ADVISORY COMMITTEE ON THE MICROBIOLOGICAL SAFETY OF FOOD

MICROBIOLOGICAL CONTROL OF DONER KEBABS

At the committees meeting in June 2004, members asked for a paper on the microbiological safety issues associated with donor kebabs. This followed observations about the way in which these products are cooked and used and whether this represented a food safety issue.

The attached paper seeks to address these points, looking at the manufacture of these meat products, the microbiological status of these foods, the evidence of outbreaks linked to kebabs and kebab outlets and advice on the hygienic handling, storage and use of kebabs for shops and caterers.

Secretariat
September 2004

Introduction

1. The “kebab” is one of the fastest growing sectors in the fast food market in some part of Europe including the UK and one large manufacturing company employs 80 people with an annual turnover of £12m. A UK survey of adults in 2002 found a 10% increase in the purchase of take-away food from kebab/middle eastern outlets between 1999 and 2002 (Mintel International, August 2002).

2. A wide range of different types of kebab are made in the UK ranging from lamb doner made from minced lamb, egg, breadcrumbs and spices, lamb schawarma comprising layers of marinated lamb and chicken doner/schawarma made from layers of marinated chicken fillet. These types of kebab are cooked on a vertical spit as a sold mass, which is rotated whilst being roasted with the surface kebab meat being cut off the outside as it browns. Other types of kebabs (lamb and chicken shish, lamb/beef kofte are cooked on skewers on a flat grill.

3. Doner kebabs typically consist of minced or thin slices of lamb which are packed onto a vertical spit. The ingredient used vary but typically include minced or pieces of lamb, lamb fat, egg, onion/onion juice, oil, salt and spices (e.g. garlic, black pepper, marjoram, rosemary). In some recipes the meat is soaked in a marinade of spices before packing on the spit**.** Other types of meat (e.g. beef) may be included in doner kebab recipes by some manufacturers. There are also different preferences for types of doner kebab in other European countries. In France, turkey or turkey and chicken are used, in Holland and Belgium veal, beef and turkey and lamb and turkey and in Germany veal and veal and turkey. In Japan pork or beef mixed with lamb are used.

4. Traditionally the cylinders of raw meat for doner kebabs are made and shaped by hand although automatic doner kebab production lines are being introduced by the larger companies. Doner/ kebabs vary in size and weight but can be 1 metre in height and weighing several 100kg. At least one large company blast freezes doner kebabs prior to distribution.

Microbiological status of doner and other types of kebebs

5. A LACOTS/PHLS survey of the microbiological quality of doner kebabs in restaurants, takeaways and other retail premises was carried out in 1995 and the report of the survey is attached at Annex A. Based on the PHLS microbiological guidelines for ready-to-eat foods at the point of sale 5/2538 samples (0.2%) were of an unacceptable microbiological quality and 307 (12%) were unsatisfactory. The unacceptable samples comprised one sample with *Salmonella* Mbandaka*,* one with a high count of *Staphylococcus aureus,* and three with high counts of *Clostridium perfringens.* The samples classed as unsatisfactory had high aerobic plate counts. The study also examined the microbiological results in terms of differences between type of premises, cuisine and hygiene. The temperature the kebab is held at between opening hours appeared to be an indicator of microbiological quality and that kebabs which were cooked and then chilled, or cooked to order, were more contaminated than other samples. The conclusion of the study was that doner kebabs are safe to eat although occasional infections could result from cross contamination occurring within the premises.

6. A more recent survey was carried out by Greater Manchester/Lancashire/PHLS food liaison group in January to April 2001 and examined 289 samples of doner kebabs from take-away food shops in the region (Williamson *et al*., 2001). The samples comprised pitta bread filled with doner kebab meat, salad and yoghurt dressing or sauce and were taken from a range of establishments between 6pm and midnight. Twelve samples (4%) were unsatisfactory/unacceptable according to the PHLS guidelines due to levels of *E.coli*, *Staphylococcus aureus* and *Bacillus subtilis.* Follow-up works indicated that 11/12 of the unsatisfactory/unacceptable results were from kebabs served with chilli sauce, some of which were kept at ambient .

7. Annex B provides microbiological data on doner kebabs from the Health Protection Agency's food database. Based on the PHLS microbiological guidelines for ready-to-eat foods sampled at the point of sale, 80% of the 397 doner kebab samples tested were satisfactory, 16% were acceptable, 4% were unsatisfactory and none were of unacceptable microbiological quality. The unsatisfactory results were due to high counts of *E. coli Listeria* spp. (not *L. monocytogenes*) or *Bacillus* spp.

Outbreaks linked to kebabs and kebab establishments

8. Table 1 provides a listing of ten general outbreaks of infectious Intestinal Disease between 1992 and 2003, which were attributed to kebabs or to foods in establishments selling kebabs. Eight of the outbreaks were attributed to *Salmonella*, and one each to *Campylobacter* and VTEC O157. In 4 of the outbreaks doner kebabs were specifically mentioned as suspected vehicles of infection and in 2 of these outbreaks, both involving *Salmonella* Mikawasima, doner kebabs were the only food vehicle mentioned (see Synott *et al*., 1993). The potential for large outbreak to occur is illustrated by the outbreak of *Salmonella* Enteritidis PT56 in 2003, which was associated with miscellaneous foods from a take-away kebab shop. At least 340 people were affected with 65 hospitalised. No outbreaks were reported for *Clostridium perfingens* during this period although outbreaks have been associated with meat products in other settings.

