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The contamination of paté by *Listeria monocytogenes* in England and Wales in 1989 and 1990*

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SUMMARY

In July 1989, 1834 samples of paté (of which 1698 were from retail displays) were examined by the PHLS for the presence of *Listeria monocytogenes*. The survey was repeated in July 1990, when 626 paté samples on retail sale were examined. Between the two surveys there was a marked reduction in the proportions of patés contaminated (10% in 1989 and 4% in 1990) and in the numbers of samples from which $> 10^3$ *L. monocytogenes*/g were recovered. The higher rate of contamination detected in 1989 was largely due to paté from a single manufacturer. In both surveys, paté sold as loose slices had higher rates of contamination than those prepackaged. Temperature control had improved between the two surveys where 65% of samples in 1989 and 83% in 1990 were stored at $\leqslant 7$ °C. Although contamination occurred at almost all temperatures, *L. monocytogenes* was both quantitatively and qualitatively more common in samples stored at > 7 °C. The majority of patés had unexpired shelf lives of between 0 and 3 weeks. Although contamination occurred throughout the shelf life of these products, the proportion of samples where *L. monocytogenes* was recovered was higher in patés with expired sell by dates. There was an association between high total viable counts and the presence of *L. monocytogenes*.

Likely routes of contamination of paté together with possible preventive measured are discussed.

INTRODUCTION

Foodborne listeriosis has caused considerable concern in recent years [1] and a wide range of food types has been associated with this disease [2]. In England and Wales between 1987–9 there was an upsurge in the annual totals of cases reported to the Public Health Laboratory Service (PHLS) [3], which was largely caused by two strains of *Listeria monocytogenes* [4].

The chance examination in 1989 of paté, from the refrigerator of a patient who had suspected food poisoning, at the Cardiff Public Health Laboratory led to a local survey of this food, and 51% of samples were found to be contaminated by

* A report of two surveys carried out by the Public Health Laboratory Service (PHLS) Area and Regional Laboratories, and the PHLS Food Surveillance Group.

L. monocytogenes [5]. In July 1989, a Government health warning was issued advising vulnerable individuals to avoid eating paté [6], and the sale of this food from a single plant (Manufacturer Y) was suspended. This action was followed by a sharp decline in the overall number of cases of listeriosis [4].

A nationwide survey of paté was carried out in England and Wales in July 1989 by the PHLS. The results of the survey [4] showed similar levels of contamination nationally to those obtained in South Wales [5, 7]. The national survey also confirmed that paté from Manufacturer Y was found to be contaminated with *L. monocytogenes* at higher levels than those of other producers tested, and that the predominant types recovered were indistinguishable from those responsible for the 1987–9 upsurge in human listeriosis [4]. Interviews with patients in the second half of 1989 showed that those individuals infected by *L. monocytogenes* indistinguishable from the isolates predominantly recovered from Manufacturer Y's paté were significantly more likely to have recently consumed this food than those affected by other strains. On the basis of these results, we have already suggested that the contamination of paté was a likely contributory cause of the increase in the incidence of listeriosis in the UK between 1987 and 1989 [4].

This paper presents a more detailed analysis of the 1989 nationwide PHLS survey of paté than hitherto published and, in addition, the results of a further survey carried out in July 1990.

METHODS

In July 1989, 53 Public Health Service Laboratories in England and Wales were invited to participate in a survey of paté for the presence of *L. monocytogenes*. A similar survey involving 16 laboratories comprising the PHLS Food Surveillance Group was carried out in July 1990. Standardized protocols were issued to laboratories for each survey.

In 1989 and 1990 patés were purchased by laboratory staff or Environmental Health Officers from a wide range of local shops and supermarkets, and details of brand, type, retail source, storage temperature and remaining shelf life ('sell by' or 'eat by' dates) were recorded. Patés were obtained either prepacked or as loose slices which were cut to the desired weight from bowls or loaves displayed in refrigerated cabinets. In the 1989 survey only, samples obtained prior to retail sale from distribution outlets or from retailers' store rooms were also examined.

After transportation to the laboratory, 25 g samples were homogenized in a stomacher with 225 ml of 1% buffered peptone water and incubated for 18–24 h at 30 °C. Ten ml aliquots of this broth were added to 90 ml of *Listeria* Selective Broth (Oxoid Ltd, Basingstoke, product codes CM862 and SR141) and incubated for a further 48 h at 30 °C. This broth was then subcultured on to 'Oxford' *Listeria* Selective Agar (Oxoid Ltd, product code CM856 and SR140), incubated for 48 h at 37 °C and examined for listeria-like colonies.

