that hygiene standards in take-away and fast food premises are also a key area of concern for consumers, with these premises emphasised more than any other outlet in relation to food hygiene concerns (27% of the UK sample) (FSA, 2008). Application of good food hygiene has been identified as greatly reducing the risk of transmission of foodborne disease from ready-to-eat foods via infected food handlers or cross-contamination (Little and Gillespie, 2008). The Food Standards Agency's 'Safer Food Better Business for Caterers' pack is a guide to implementing a food safety management system in smaller catering premises in the UK. The pack has been developed to help small catering businesses, such as take-aways, to comply with food hygiene regulations introduced in January 2006 and to minimise microbial food safety hazards in their food business operations (FSA, 2006a).

Although the results from this study indicate that overall ready-to-eat salad vegetables and sauces from kebab take-aways were of satisfactory quality, two recent large outbreaks of salmonellosis in the UK (ACMSF, 2004; Little, 2008) demonstrate that significant health problems can arise from consumption of contaminated salad and sauce products in addition to kebab meat. It follows that sound approaches to food safety management in kebab take-aways must be implemented. It is also recommended that enforcement officers pay attention to such food products when both visiting and sampling from these types of premises.

Acknowledgements

The authors would like to thank all the staff in the Environmental Health Departments throughout the United Kingdom who collected samples for this study, and all the staff in HPA, HPA collaborating and non-HPA laboratories who performed the microbiological examinations. Thanks are extended to LGP, HPA Centre for Infections for typing isolates, to David Lock and Gemma Cantelo at LACORS for coordinating the participation of Environmental Health Practitioners and advice from the LACORS Food Examination Focus Group and Food Hygiene Focus Group, to the HPA Regional Food, Water and Environmental Co-ordinators Forum for advice on the sampling protocols, and to Lilian Hucklesby for coordinating data collation and validation.

References

Advisory Committee on the Microbiological Safety of Food, 2004. Microbiological Control of Doner Kebabs. Food Standards Agency, London.
Ash, C., Farrow, J.A.E., Wallbanks, S., Collins, M.D., 1991. Phylogenetic heterogeneity of the genus *Bacillus* revealed by comparative analysis of small-subunit-ribosomal RNA sequences. Lett. Appl. Microbiol. 13, 202–206.
Bale, J., de Pinna, E., Threlfall, E.J., Ward, L., 2007. Kauffmann-White Scheme - 2007: *Salmonella* Identification - Serotypes and Antigenic Formulae. Health Protection Agency, London.

Blackwood, K.S., Turenne, C.Y., Harmsen, D., Kabani, A.M., 2004. Reassessment of sequence-based targets for identification of *Bacillus* species. J. Clin. Microbiol. 42, 1626–1630.

Elson, R., 2007. Personal hygiene of the food handler. In: McLauchlin, J., Little, C.L. (Eds.), Hobbs' Food Poisoning and Food Hygiene. Arnold, London, pp. 169–179.

European Commission (EC), 2002. Regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. Off. J. Europ. Union L31, 1–24.

European Commission (EC), 2004. Regulation (EC) No. 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs. Off. J. Europ. Union L139, 1–54.

Evans, M.R., Salmon, R.L., Nehaul, L., Mably, S., Wafford, L., Nolan-Farrell, M.Z., Gardner, D., Ribeiro, C.D., 1999. An outbreak of *Salmonella typhimurium* DT 170 associated with kebab meat and yoghurt relish. Epidemiol. Infect. 122, 377–383.

Food Standards Agency (FSA), 2008. Consumer Attitudes to Food Standards: Wave 8. UK Final Report, January 2008. COI Ref: 282008. Available from: <http://www.food.gov.uk/multimedia/pdfs/cas2007ukreport.pdf>; (accessed 06.02.2009.).

Food Standards Agency (FSA), 2006a. Safer Food, Better Business for Caterers Available from: <http://www.food.gov.uk/foodindustry/regulation/hygleg/hyglegresources/sfbb/sfbbcaterers/> (accessed 06.02.2009.).

Food Standards Agency (FSA), 2006b. Food Law Code of Practice. FSA, London. Available from: <http://www.food.gov.uk/news/newsarchive/2006/mar/copengland> (accessed 06.02.2009.).