Table 1. General outbreaks of Infectious Intestinal Disease linked with Kebab restaurants and/or kebabs, England & Wales, 1992-2003. The outbreaks listed are those reported to the Health Protection Agency's Communicable Surveillance Centre.

Year	Restaurant specifics	Pathogen/toxin	Affected	Hospital	Died	Vehicles*
1992	Indian takeaway	*S*. Enteritidis PT4	11	1	0	Chicken, Kebab (donor)
1992	Pizza house takeaway	*S*. Mikawasima	11	1	0	Kebab (doner)
1993	Greek takeaways	*S*. Mikawasima	64	4		Kebabs (doner)
1993	Indian	*S*. Typhimurium DT104	7	1	0	Onion, Kebabs
1999	Turkish - kebab shop	VTEC O157 PT2	12	2		Chicken kebab
1999	Indian	*S*. Enteritidis PT4	3			Chicken tikka kebab
1999	Takeaway kebab house	*S*. Hindmarsh	12	3		Lamb doner kebab, Salads, sauces
2002	Take away	*Campylobacter*	3	0	0	Chicken kebabs
2002	Take away kebab shop	*S*. Typhimurium DT104	5	3	0	Chicken
2003†	Take away kebab shop	*S*. Enteritidis PT56	340	65		Misc. foods

* More than one vehicle can be reported in any given outbreak

† Data for 2003 remain provisional

Data source: Health Protection Agency, Communicable Disease Surveillance Centre

9. During July 1995 an outbreak of *Salmonella* Typhimurium DT170 in South Wales was linked to the consumption of kebabs, doner kebabs, kebabs with yoghurt based relish but not with consuming kebabs with mayonnaise-based relish (Evans et al., 1999). Investigations pointed to cross-contaminated relishes and dressings as well as undercooked meat as potential vehicles.

Guidance on the storage and use of kebabs

10. An internet search revealed that a large number of Local Authorities provide advice/fact sheets for shops/caterers on their websites concerning the preparation, safe cooking and storage of doner kebabs/kebab meat. . Examples were found on the websites for Brighton and Hove City Council, Coventry City Council, Eastbourne Borough Council, Gloucester City Council, London Borough of Hillingdon, Royal Borough of Kensington and Chelsea, Newark and Sherwood District Council, Rushcliffe Borough Council, City of Salford Council, Sedgefield Borough Council, Uttlesford and Vale Royal Borough Council. Web links to a selection of these documents are provided in the list of references to this paper. The advice emphasises the importance of temperature control prior to cooking, hot holding storage and use of kebabs.

Conclusion

11. Donor kebabs and other types of kebab are increasingly popular foods available from a wider range of outlets throughout the UK. The findings from microbiological surveys and other testing over the last decade do not suggest a major problem with this type of food. The vast majority of samples tested were satisfactory according to the PHLS/HPA microbiological guidelines for ready-to-eat foods at the point of sale. Most doner kebabs are likely to be served in pitta bread with salad and various dressings. The evidence from outbreaks and from the studies by Evans *et al.* (1999), Williamson *et al*. (2001) and from some of the outbreaks listed in Table 1 suggest that contamination of foods other than or in addition to the kebab meat my also be important. Potential hazards associated with the production, storage and use of doner kebabs and kebab meat appear to be well recognised and many local authorities provide guidance to shops and caterers through information sheets which are available on their websites.

References

Evans MR, Salmon RL, Nehaul L, Mably S, Wafford L, Nolan-Farrell MZ, Gardner D, Ribeiro CD. An outbreak of *Salmonella typhimurium* DT170 associated with kebab meat and yogurt relish. Epidemiol Infect. 1999 Jun; 122(3): 377-383.

Synnott M, Morse DL, Maguire H, Majid F, Plummer M, Leicester M, Threlfall EJ, Cowden J. An outbreak of *Salmonella mikawasima* associated with doner kebabs. Epidemiol Infect. 1993; 111: 473-481.

Williamson K, Allen G, Bolton FJ. 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, August 2001.

A selection of web links to advice on doner kebabs issued by Local Authorities

Brighton and Hove City Council
http://www.brighton-hove.gov.uk/site01.cfm?request=c1123941

Eastbourne Borough Council
http://www.eastbourne.gov.uk/Business/downloads/food_hygiene_doner.pdf

London Borough of Hillingdon
http://www.hillingdon.gov.uk/environment/food_safety/kebabs.php

Royal Borough of Kensington and Chelsea
http://www.rbkc.gov.uk/EnvironmentalServices/foodhygieneandstandards/dona.asp

Newark and Sherwood District Council
http://www.newark-sherwooddc.gov.uk/environmentalservices/foodandoccupationalhealth/fact/sheet05.htm

Rushcliffe Borough Council
http://www.rushcliffe.gov.uk/environmental_health/food/guides/kebabs.htm

City of Salford
http://www.salford.gov.uk/advisory-note-7-doner-kebabs.pdf

Sedgefield Borough Council
http://www.sedgefield.gov.uk/environmentalhealth/htdocs/foodsafety/food_az/donna_kebabs.htm

Secretariat
September 2004

Annex A - Report of survey carried out in October – November 1995

LACOTS / PHLS study of the Microbiological Quality of Doner Kebab Meat

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SUMMARY

A study of kebab meat sampled in restaurants, takeaways and other retail premises found 5/2538 samples (0.2%) were of an unacceptable microbiological quality and 307 (12%) were unsatisfactory. Of the unacceptable samples one contained *Salmonella mbandaka,* one had a high count of *Staphylococcus aureus,* and three samples had high counts of *Clostridium perfringens.* The most common reason for unsatisfactory results was a high aerobic plate count. The microbiological quality of the kebab meat was used to examine differences between premises types, cuisine and hygiene. Poor microbiological quality appears to be due to the temperature the kebab is held at between opening hours. Overall doner kebabs are safe to eat although occasional infections may result from cross contamination within the premises.

