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Microbiological Quality of Open Ready-to-Eat Salad Vegetables: Effectiveness of Food Hygiene Training of Management

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ABSTRACT

During September and October 2001, a microbiological study of open, ready-to-eat, prepared salad vegetables from catering or retail premises was undertaken to determine their microbiological quality. The study focused on those salad vegetables that were unwrapped and handled either by staff or customers in the premises where the sample was taken. Examination of salad vegetables from food service areas and customer self-service bars revealed that most (97%; 2,862 of 2,950) were of satisfactory or acceptable microbiological quality, 3% (87) were of unsatisfactory microbiological quality because of *Escherichia coli* levels in the range of 10^2 to 10^5 colony-forming units per gram. One (<1%) sample was of unacceptable microbiological quality because of the presence of *Listeria monocytogenes* at 840 colony-forming units per gram. The pathogens *E. coli* O157, *Campylobacter* spp., and salmonellas were not detected in any of the samples examined. The display area for most food service and preparation areas (95%) and self-service salad bars (98%) that were visited was judged to be visibly clean by the sampling officer. Most self-service bars (87%) were regularly supervised or inspected by staff during opening hours, and designated serving utensils were used in most salad bars (92%) but in only a minority of food service areas (35%). A hazard analysis system was in place in most (80%) premises, and in 61%, it was documented. Most (90%) managers had received food hygiene training. A direct relationship was shown between increased confidence in the food business management and the presence of food safety procedures and the training of management in food hygiene.

Ready-to-eat salad vegetables are generally considered safe to eat by consumers *(8),* and consumption of these vegetables has increased in quantity and in variety in recent years *(17).* Although advances in farming and horticultural practices, processing, and distribution have generally enabled the raw vegetable industry to supply high-quality produce to consumers all year round, some practices have resulted in an expansion of the geographical distribution and incidence of human illness associated with an increasing number of pathogenic bacteria and viral and parasitic microorganisms *(2).* Long et al. reported that between 1992 and 2000, 85 of 1,518 (5.6%) foodborne outbreaks of infectious intestinal disease in England and Wales were associated with consumption of salad vegetables and fruit (SVF) *(15).* Guidance documents have been developed to help producers minimize microbiological hazards for fresh fruit and vegetables. They incorporate control strategies based on the principles of the Hazard Analysis Critical Control Point system (HACCP), good handling practices, and good hygienic practices *(3, 5, 9, 12, 13).*

Food businesses must apply the hazard analysis principles on their own premises, which also must be kept clean and maintained in good repair and condition *(26).* Legislation also requires proprietors to ensure that food handlers are appropriately supervised and instructed or trained in food hygiene *(26).* Nevertheless, cross-contamination and infected food handlers were the two contributory factors most commonly reported in SVF outbreaks in England and Wales *(15),* highlighting the importance of training food handlers in good hygiene practices.

Although the proportion of reported outbreaks of infectious intestinal disease attributed to SVF is low, there is no room for complacency; in 2000, two community SVF outbreaks in England and Wales were linked with the consumption of wholesaled lettuce served with fast foods. The causative agents were *Salmonella enterica* serotype Typhimurium DT 104 and *S.* Typhimurium DT 204b *(15).* Moreover, these two SVF outbreaks were part of international outbreaks involving several European countries *(15).* In response to these two outbreaks of salmonellosis, the Local Authorities Co-ordinators of Regulatory Services (LACORS) and the Public Health Laboratory Service (PHLS) Co-ordinated Food Liaison Group program undertook two studies in 2001 on the microbiological quality of prepared, ready-to-eat salad vegetables in the United Kingdom, the first of which focused on bagged, prepared, ready-to-eat salad vegetables *(25).* Reported here are the results of the second of these studies on open, prepared, salad vegetables from retail and catering premises.