Gilbert, R.J., de Louvois, J., Donovan, T., Little, C., Nye, K., Ribeiro, C.D., Richards, J., Roberts, D., Bolton, F.J., 2000. Guidelines for the microbiological quality of some ready-to-eat foods sampled at the point of sale. Commun. Dis. Pub. Health 3, 163–167.

Grimont, P.A.D., Weill, F.-X., 2007. Antigenic Formulae of the *Salmonella Serovars*, nineth ed. WHO Collaborating Centre for Reference and Research on Salmonella, Institut Pasteur, Paris.

Health Protection Agency (HPA), 2004a. Direct Enumeration of *Escherichia coli*. National Standard Method Standard F20, Issue 1 Available from: <http://www.hpa-standardmethods.org.uk/documents/food/pdf/F20.pdf> (accessed 06.02.2009.).

Health Protection Agency (HPA), 2004b. Enumeration of *Staphylococcus aureus*. National Standard Method: F12, Issue 1 Available from: <http://www.hpa-standardmethods.org.uk/documents/food/pdf/F12.pdf> (accessed 06.02. 2009.).

Health Protection Agency (HPA), 2005a. Standard Methods for Food Products. Detection of *Salmonella* Spp. F13, Issue 3.1. HPA, London. Available from: <http://www.hpa-standardmethods.org.uk/documents/food/pdf/F13.pdf> (accessed 06.02.2009.).

Health Protection Agency (HPA), 2005b. Standard Methods for Food Products. Enumeration of *Bacillus cereus* and Other *Bacillus* species F15, Issue 1. HPA, London. Available from: <http://www.hpa-standardmethods.org.uk/documents/food/pdf/F15.pdf> (accessed 06.02.2009.).

Little, C.L., 2008. Health Protection Agency. 24 October 2008. Personal communication.

Little, C.L., Gillespie, I.A., 2008. Prepared salads and public health. J. Appl. Microbiol. 105, 1729–1743.

Little, C.L., Lock, D., Barnes, J., Mitchell, R.T., 2003a. The microbiological quality of food in relation to hazard analysis systems and food hygiene training in UK catering and retail premises. Commun. Dis. Pub. Health 6, 250–258.

Little, C.L., Omotoye, R., Mitchell, R.T., 2003b. The microbiological quality of ready-to-eat foods with added spices. Int. J. Environ. Health 13, 31–42.

Local Authorities Co-ordinators of Regulatory Services (LACORS), 2006. LACORS Guidance Food Sampling for Microbiological Examination, Issue 2. Available from: <http://www.lacors.com>; (accessed 6 February 2009.).

Meldrum, R.J., Smith, R.M.M., Garside, J., 2006. Microbiological quality of randomly selected ready-to-eat foods sampled between 2003 and 2005 in Wales, UK. Int. J. Food Microbiol. 108, 397–400.

Mintel, 2002. Market Intelligence. Ethnic Takeaway and Other Fast Food - UK - August 2002. Market Intelligence Report. Mintel International Group Ltd., London.

Nichols, G., Monsey, H., de Louvois, J., 1996. LACOTS/PHLS Study of the Microbiological Quality of Doner Kebab Meat. Available from: <http://www.lacors.gov.uk/lacors/home.aspx>; (accessed 06.02.2009.).

Sagoo, S.K., Little, C.L., Griffith, C.J., Mitchell, R.T., 2003a. Study of the cleaning standards and practices in food premises in the United Kingdom. Commun. Dis. Pub. Health 6, 6–17.

Sagoo, S.K., Little, C.L., Mitchell, R.T., 2003b. Microbiological quality of open ready-to-eat salad vegetables: effectiveness of food hygiene training of management. J. Food Protect. 66, 1581–1586.

Synnott, M., Morse, D.L., Maguire, H., Majid, F., Plummer, M., Leicester, M., Threlfall, E.J., Cowden, J., 1993. An outbreak of *Salmonella mikawasima* associated with doner kebabs. Epidemiol. Infect. 111, 473–481.

Williamson, K., Allen, G., Bolton, F.J., 2001. Report of the Greater Manchester/Lancashire/PHLS Liaison Group Survey on the Microbiological Examination of Doner Kebabs from Take-away Food Shops. Survey Code No. 104001. Available from: <http://www.salford.gov.uk/104001_report.doc>; (accessed 06.02.2009.).

Willis, C., Jones, S., 2008. Health Protection Agency. 20 October 2008. Personal communication.