INTRODUCTION

The ready to eat doner kebab study was the third in the national co-ordinated food liaison group sampling programme for 1995/1996. The study was designed to establish the microbiological quality of ready to eat doner kebab meat from takeaways, restaurants, cafes and mobile vendors in the UK.

The microbiological quality was assessed in order to determine whether ready to eat doner kebab meat at the point of sale is fit for human consumption and is of the quality demanded by the purchaser. The study was also intended to identify any hygiene problems and to make appropriate recommendations to food enforcement officers to assist them with their task of ensuring food safety, with particular regard to the microbiological quality of ready to eat doner kebab meat.

MATERIALS AND METHODS

Sampling

Sampling took place during October and November 1995. Each Food Liaison Group in England and Wales was invited to submit up to 100 samples of doner kebab meat collected from a variety of retail outlets. Only kebab meat which had not come into contct with other constituents was sampled. The sampling method was in accordance with that detailed in Food Safety Act 1990, Code of Practice No 7:- Sampling for Analysis and Examination with reference to Part III, Samples for Examination.

Samples were examined for aerobic plate count, enumeration of coliforms, enumeration of *Escherichia coli* (presumptive), enumeration of *S.aureus,* enumeration of *Cl.perfringens* and detection of *Salmonella* spp.

Microbiological methods

Standard microbiological procedures were used to determine the aerobic plate count, to enumerate coliforms, *Escherichia coli, Staphylococcus aureus* and *Clostridium perfringens* and to detect the presence of *Salmonella* spp.

Variations on the standard methods are shown below.

Aerobic plate count at 30^0 C for 48 hours. The method differed from BS5763: Part 5:1981 Colony count at 30^0 C - Surface plate technique in that it allows the use of a

spiral plater and surface counts and plates were incubated for 48 hours instead of 72 hours.

Enumeration of coliforms and *E.coli.* A most probable number procedure was used, (BS 5763: Part 8: 1985) but with minerals modified glutamate broth (MMGB) instead of lauryl sulphate tryptose broth and brilliant green bile broth (BGBB) instead of *E.coli* broth (Practical Food Microbiology, 1995).

Enumeration of *S.aureus.* The method was based on BS 5763: Part 7: 1983, but differed in allowing the use of a spiral plater. A surface spread plate (0.5ml of a 10^{-1} dilution) was also used. The sensitivity of this method was 20 organisms per gram.
Enumeration of *Cl.perfringens*. The method was based on BS 5763: Part 9: 1986, but 5 not 10 characteristic colonies were subcultured and lactose-gelatin medium was refrigerated for 30 minutes not for 1 hour.

Detection of *Salmonella* spp. The method was based on BS 5763: Part 4: 1993.

RESULTS

A total of 2,538 samples were collected by Environmental Health Officers from 44 Food Liaison Groups and examined by 68 laboratories, including 11 Scottish laboratories. Samples were collected from a range of retail outlets (Table1). The majority of samples were collected from takeaways (2202/2538, 87%). A variety of types of cuisine were sampled, the most common being Turkish (971/2538, 38%). Samples from 'other' cuisine types (Table 1) accounted for 29% of the total. These comprised 209 fish and chip outlets, 55 Italian premises, 26 pizza outlets, 20 burger bars and 416 premises of various other types.

Premises were categorised according to the Food Safety Act 1990 (Code of Practice No 9) (Table 2). The majority of samples (61%) were in categories A, B and C. Risk category information was not recorded on 945 (37%) samples. During the course of the study 315 premises were sampled on more than one occasion. The microbiological results of kebabs from premises which were revisited were similar to those from premises which were sampled only once.

Of the 1,596 kebabs on which information on the composition was collected 1,012 (63%) were prepared from minced meat and 584 (37%) from sliced meat. This information was not recorded on 942 (37%) samples. The majority of kebabs (64%) had been obtained from a supplier, while 32% (820/2538) had been prepared on the retailer's premises. The majority of kebabs (2256/2538, 89%) were made from lamb.

Information on the temperature of kebabs when placed on the spit prior to cooking and the temperature of the meat when the samples were collected is shown in Table3. Most kebab samples were frozen or chilled when first placed on the spit (57% frozen, 30% chilled). Most kebabs were hot when sampled (2016/2538, 79%). Most samples were either taken directly from a spit (1547/2538, 61%) or from a hot bain marie (806/2538, 32%). The majority of samples (1554/2538, 61%) were reported to have been on the spit for less than 3 hours, 5% for 13-24 hours, and 2% for 1-2 days. Nine kebabs were reported to have been on the spit for 3-4 days and two for 5 days.

Most samples were received in the laboratory at a temperature below 8^0C (1075/2538, 42%), although this information was not recorded for 39% of samples.