MATERIALS AND METHODS

Sample collection. A total of 2,950 open, ready-to-eat prepared salad vegetables from catering and retail establishments were examined by 38 laboratories (31 PHLS and 7 non-PHLS) in the United Kingdom between 1 September and 31 October 2001

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TABLE 1. *Inspection rating and frequency of inspection of food premises*

Inspection rating category	Minimum frequency of inspection
A	At least every 6 months
B	At least every year
C	At least every 18 months
D	At least every 2 years
E	At least every 3 years
F	At least every 5 years

according to a standardized protocol and reporting system. Local Authorities (348), involving 56 Local Authority Food Liaison Groups, submitted samples. Single or mixed salad vegetables included in the study were those that were exposed as open food at the premises sampled from and could be consumed without any cooking or further washing or preparation by the consumer. Dressed or seasoned salads were specifically excluded from the study. Salad vegetable samples (~150 g) were collected from either customer self-service bars or food preparation areas in restaurants, hotels, cafés, public houses (establishments selling beer and other alcoholic and nonalcoholic drinks that also serve food to be consumed on the premises), sandwich bars, take-aways (shops selling cooked food to be eaten elsewhere), mobile food premises, and supermarkets by staff from local Environmental Health Departments and were transported to the laboratory in accordance with the Food Safety Act 1990, Code of Practice No. 7 *(6)*.

Information on the salad vegetable samples and premises was obtained by observation and inquiry and recorded on a standard proforma. This included information on the premises and practices. Food hygiene inspections of premises are carried out by environmental health officers to assess hygiene and compliance with public health protection aspects of food law *(7)*. Some food premises and businesses pose a greater risk to the consumer than others, which is reflected by the frequency of inspection. Premises rated Inspection Rating Category A pose the greatest risk and are visited at least once every 6 months, whereas premises rated Inspection Rating Category F pose the least risk and are visited at least once every 5 years (Table 1). Environmental health officers also 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 premise and award a consumer at risk score accordingly. Scores range from 0 (very few customers at risk) to 15 (a substantial number of customers at risk). Confidence in management and food safety management systems are also assessed and scored accordingly. Confidence in management scores range from 0 (highly confident) to 30 (no confidence). Additional information collected on salad vegetables included type, methods of supply, and handling practices in the customer self service salad bar or food service and preparation areas.

Sample examination. Enterobacteriaceae, *Escherichia coli, Listeria monocytogenes,* and other *Listeria* spp., *Campylobacter* spp., salmonellas, and *E. coli* O157 were enumerated or detected in accordance with PHLS Standard Microbiological Methods *(18–21, 23, 24)*. *L. monocytogenes* at levels of 10^2 colony-forming units (CFU)/g or more were sent to the Food Safety Microbiology Laboratory, Central Public Health Laboratory, for further characterization. Microbiological results were compared to the PHLS Guidelines for the microbiological quality of some ready-to-eat foods sampled at the point of sale (Table 2) *(22)*. Satisfactory results indicate good microbiological quality; acceptable results are an index reflecting a borderline limit of microbiological quality; unsatisfactory results indicate that further sampling might be necessary and that environmental health officers might want to undertake a further inspection of the premises concerned to determine whether hygiene practices for food production or handling are adequate. An unacceptable microbiological result indicates that urgent attention is needed to locate the source of the problem.

RESULTS

Microorganisms isolated from open, prepared, ready-to-eat salad vegetables. Enterobacteriaceae were detected in two-thirds (67%; 1,976 of 2,950) of the samples tested and were present at 10^4 CFU/g or more in 33% (974) of the samples (Table 3). There are, however, no EU or U.S. guidelines for Enterobacteriaceae in salad vegetables because these vegetables often carry high levels of these organisms as part of their normal flora *(16)*. *E. coli* was detected in 7% (198 of 2,944) of the salad vegetable samples examined and was present at 10^2 CFU/g or more in 3% (87) of the samples (Table 3). Total *Listeria* spp. were detected in 4% (125 of 2,934) of the samples examined and was present at 10^2 CFU/g or more in one (0.03%) sample. *L. monocytogenes* was detected in 3% (88 of 2,934) of the samples examined and were present at 10^2 CFU/g or more in one (0.03%) sample (Table 3). The *L. monocytogenes* isolate in excess of 10^2 CFU/g was *L. monocytogenes* serotype 4b. *Campylobacter* spp., salmonellas, and *E. coli* O157 were not detected in any of the samples examined.

TABLE 2. *PHLS guidelines for the microbiological quality of some ready-to-eat foods sampled at the point of sale: key to classification for fresh vegetables (22)*

	Microbiological quality (CFU/g unless stated)			
Criterion	Satisfactory	Acceptable	Unsatisfactory	Unacceptable/potentially hazardous
Escherichia coli	<20	20 to $<10^2$	$\geq 10^2$	N/A[a]
Listeria spp. (total)	<20	20 to $<10^2$	$\geq 10^2$	N/A
Listeria monocytogenes	<20	20 to $<10^2$	N/A	$\geq 10^2$
Campylobacter spp.	Not detected in 25 g			Detected in 25 g
Salmonella spp.	Not detected in 25 g			Detected in 25 g
Escherichia coli O157	Not detected in 25 g			Detected in 15 g

[a] N/A, not applicable.