Microbiological results

The overall microbiological results on the kebabs tested are presented in Table 4. The aerobic plate count exceeded 10^4 orgs/g in 300/2538, (12%) of samples. In 1% of samples the APC exceeded 10^6 orgs/g. Coliforms in excess of 10^2/g were present in 65 samples and of these, the count exceeded 10^3 orgs/g in 27 samples (1%). Similarly 16 samples contained *E.coli* in excess of 10^2/g and six of these had counts greater than 10^3/g. *Staphylococcus aureus* was present in excess of 10^2/g in eight samples (<1%). *C.perfringens* was present in excess of 10^2/g in 14 samples (<1%), three of which exceeded 10^4orgs/g. Salmonella (*S.mbandaka*) was detected in one sample.

When compared with the Microbiological Guidelines for Ready to Eat Foods published by the PHLS (Gilbert et al, 1996), 65% of kebabs were satisfactory, 23% were borderline, 12% unsatisfactory and 0.2% unacceptable (Table 5). Of the 5 samples which were unacceptable / potentially hazardous, three had >10^4/g *C.perfringens,* one had >10^4/g *S.aureus,* and there was a single sample containing salmonella. The aerobic plate count (APC) was the microbiological parameter most often associated with unsatisfactory microbiological quality, representing 300/307 of the unsatisfactory samples. Samples with an APC of 10^4/g or more were more frequently contaminated with *E.coli*, *S.aureus* or *C.perfringens* than those with lower APCs (Table 6).

The microbiological quality of kebab samples from a variety of cuisine types was examined (Tables 7 and 8). Indian and Chinese cuisine had a greater percentage of samples with aerobic plate counts in excess of 10^4/g than other types of cuisine. The kebabs from certain types of premises were associated with poorer microbiological quality, with a greater

percentage of samples from restaurants having an APC in excess of 10^4 orgs/g, compared to all other premises (Tables 9 and 10).

Kebabs made from sliced meat were of poorer microbiological quality than those made from minced meat as judged by APC and coliform counts (Tables 11 and 12). Kebabs which were made on the premises were of similar microbiological quality to those made by a supplier. Kebabs made from chicken meat were more frequently unsatisfactory or unacceptable (35%) than those made from lamb (10%) or other types of meat (21%) (Table 13).

Kebabs were less frequently unsatisfactory when sliced straight from the spit (12%) or from a hot bain marie (9%) compared to all other samples (32%) (Table 14). Kebabs cooked to order (80%), and those cooked and stored chilled (53%) were the most frequently unsatisfactory. However all the samples with an unacceptable count were from kebabs which were sampled sliced from the spit or from the hot bain marie. There were only 188 samples which were not from these sampling points, and the absence of any unacceptable results from these is probably due to the small sample size of this subgroup.

There was little difference in the microbiological quality of kebabs from different risk categories with the exception of the 37 samples from category D, which had a higher percentage of kebabs with an APC in excess of 10^4 orgs/g than the other categories (Table 15).

The aerobic plate counts of kebabs kept under various temperature conditions were compared, including the temperature of storage between opening hours, when first placed on the spit, and when sampled (Table 16). A lower percentage of samples had an APC in excess of 10^4 orgs/g when the whole kebab was stored frozen, compared to those stored at other temperatures. Kebabs which were hot or warm when sampled had a lower percentage of samples with a high APC compared to those at other temperatures. The length of time for which the kebabs were placed on the spit also affected the microbiological quality of the product. There was no significant difference in the microbiological quality of kebab meat where the whole kebab had been on the spit for more than 12 hours compared with those kept on the spit for less than 12 hours.

There were differences in the microbiological quality of kebabs sampled in different regions of the United Kingdom, with the percentage unsatisfactory or unacceptable being highest in the Midlands and Northern Ireland (Table 17).

DISCUSSION

This study has shown that most kebabs from retail take-away premises in England, Wales or Scotland are safe to eat, although the fact that 12% were classed as unsatisfactory using the PHLS Guidelines for Ready to Eat Foods suggests that improvements could be made in the hygiene of these products. Only 0.2% of the samples were potentially hazardous, and the main reason for unsatisfactory results was a high aerobic plate count which is not in itself a health risk but does indicate an overall lack of hygiene. The three samples with high counts of *C.perfringens* had levels which could cause food poisoning. All three were sliced meat chicken kebabs from take away premises. This, together with a considerably higher level of unsatisfactory samples in chicken kebabs, suggest that these products present a greater risk than lamb kebabs. This study shows that the greatest food poisoning risk to the public from donor kebabs is *C.perfringens*. Kebabs are usually manufactured in a production unit and stored frozen. They are put onto the spit while still frozen, thawed for a while, and then cooked on the outside. At the end of the day the kebab is returned to the freezer or fridge until the following day. These cooking practices allow variations in the temperature control of the product, and these could be one of the reasons for differences between the results between different premises. The donor kebab is a large quantity of meat which will heat up and cool down rather slowly. As better results were obtained from premises where the whole kebab was returned to the freezer between opening hours, it is likely that this practice allows the large amount of meat to cool relatively quickly. *C.perfringens* is the commonest form of food poisoning associated with cooked meat products (Roberts et al, 1995). The cooking process

drives off oxygen and this favours the growth of anaerobic bacteria, particularly spore bearing species.

Cross contamination of the cooked meats can occur from raw meats or from contaminated equipment. The salmonella isolated from a single sample could have derived from the original meat, been cross contaminated from uncooked food, work surfaces or equipment, or from a food handler. Cross contamination in these types of premises remains a potential source of sporadic infections with salmonella and campylobacter.