TABLE 3. *Microbiological results of 2,950 open prepared ready-to-eat salad vegetables*

	No. of samples[a]										
	ND in 25 g	D in 25 g	<10/<20 (CFU/g)	20 to $<10^2$	10^2 to $<10^3$	10^3 to $<10^4$	10^4 to $<10^5$	10^5 to $<10^6$	10^6 to $<10^7$	$\geq 10^7$	NE
Enterobacteriaceae			472[b]	311	529	664	534	334	81	25	
Escherichia coli	1		2,746[c]	111	59	25	3				6
Listeria spp. (total)	2,807	125[c]		1	1						16
L. monocytogenes		88[c]			1						
Campylobacter spp.	2,870										80
Salmonella spp.	2,943										7
E. coli O157	2,820										130

[a] ND, not detected; D, detected; NE, not examined (full set of microbiological parameters were not performed on samples because insufficient sample collected).
[b] Lower limit of detection was 10 CFU/g.
[c] Lower limit of detection was 20 CFU/g.

Microbiological quality of open, prepared, ready-to-eat salad vegetables. Based on the PHLS microbiological guidelines for some ready-to-eat foods at the point of sale (Table 2) *(22),* 93% (2,750 of 2,950) of open, prepared, ready-to-eat salad vegetables were satisfactory, 4% (112) were acceptable, and 3% (87) were of unsatisfactory microbiological quality because of the presence of *E. coli* in the range of 10^2 to 10^5 CFU/g. However, one (<1%) sample was of unacceptable microbiological quality because of the presence of *L. monocytogenes* at 840 CFU/g.

Product and premises information. A major feature of the data is that most open, prepared, ready-to-eat salad vegetables (97%) were of satisfactory or acceptable microbiological quality, and no association was found between samples of unsatisfactory or unacceptable microbiological quality and the product information collected (presented below).

Type of salad vegetable. Fifty-four percent (1,599 of 2,950) of the samples collected consisted of a single type of salad vegetable, and 46% (1,351) consisted of mixed salad vegetables. The breakdown of samples (1,599) that consisted of a single type of salad vegetable was: lettuce (36%; 572), tomato (22%; 346), cucumber (20%; 316), grated carrot (7%; 114), pepper (5%; 81), and watercress (<1%; 8). Other samples (10%; 162) included bean sprouts, cabbage, celery, onion, radish, and mushrooms. Of the samples (1,351) that consisted of mixed salad vegetable types, 75% (1,008) were lettuce and one or more other salad vegetable types and 16% (221) were two or more lettuce types. Other mixed salad vegetables (not lettuce) accounted for 9% (122) of the samples.

Supplier and production details. Over half (59%; 1,754 of 2,950) of the salad vegetable samples were supplied from a wholesaler, 14% (403) from greengrocers, 11% (344) from supermarkets, and a smaller proportion from market stalls (3%; 81). Other suppliers (distribution depots, farms) accounted for 11% (316) of the samples. For 2% (52) of the samples, this information was not recorded. Forty-three percent (1,254 of 2,950) of the samples were supplied loose, 36% (1,075) in bulk catering packs, and 18% (532) in retail packs. Other methods of packaging (boxes, trays) accounted for 3% (89) of the samples.

Over 77% (2,257 of 2,950) of the samples were supplied as unprepared (unwashed) salad vegetables, and 22% (670) were supplied as bagged, prepared, ready-to-eat salad vegetables that were subsequently opened. For 1% (23) of the samples, this information was not recorded. Questioning of the operators indicated that of the salad vegetables supplied unwashed (2,257), almost 63% (1,411 of 2,257) were then washed on the premises in running water, 15% (335) were washed in a chemical disinfectant wash, 8% (181) were washed in still water, and 3% (73) were washed in a vegetable wash (produce wash based on sucrose esters, sodium citrate, cocoyl glutamate, and glycerine). Two percent (45) of the unprepared salad vegetable samples were washed using other methods (salted water, water with vinegar), but 1% (31) of the samples were not washed. For 8% (181) of the samples, this information was not recorded.