The lower microbiolological quality of kebabs in restaurants compared to other premises may reflect differences in the types of kebab sold in these premises and differences in preparation and cooking practices. The kebabs sold in Indian restaurants are not donor kebabs, and they are of lower microbiological quality. Kebabs which were cooked and then chilled, or cooked to order, were more contaminated than other samples. High bacterial counts were associated with kebabs which had been on the spit for more than 12 hours may reflect growth of microorganisms in the doner kebab, or on its surface due to post cooking contamination. Although the practices used to prepare and cook kebabs are probably adequate, there has been some concern that these practices may not be adequate to prevent occasional outbreaks of food poisoning (Synott et al, 1993).

The revised Microbiological Guidelines for ready-to-eat foods published by the PHLS (Gilbert et al, 1996) have been extended and changed from the previous provisional Guidelines (Gilbert, 1992). The new guidelines provided a useful way of comparing the quality and safety of kebabs in conjunction with the other detailed information on the samples.

References

1. Gilbert RJ. 1992. Provisional microbiological guidelines for some ready-to-eat foods at point of sale. PHLS Microbiology Digest, **9**, 98-102.
2. Gilbert RJ, de Louvois J, Donovan T, Hooper WL, Nichols G, Peel NR, Ribiero CD, Roberts D. Microbiological guidelines for some ready-to-eat foods sampled at the point of sale. PHLS Microbiology Digest 1996; **13**: 41-43.
3. Roberts D, Hooper W, Greenwood M. Practical Food Microbiology, PHLS London, 1995.
4. Synnott M, Morse DL, Maguire H, Majid F, Plummer M, Leicester M, Threlfall EJ, Cowden J. An outbreak of *Salmonella mikawasima* associated with doner kebabs. Epidemiology and Infection 1993; **111**: 473-481.

Table 1. Samples of ready-to-eat kebab meat from various retail outlets and cuisine types

premise type	Turkish	Arabic	Greek	Chinese	Indian	other	not stated	total
Takeaway	802 (36%)	56 (3%)	322 (15%)	27 (1%)	201 (9%)	666 (30%)	128 (6%)	2202
restaurant	20 (39%)	1 (2%)	10 (20%)	1 (2%)	9 (18%)	6 (12%)	4 (8%)	51
Café	9 (41%)	0	6 (27%)	0	2(9%)	4 (18%)	1 (5%)	22
Mobile	114 (70%)	8 (5%)	6 (4%)	0	3 (2%)	24 (15%)	9 (6%)	164
Other	23 (34%)	1 (1%)	15 (22%)	0	3 (4%)	21 (31%)	5 (7%)	68
not stated	3 (10%)	0	2 (7%)	0	2 (7%)	7 (23%)	17 (55%)	31
Total	971 (38%)	66 (3%)	361 (14%)	28 (1%)	220 (9%)	728 (29%)	164 (6%)	2538

Table 2 Kebabs meat samples from premises in the Food Safety Act risk categories

Premise	A	B	C	D	E	F	Not known / not stated	total
Takeaway	153 (7%)	465 (21%)	747 (34%)	35 (2%)	1 (<1%)	3 (<1%)	798 (36%)	2202
Restaurant	8 (16%)	10 (20%)	13 (25%)	0	0	0	20 (39%)	51
Café	2 (9%)	3 (14%)	7 (32%)	0	0	0	10 (45%)	22
Mobile	15 (9%)	37 (23%)	52 (32%)	1 (<1%)	0	0	59 (36%)	164
Other	5 (7%)	12 (18%)	14 (21%)	1 (1%)	0	0	36 (53%)	68
not stated	0	2 (6%)	7 (23%)	0	0	0	22 (71%)	31
Total	183 (7%)	529 (21%)	840 (33%)	37 (1%)	1 (<1%)	3 (<1%)	925 (36%)	2538

Table 3. Samples of ready-to-eat kebab meat at various temperatures of storage, on the spit or when sampled

temperature	Temperature of Kebab when first placed on the spit	Temperature when sampled	Temperature of storage between opening hours
Frozen	1453 (57%)	not applicable	1090 (43%)
Chilled	767 (30%)	61 (2%)	821 (32%)
Ambient	147 (6%)	49 (2%)	238 (9%)
Warm	3 (<1%)	332 (13%)	38 (2%)
Hot	14 (<1%)	2016 (79%)	52 (2%)
not stated	154 (6%)	80 (3%)	299 (12%)
Total	2538	2538	2538

Table 4. Microbiological results from kebab meat

	Not detected	Detected in 25 g	$<10^2$ per g	10^2 to $<10^3$ per g	10^3 to $<10^4$ per g	10^4 to $<10^5$ per g	10^5 to $<10^6$ per g	10^6 to $<10^7$ per g	= or $>10^7$ per g	Not stated
APC	902			759	571	214	64	16	6	6
Coliforms	2227		226	38	25	1	1	0	0	20
E.coli	2434		78	10	6	0	0	0	0	10
S.aureus	2513		14	5	2	1	0	0	0	3
C.perfringens	2519			10	1	1	2	0	0	5
Salmonella	2522	1								15

Table 5. Kebab meat samples in each of the categories in the PHLS Guidelines for Ready to Eat Foods

	Satisfactory	Borderline	Unsatisfactory	Unacceptable	Not known
APC	1661	571	300	-	6
E.coli	2434	78	16	0	10
S.aureus	2513	14	7	1	3
C.perfringens	2519	0	11	3	5
Salmonella	2522	0	0	1	15
Total	1652	574	307	5	-