The majority (94%; 2,773 of 2,905) of the samples were produced using conventional farming methods, 1% (20) of the samples were produced using organic farming methods, and for 5% (157) of the samples, this information was not recorded.

Type of premises. Samples of salad vegetables were collected from restaurants (24%; 717 of 2,950), sandwich bars (22%; 655), supermarkets (14%; 414), cafés (10%; 307), take-aways (10%; 304), public houses (9%; 256), hotels (3%; 96), and mobile food premises (<1%; 7). Other premises (bakeries, butchers, delicatessens, staff canteens, educational establishments) accounted for 6% (174) of the samples. For 1% (20) of the samples, this information was not recorded.

Food service or preparation areas and customer self-service areas. Of the premises visited, 67% (1,985 of 2,950) of the samples were collected from food service or preparation areas and 33% (965) from customer self-service bars. The display area for the majority of the food service and preparation areas (95%; 1,885 of 1,985) and self service bars (98%; 945 of 965) visited was judged to be visibly clean by the sampling officer. For 2% (44 of 1,985) of the

TABLE 4. *Details of salad vegetables from food service areas and customer self-service bars*

Salad vegetables	No. of samples (%)	
	Food service/ preparation area (n = 1,985)	Customer self-service area (n = 965)
Handling/serving salad		
Designated serving utensil	699 (35)	888 (92)
Shared serving utensil	359 (18)	77 (8)
Bare hand (in direct contact with salad)	618 (31)	—
Gloved/protected hand	309 (16)	—
Display/storage temperature of salad		
≤8°C	1,246 (63)	754 (78)
>8°C	681 (34)	180 (19)
Not recorded	58 (3)	31 (3)
Length of time salad in display/ preparation area		
≤4 h	1,598 (82)	758 (79)
>4 h	243 (12)	111 (12)
Not known	144 (6)	96 (9)
End of display/serving period		
Salad discarded	1,294 (66)	689 (71)
Stored	629 (32)	276 (29)
Temperature ≤8°C	583 (92)	249 (90)
Temperature >8°C	11 (2)	5 (2)
Not recorded	35 (6)	22 (8)
Not recorded	35 (2)	

food service and preparation areas and 1% (6 of 965) of the customer self-service bars, the display was not visibly clean, and for 3% (56) and 1% (14) of the premises, respectively, this information was not recorded.

In more than half (55%; 1,091 of 1,985) of food service and preparation areas visited to collect samples, salad vegetables were not covered and 41% (811) were covered, and for 4% (83) of the samples, this information was not recorded. For most (58%; 562 of 965) customer self-service bars, display screens or individual covers were present for salad vegetables, in 39% (378) they were not, and for 3% (25) of the samples, this information was not recorded. Salad vegetables were served or handled using a designated serving utensil in the majority (92%; 888 of 965) of the customer self-service bars but in only approximately a third (35%; 699 of 1,985) of the food service and preparation areas (Table 4).

In almost two-thirds of food service and preparation areas (63%; 1,246 of 1,985) and in over three-quarters of customer self-service bars (78%; 754 of 965), salad vegetables were stored or displayed at or below 8°C (Table 4). Questioning of the operators indicated that salad vegetables were kept in the food service or display area for 4 or fewer hours in most food service and preparation areas (81%; 1,598 of 1,985) and customer self-service bars (79%; 758 of 965) (Table 4).

In over half (52%; 497 of 965) of customer self-service bars visited, the salad vegetables were topped up (an extra amount added on top to restore the quantity to the former level) and 42% (404) were not. For 6% (64) of samples, this information was not recorded. Of those that topped up salad vegetables on display 46% (227 of 497) were topped up within 2 h, 22% (11) between 2 and 4 h, and 3% (17) every 4 h or more. For 29% (142) of the samples this information was not known.

In two-thirds (66%; 1,294 of 1,985) of food service and preparation areas and 71% (689 of 965) of customer self-service bars, the salad vegetables were discarded at the end of the serving or display period (Table 4). Of those food service and preparation areas and customer self-service bars that stored salad vegetables at the end of serving or display period, the majority (92% [583 of 629] and 90% [249 of 276], respectively) stored the vegetables at or below 8°C (Table 4).