Key for kebabs by PHLS Microbiological Guidelines for ready to eat foods sampled at the point of sale (*Gilbert et al*., 1996)

Category	APC	*E.coli*	*S.aureus*	*L.monocytogenes*	*Listeria* spp (other)
Satisfactory	$<10^3$/g	Not detected in 25g	<20/g	Not detected in 25g	Not detected in 25g
Borderline - limit of acceptability	10^3-$<10^4$/g	20 - <100/g	20 - <100/g	present in 25g - <200/g	present in 25g - <200/g
Unsatisfactory	$\geq 10^4$/g	100 - $<10^4$/g	100 - $<10^4$/g	200 - $<10^3$/g	200 - $<10^4$/g
Unacceptable / potentially hazardous	Not applicable	$\geq 10^4$/g	$\geq 10^4$/g	$\geq 10^3$/g	$\geq 10^4$/g

Table 6. Samples of ready-to-eat kebab meat with unsatisfactory or unacceptable counts of pathogens in relation to their aerobic plate counts

	Low APC ($<10^4$/g)	High APC ($>10^4$/g)	Total
Number tested	2232	300	2532
E.coli unsatisfactory/unacceptable	2 (0.1%)	14 (4.7%)	16 (0.6%)
C.perfringens unsatisfactory/unacceptable	6 (0.3%)	8 (2.7%)	14 (0.5%)
S.aureus unsatisfactory/unacceptable	3 (0.1%)	5 (1.6%)	8 (0.3%)
Salmonella unacceptable	1 (0.05%)	0	1 (0.05%)

Table 7. Comparison of the premises cuisine type with kebab meat samples with high microbial counts

	APC>10^4	coliforms >10^2	*E.coli* >10^2	*S.aureus* >10^2	*Cl.perfringens* >10^2
Arabic	7 (11%)	1 (2%)	1 (2%)	0	0
Chinese	6 (21%)	1 (4%)	0	0	1 (4%)
Greek	43 (12%)	14 (4%)	2 (<1%)	2 (<1%)	5 (1%)
Indian	48 (22%)	12 (6%)	3 (1%)	0	3 (1%)
Turkish	91 (9%)	18 (2%)	6 (<1%)	4 (<1%)	2 (<1%)
Other cuisines	88 (12%)	13 (2%)	2 (<1%)	2 (<1%)	3 (<1%)
Not stated	17 (10%)	6 (4%)	2 (1%)	0	0
Total	300 (12%)	65 (3%)	16 (<1%)	8 (<1%)	14 (<1%)

Table 8. Kebab meat of different cuisine meeting the categories in the Guidelines for Ready to Eat Foods

	Satisfactory	Borderline	Unsatisfactory	Unacceptable	Grand Total
Arabic	39 (59%)	20 (30%)	7 (11%)	0 (0%)	66 (100%)
Chinese	13 (46%)	9 (32%)	6 (21%)	0 (0%)	28 (100%)
Greek	235 (65%)	80 (22%)	46 (13%)	0 (0%)	361 (100%)
Indian	104 (47%)	68 (31%)	47 (21%)	1 (0.5%)	220 (100%)
Turkish	693 (71%)	182 (19%)	94 (10%)	2 (0.2%)	971 (100%)
Other cuisines	460 (63%)	177 (24%)	90 (12%)	1 (0.1%)	728 (100%)
Not known	108 (66%)	38 (23%)	17 (10%)	1 (0.6%)	164 (100%)
Total	1652 (65%)	574 (23%)	307 (12%)	5 (0.2%)	2538 (100%)

Table 9. Microbiological results on kebab meat from different types of premises

Premise type	APC>10^4	coliforms >10^2	*E.coli* >10^2	*S.aureus* >10^2	*Cl.perfringens* >10^2
Takeaway	258 (12%)	55 (3%)	12 (<1%)	6 (<1%)	12 (<1%)
Restaurant	14 (27%)	1 (2%)	0 (0%)	0 (0%)	1 (2%)
Café	2 (9%)	2 (9%)	0 (0%)	0 (0%)	0 (0%)
Mobile	9 (6%)	4 (2%)	2 (1%)	2 (1%)	0 (0%)
Other	13 (19%)	3 (4%)	2 (3%)	0 (0%)	1 (2%)
Not Stated	4 (13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	300 (12%)	65 (3%)	16 (<1%)	8 (<1%)	14 (<1%)

Table 10. Kebab meat from different premises meeting the categories in the Guidelines for Ready to Eat Foods

Premises	Satisfactory	Borderline	Unsatisfactory	Unacceptable	Total
Takeaway	1440 (65%)	494 (22%)	263 (12%)	5 (0.2%)	2202
Restaurant	22 (43%)	15 (29%)	14 (27%)	0 (0%)	51
Café	12 (55%)	8 (36%)	2 (9%)	0 (0%)	22
Mobile	118 (72%)	35 (21%)	11 (7%)	0 (0%)	164
Other	39 (57%)	16 (24%)	13 (19%)	0 (0%)	68
Not known	21 (68%)	6 (19%)	4 (13%)	0 (0%)	31
Total	1652 (65%)	574 (23%)	307 (12%)	5 (0.2%)	2538

Table 11. Comparison of the microbiology of different kebab types

Kebab type	APC >10^4	coliforms >10^2	*E.coli* >10^2	*S.aureus* >10^2	*Cl.perfringens* >10^2	Total number of samples