For most (87%; 839 of 965) customer self-service bars visited, the display area was regularly supervised or inspected (monitoring use of covers, temperature, general cleanliness, and hygiene) by staff during opening hours. For 1% (12) of premises, the display area was not supervised, and for 12% (115) of premises, this information was not recorded.

Food hygiene inspections. The food premises visited (2,950) were categorized as Inspection Rating Category A (5%; 146), B (21%; 618), C (62%; 1,815), D (3%; 94), E (1%; 24), and F (<1%; 13). For 8% (240) of the premises, the Inspection Rating Category was not recorded. The food premises visited (2,950) were categorized as consumer at risk score of 0 (1%; 23), 5 (67%; 1,963), 10 (21%; 612), and 15 (1%; 31). For 10% (321) of the premises, the consumer at risk score was not recorded. Premises visited (2,950) had a confidence in management score of 0 (5%; 139), 5 (31%; 917), 10 (42%; 1,226), 20 (11%; 328), and 30 (1%; 28). For 10% (312) of the premises, the confidence in management score was not recorded.

Hazard analysis system. Sixty-one percent (1,793 of 2,950) of premises had a documented hazard analysis system in place, and a further 19% (559) had an undocumented hazard analysis system in place. However, 15% (432) of the premises did not have a hazard analysis system in place and in the remaining 5% (166), this was not recorded.

Food hygiene training. The manager in 90% (2,648 of 2,950) of the premises had received food hygiene training, in 5% (140) he or she had received no food hygiene training, and in 5% (162), this information was not recorded. Of those with food hygiene training, 68% (1,798 of 2,648) had attended a 6-h basic course, but 17% (429) and 5% (146) had attended an intermediate or advanced course, respectively. A further 4% (103) had attended another recognized course (City and Guilds qualifications, National Vocational Qualifications [NVQ], RIPHH, Meat and Livestock Commission [MLC] hygiene training, and internal company training), and in 6% (172) the type of training was not specified.

Significantly, where managers had received some form

TABLE 5. *Hazard analysis in place and documented in relation to management food hygiene training*

Hazard analysis	Food hygiene training		*P*-value
	Yes	No	
In place and documented	1,722/2,237 (77%)	16/50 (32%)	<0.00001
In place and undocumented	465/2,237 (21%)	27/50 (54%)	<0.00001
Not in place	330/2,648 (12%)	84/140 (60%)	<0.00001

of food hygiene training, hazard analysis systems were more likely to be in place and documented (77%; 1,733 of 2,237) ($P < 0.00001$) (Table 5).

Significantly more managers from premises with a consumer at risk score of 0–5 (6%; 113 of 1,986) had received no food hygiene training compared to managers in premises scoring 10 or above (2%; 13 of 643) ($P < 0.001$). In addition, more managers of premises with confidence scores of 20 and above (11%; 40 of 356) had received no food hygiene training compared with those premises with confidence scores of 10 or less (4%; 86 of 2,282) ($P < 0.00001$).

DISCUSSION

Open foods are at greater risk of contamination from the environment than wrapped or packaged foods, and greater care must be taken with these products in catering and retail premises. Contamination of open food can occur from the environment generally and from contact with contaminated containers, equipment and utensils, hands, aerosols, cleaning cloths or pests *(5).* Long et al. *(15)* identified that the application of good basic food hygiene would greatly reduce the risk of transmission of infectious intestinal disease from SVF via infected food handlers or cross-contamination. Good hygiene practices and high standards of cleanliness must be maintained at all times to avoid microbiological contamination occurring. Voluntary industry guides have been produced to help minimize microbial food safety hazards from farm to fork, i.e., from produce suppliers to food handlers *(3, 5, 9, 12, 13).*

This study has shown that the vast majority (97%) of open, prepared, ready-to-eat, raw salad vegetables sampled from catering and retail premises in the United Kingdom were of satisfactory or acceptable microbiological quality according to published microbiological guidelines *(22).* The proportion of open salad vegetable samples (3%) in this study of unsatisfactory quality was higher than that found in the earlier LACORS and PHLS study of bagged, prepared, ready-to-eat salad vegetables (<1%), although both studies had a very small number of samples that were of unacceptable microbiological quality (<1%). The U.S. Food and Drug Administration survey of domestic fresh produce carried out between 2000 and 2001 *(26)* also reported a small proportion (<1%) of salad vegetable samples that were of unacceptable microbiological quality because of the presence of salmonellas or *Shigella* spp. However, the U.S. Food and Drug Administration survey of imported fresh produce undertaken in 1999 *(27)* found that 4.5% of salad vegetables were of unacceptable microbiological quality because of the presence of salmonellas or *Shigella* spp. and might reflect differences in conditions during pre- and postharvest operations.