Minced Meat Kebab	99 (10%)	20 (2%)	2 (<1%)	4 (<1%)	3 (<1%)	1012
Sliced Meat Kebab	84 (14%)	21 (4%)	7 (1%)	1 (<1%)	4 (<1%)	584
Not Stated	117 (12%)	24 (3%)	7 (<1%)	3 (<1%)	7 (<1%)	942
Total Samples	300 (12%)	65 (3%)	16 (<1%)	8 (<1%)	14 (<1%)	2538

Table 12. Comparison of different kebab types meeting the categories in the PHLS Microbiological Guidelines for Ready to Eat Foods

Sample	Satisfactory	Borderline	Unsatisfactory	Unacceptable	Total
Minced meat kebab	711 (70%)	198 (20%)	101 (10%)	2 (0.2%)	1012
Sliced meat kebab	347 (59%)	152 (26%)	82 (14%)	3 (0.5%)	584
Not known	594 (63%)	224 (24%)	124 (13%)	0 (0%)	942
Total	1652 (65%)	574 (23%)	307 (12%)	5 (0.2%)	2538

Table 13. Comparison of kebab meat meeting the categories in the PHLS Microbiological Guidelines for Ready to Eat Foods by animal meat type

Meat	Satisfactory	Borderline	Unsatisfactory	Unacceptable	Total
Chicken	63 (33%)	62 (32%)	65 (34%)	3 (1.6%)	193
Lamb	1539 (68%)	492 (22%)	223 (10%)	2 (0.1%)	2256
Beef	13 (57%)	5 (22%)	5 (22%)	0 (0%)	23
Pork	0 (0%)	2 (67%)	1 (33%)	0 (0%)	3
Other	10 (59%)	3 (18%)	4 (24%)	0 (0%)	17
Not known	27 (59%)	10 (22%)	9 (20%)	0 (0%)	46
Total	1652 (65%)	574 (23%)	307 (12%)	5 (0.2%)	2538

Table 14. Comparison of kebab meat meeting the categories in the PHLS Microbiological Guidelines for Ready to Eat Foods by where the kebab was sampled from

	Satisfactory	Borderline	Unsatisfactory	Unacceptable	Total
Sliced from spit	1015 (66%)	349 (23%)	178 (12%)	2 (0.1%)	1544
Hot bain mari	557 (69%)	177 (22%)	69 (9%)	3 (0.4%)	806
Cooked & stored chilled	7 (22%)	8 (25%)	17 (53%)	0 (0%)	32
Grilled	13 (50%)	7 (27%)	6 (23%)	0 (0%)	26
Microwaved	11 (65%)	5 (29%)	1 (6%)	0 (0%)	17
Cooked to order	0 (0%)	2 (20%)	8 (80%)	0 (0%)	10
Other / not known	49 (48%)	26 (25%)	28 (27%)	0 (0%)	103
Total	1652 (65%)	574 (23%)	307 (12%)	5 (0.2%)	2538

Table 15 Comparison of kebab meat meeting the categories in the PHLS Microbiological Guidelines for Ready to Eat Foods by premises in the Food Safety Act risk categories

Risk category	Satisfactory	Borderline	Unsatisfactory	Unacceptable	Grand Total
A	127 (67%)	38 (20%)	23 (12%)	1 (0.5%)	189 (100%)
B	352 (66%)	124 (23%)	59 (11%)	1 (0..2%)	536 (100%)
C	545 (65%)	191 (23%)	101 (12%)	3 (0.4%)	840 (100%)
D	19 (51%)	10 (27%)	8 (22%)	0 (0%)	37 (100%)
E	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)
F	3 (100%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)
Not known	605 (65%)	211 (23%)	116 (12%)	0 (0%)	932 (100%)
Grand Total	1652 (65%)	574 (23%)	307 (12%)	5 (0..2%)	2538 (100%)

Table 16. Percentage of kebab meat samples with aerobic plate counts of over 10^4/g under various temperatures of storage, on the spit or when sampled

Temperature	Temperature of Kebab when first placed on the spit	Temperature when sampled	Temperature of storage between opening hours
Frozen	139/1453 (10%)	Not applicable	105/1090 (10%)
Chilled	116/767 (15%)	21/61 (34%)	127/821 (16%)
Ambient	21/147 (14%)	16/49 (33%)	33/238 (14%)
Warm	2/3 (67%)	47/332 (14%)	7/38 (18%)
Hot	1/14 (7%)	206/2016 (10%)	8/52 (15%)
not stated	21/154 (14%)	10/80 (13%)	20/299 (7%)
Total	300/2538 (12%)	300/2538 (12%)	2538

Table 17. Regional breakdown of results of kebabs meeting the categories in the PHLS Microbiological Guidelines for Ready to Eat Foods

Region	Satisfactory	Borderline	Unsatisfactory	Unacceptable	Total
East	134 (68%)	41 (21%)	23 (12%)	0 (0%)	198
Mid South	60 (72%)	19 (23%)	4 (5%)	0 (0%)	83
Midlands	192 (54%)	77 (22%)	85 (24%)	1 (0.3%)	355
North	117 (54%)	75 (35%)	25 (12%)	0 (0%)	217
North West	208 (66%)	68 (22%)	37 (12%)	1 (0.3%)	314
Northern Ireland	19 (54%)	8 (23%)	8 (23%)	0 (0%)	35
Scotland	41 (64%)	22 (34%)	1 (2%)	0 (0%)	64
South Thames	306 (73%)	78 (18%)	37 (9%)	1 (0.2%)	422
South West	138 (65%)	49 (23%)	25 (12%)	0 (0%)	212
Thames Valley	249 (72%)	64 (18%)	33 (9%)	2 (0.6%)	348
Trent	146 (64%)	58 (26%)	23 (10%)	0 (0%)	227
Wales	42 (67%)	15 (24%)	6 (10%)	0 (0%)	63
Total	1652 (65%)	574 (23%)	307 (12%)	5 (0.2%)	2538

Annex B – HPA data on the microbiological status of doner kebabs

Health Protection Agency Food Microbiology Database: Microbiological Quality of Doner Kebabs

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23 July 2004

Summary
The Health Protection Agency Food Microbiology Database contains 397 samples of doner kebabs (meat, poultry).

Doner kebabs are generally served in pitta bread with salad garnishes and yoghurt/sauce dressings. Category 5 (sandwiches/filled rolls with salad) of the PHLS microbiological guidelines for some ready-to-eat foods sampled at point of sale[1] was therefore used to determine the microbiological quality of doner kebab results held on the HPA Food Database. Enterobacteriaceae results were also excluded from the determination of microbiological quality as this products contains salad vegetables.

Based on the PHLS microbiological guidelines for some ready-to-eat foods sampled at point of sale, (80%) of the 397 doner kebab samples were satisfactory, 16% were acceptable, and 4% were of unsatisfactory microbiological quality. None of the samples were of unacceptable microbiological quality.

- Unsatisfactory results were largely due to high *E. coli* and *Listeria* spp. (not *L.* monocytogenes) in excess of 10^2 cfu/g, and *Bacillus* spp at 10^5 cfu/g or more (Table 1).

- Table 2 provides the microbiological profile for the 397 samples of doner kebabs (including ACC and Enterobacteriaceae data). *E. coli* O157, *Salmonella* spp., and *Campylobacter* spp. were not detected in any of the samples tested. Samples were examined for *Listeria monocytogenes* by the enumeration method only, of which all results were reported as <20 cfu/g (limit of detection).

[1] Public Health Laboratory Service. 2000. Guidelines for the Microbiological Quality of Some Ready-To-Eat foods sampled at the Point of Sale. *Comm. Dis. Pub. Health* **3:** 163-7.

Table 1. Microbiological Results of Doner Kebabs according to the PHLS Microbiological Guidelines for ready-to-eat foods (n=397)

	Satisfactory	Acceptable	Unsatisfactory	Unacceptable	Samples Tested
Aerobic Colony Count	137 (35%)	69 (18 %)	185 (47 %)	N/A	391 (98 %)
Enterobacteriaceae	181 (51 %)	101 (28 %)	73 (21 %)	N/A	355 (89 %)
E. coli	382 (97 %)	8 (2 %)	4 (1 %)	N/A	394 (99 %)
***Listeria* spp. (total)**	308 (98.7 %)	1 (0.3 %)	3 (1.0 %)	N/A	312 (79 %)
L monocytogenes	248 (100 %)	0	N/A	0	248 (62 %)
***Salmonella* spp.**	294 (100 %)	-	-	0	294 (74 %)
***Campylobacter* spp.**	23 (100 %)	-	-	0	23 (6 %)
***E. coli* O157**	5 (100 %)	-	-	0	5 (1 %)
Staph. aureus	380 (97.7 %)	7 (1.8 %)	2 (0.5 %)	0	389 (98 %)
C. perfringens	265 (99.3 %)	1 (0.4 %)	1 (0.4 %)	0	267 (67 %)
B. cereus	243 (99.6 %)	0	1 (0.4 %)	0	244 (61 %)
***Bacillus* spp.**	18 (26 %)	46 (67 %)	5 (7 %)	0	69 (17 %)

Table 2. Microbiological results of doner kebabs

	ND* in 25g	**D[§] in 25g**	**ND**	**<10^{2}†**	**10^{2} - <10^{3}**	**10^{3} - <10^{4}**	**10^{4} - <10^{5}**	**10^{5} - <10^{6}**	**10^{6} - <10**
Aerobic colony count			18 (4.5 %)	18 (4.5 %)	55 (13.9 %)	46 (11.6 %)	69 (17.4 %)	60 (15.1 %)	73 (18. %)
Enterobacteriaceae			40 (10.1 %)	141 (35.5 %)	50 (12.6 %)	51 (12.9 %)	39 (9.8 %)	30 (7.6 %)	3 (0.8 %)
Escherichia coli			66 (16.6 %)	324 (81.6 %)	3 (0.8 %)	0 (0 %)	1 (0.3 %)		
Salmonella spp.	294 (74 %)								
Campylobacter spp	23 (5.8 %)								
Escherichia coli O157	5 (1.3 %)								
Staphylococcus aureus			64 (16.1 %)	323 (81.4 %)	1 (0.3 %)	1 (0.3 %)			
Clostridium perfringens			59 (14.9 %)	207 (52.1 %)	1 (0.3 %)				
L monocytogenes				248 (62.5 %)					
Listeria spp		1 (0.3 %)	40 (10.1 %)	267 (67.3 %)	1 (0.3 %)	3 (0.8 %)			
Bacillus cereus			6 (1.5 %)	215 (54.2 %)	22 (5.5 %)	0 (0 %)	1 (0.3 %)		
Bacillus spp.			5 (1.3 %)	5 (1.3 %)	8 (2.0 %)	46 (11.6 %)	5 (1.3 %)		