In this study, the display area for most food service and preparation areas (95%) and self-service salad bars (98%) visited was judged to be visibly clean by the sampling officer. Most self-service bars (87%) were regularly supervised or inspected by staff during opening hours, and designated serving utensils were used in most salad bars (92%) but in only a minority of food service areas (35%). In food service areas, 31% of staff used bare hands to prepare or handle salad vegetables. Because contamination of open food can occur from hands, handling open salads with bare hands should be reduced to avoid the potential for cross-contamination from occurring. In over a third (34%) of food service and preparation areas, salad vegetables were stored or kept for service at above 8°C. Where prepared, ready-to-eat salad vegetables are being stored, they should be kept at or below 8°C to satisfy the legal requirements of the Food Safety (Temperature Control) Regulations 1995 *(1).* As a matter of good practice, it is recommended that such salad vegetables should also be kept at or below 8°C during service or display for sale.

A hazard analysis system was in place in the majority (80%) of catering and retail premises visited and was documented in 61% of these, and most managers (90%) had received some form of food hygiene training. High confidence in the food business management of food hygiene, as indicated by Local Authority Inspectors' Confidence in Management scores and food safety procedures, i.e., the presence of a hazard analysis system, was in turn related to management food hygiene training. However, because most samples (97%) were of satisfactory or acceptable microbiological quality, no association could be established between confidence in the food business management, hazard analysis system, or food hygiene training of management staff, and the microbiological quality of open, prepared salad vegetables. There is, however, growing acceptance throughout the European Community and in many other countries of the value of the application of HACCP principles in ensuring the microbiological safety of foods. Implementing and maintaining food safety procedures based on HACCP principles is expected to become a European legal requirement for all food businesses, including caterers and retailers, regardless of size *(4).* The House of Commons Agriculture Committee state that HACCP "will make a significant contribution to food safety, in conjunction with adequate training of food business managers and handlers" and that "the effective implementation of HACCP depends crucially on well trained managers and employees in food businesses" *(10).*

Vegetables carry a natural nonpathogenic epiphytic microflora, the majority of which consists of gram-negative bacteria belonging to either the Enterobacteriaceae or *Pseudomonas* group. The number of bacteria present will vary depending on seasonal and climatic variation and might range from 10^4 to 10^8 per gram *(16).* The findings from this and previous studies *(11, 25)* have shown that high levels of Enterobacteriaeae are normal in salad vegetables; therefore, levels of fecal indicator organisms such as *E. coli* are a better indication of contamination and hygienic quality. The incidence of *E. coli* in open salad vegetables found in this study (7%) is similar to that reported in a U.S. study of vegetable salads collected from food service facilities (12%) *(14).* Levels of *E. coli* in raw, ready-to-eat vegetables, however, should be kept to a minimum.

Although the results from this study indicate that overall open, prepared, ready-to-eat salad vegetables from catering and retail premises were of satisfactory or acceptable quality, the two recent outbreaks of salmonellosis in the United Kingdom and other European countries *(15)* demonstrate that major health problems can arise from consumption of contaminated salad products if hygiene practices break down. It follows that the need for a sound approach to food safety management cannot be overemphasized.

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REFERENCES

1. Anonymous. 1995. The food safety (general food hygiene) regulations. Her Majesty's Stationery Office, London.
2. Beuchat, L. R. 1998. Food safety issues. Surface decontamination of fruits and vegetables eaten raw: a review. WHO/FSF/FOS/98.2. Food Safety Unit, World Health Organization, Geneva.
3. Chilled Food Association. 2002. Microbiological guidance for produce suppliers to chilled food manufacturers, 1st ed. Chilled Food Association Ltd., London.
4. European Commission. 2002. Proposal for a regulation of the European Parliament and of the Council on the hygiene of foodstuffs. COM (2000) 438 final.
5. Food Safety and Hygiene Working Group. 1997. Industry guide to good hygiene practice: retail guide. Chadwick House Group Ltd., Chartered Institute of Environmental Health, London.
6. Food Standards Agency. 2000. Food Safety Act 1990, Code of Practice No. 7: sampling for analysis and examination (Revised October 2000). Food Standards Agency, London.
7. Food Standards Agency. 2000. Food Safety Act 1990, Code of Practice No. 9: food hygiene inspections (Revised October 2000). Food Standards Agency, London.
8. Food Standards Agency. 2001. Consumer attitudes to food standards, final report. Taylor Nelson Sofres plc., London.
9. Fresh Produce Consortium. 1999. Industry guide to good hygiene practice: fresh produce. Chadwick House Group Ltd., Chartered Institute of Environmental Health, London.
10. House of Commons Agricultural Committee. 22 April 1998. Fourth report. Food safety, vol. 1. Her Majesty's Stationery Office, London.
11. Johannessen, G. S., S. Loncarevic, and H. Kruse. 2002. Bacteriological analysis of fresh produce in Norway. *Int. J. Food Microbiol.* 77: 199–204.
12. Joint Hospitality Industry Congress Food Safety and Hygiene Working Group. 1997. Industry guide to good hygiene practice: catering guide. Chadwick House Group Ltd., Chartered Institute of Environmental Health, London.
13. Knight, C., and R. Stanley. 2000. Assured crop production: HACCP in agriculture and horticulture, 2nd ed. CCFRA guideline no. 10. Campden and Chorleywood Food Research Association Group, Chipping Campden, UK.
14. Lin, C.-M., S. Y. Fernando, and C.-I. Wei. 1996. Occurrence of *Listeria monocytogenes, Salmonella* spp., *Escherichia coli* and *E. coli* O157:H7 in vegetable salads. *Food Control* 7:135–140.
15. Long, S. M., G. K. Adak, S. J. O'Brien, and I. A. Gillespie. 2002. General outbreaks of infectious intestinal disease linked with salad vegetables and fruit, England and Wales, 1992–2000. *Comm. Dis. Public Health* 5:101–105.
16. Lund, B. M. 1992. Ecosystems in vegetable foods. *J. Appl. Bacteriol.* 73(Suppl. 21):115S–135S.
17. Mintel International Group. 2002. Fresh fruits and vegetables, May 2000. Market intelligence report. Mintel International Group Ltd., London.
18. Public Health Laboratory Service. 1998. Standard methods for food products. Detection of *Campylobacter* spp. Standard method F21. Public Health Laboratory Service, London.
19. Public Health Laboratory Service. 1998. Standard methods for food products. Detection of *Salmonella* spp. Standard method F13. Public Health Laboratory Service, London.
20. Public Health Laboratory Service. 1998. Standard methods for food products. Direct enumeration of *Escherichia coli.* Standard method F20. Public Health Laboratory Service, London.
21. Public Health Laboratory Service. 1998. Standard methods for food products. Enumeration of *Enterobacteriaceae* by colony count technique. Standard method F23. Public Health Laboratory Service, London.
22. Public Health Laboratory Service. 2000. Guidelines for the microbiological quality of some ready-to-eat foods sampled at the point of sale. *Comm. Dis. Public Health* 3:163–167.
23. Public Health Laboratory Service. 2000. Standard methods for food products. Detection and enumeration of *Listeria monocytogenes* and other *Listeria* spp. Standard method F19. Public Health Laboratory Service, London.
24. Public Health Laboratory Service. 2001. Standard methods for food products. Detection of *Escherichia coli* O157 by immunomagnetic bead separation. Standard method F17. Public Health Laboratory Service, London.
25. Sagoo, S. K., C. L. Little, L. Ward, I. A. Gillespie, and R. T. Mitchell. 2003. Microbiological study of bagged prepared ready-to-eat salad vegetables from retail establishments uncovers a national outbreak of salmonellosis. *J. Food Prot.* 66:403–409.
26. Food and Drug Administration (FDA). 30 January 2001. FDA survey of imported fresh produce, FY 1999 field assignment. Available at: http://www.cfsan.fda.gov/~dms/prodsur6.html. Accessed 5 February 2003.
27. Food and Drug Administration (FDA). January 2003. FDA survey of domestic fresh produce, FY 2000/2001 field assignment. Available at: http://www.cfsan.fda.gov/~dms/prodsu10.html. Accessed 5 February 2003.