In the 1989 survey, remaining samples of paté were frozen, and if *L. monocytogenes* was detected by enrichment, a further 10 g sample was thawed and homogenized into peptone water. Numbers of listeria were estimated by preparing decimal dilutions of the homogenate, and spreading 50 μl on to the surface of *Listeria* Selective Agar.

In the 1990 survey, the original homogenates were spiral plated or decimally diluted and spread on to *Listeria* Selective Agar as above. Listeria were identified by the investigating laboratories and subcultures from three separate colonies of *L. monocytogenes* were sent to the Central Public Health Laboratory (CPHL, Colindale) for confirmation of identity using the previously outlined criteria [8].

In 1989, total viable counts (TVCs) were carried out on some samples only using standard techniques. In 1990, TVCs were made on almost all samples by performing surface colony counts of the original homogenate using blood agar incubated at 37 °C for 48 h.

RESULTS

The numbers, types and origin of the samples examined are presented in Table 1. Information was not available on the conditions used for the transporting of samples to the laboratory in the 1989 survey, but in 1990, 5 out of 15 laboratories used a cool box and the remainder delivered specimens to the laboratory at ambient temperature within 4 h of purchase. On arrival, the patés were refrigerated and microbiological examination on 319 (70%) of 453 samples commenced on the same day. The remaining 134 samples (30%) were all examined within 3 days of receipt.

The proportion of patés contaminated by *L. monocytogenes* was markedly reduced between 1989 and 1990 (Table 2). This was due in part to the inclusion of samples from Manufacturer Y in the earlier survey: 51 (48%) of 107 samples from Manufacturer Y examined in 1989 were contaminated by *L. monocytogenes*, and 12 of 50 of these (> 11% of all samples) were contaminated at levels of $> 10^3$ c.f.u./g. In 1989, the proportions of samples of patés from identifiable producers other than Manufacturer Y was however comparable to that found in 1990. Of 781 patés from identifiable producers other than Manufacturer Y collected in 1989, 33 (4%) were contaminated by *L. monocytogenes*, and 5 of 29 (> 6% of all samples) at levels of $> 10^3$ c.f.u./g. This compares with 4% of samples in 1990 which were contaminated, and 0·3% at levels of $> 10^3$ c.f.u./g (Table 2).

Of the patés prepared from fish products, *L. monocytogenes* was recovered from 9 (15%) out of the 60 samples in 1989, and from 2 (17%) out of 12 in 1990, and were thus more frequently contaminated by *L. monocytogenes* than all meat patés sampled in 1989 (except those from Manufacturer Y) and in 1990.

Species of *Listeria* other than *L. monocytogenes* were isolated from 85 (5%) of patés examined in 1989 and 30 (5%) in 1990, *L. innocua* being the most frequently recovered. Other *Listeria* spp. were found together with *L. monocytogenes* in 8 samples in 1989 and 6 in 1990.

In both surveys, the patés sold as loose slices were more frequently and more heavily contaminated by *L. monocytogenes* than the prepacked samples and were more likely to contain $> 10^3$ *L. monocytogenes*/g (Table 3). The numbers of loose and prepacked samples containing *Listeria* spp. other than *L. monocytogenes* was 27 (6%) and 32 (4%) in 1989, and 21 (9%) and 9 (2%) in 1990, a similar distribution to those contaminated by *L. monocytogenes*.

The storage temperatures at retail sale were recorded for 844 (49%) of patés in 1989 and 273 (44%) in 1990. In 1989, 65% of all retail samples were on sale at

Table 1. *Description of samples in paté surveys*

Year of survey	1989	1990
Total number of samples	1834	626
Numbers of samples collected at		
Retail sale	1698	626
Pre-sale	136	0
Type of paté		
Meat	1726	614
Fish or other marine products	60	12
NK	48	0
Type of retailer*		
National 'chain' supermarkets	1091	516
Other	510	106
NK	97	4
Country of origin*		
Belgium	429†	260
Other‡	459	175
NK	810	191
Type of packaging*		
Prepacked	792	376
Loose	434	242
NK	472	8

* Excluding pre-sale samples.
† Includes 107 samples from Manufacturer Y.
‡ France, Germany, the Netherlands and UK.
NK, not known.

Table 2. *Occurrence and levels of* L. monocytogenes *in paté*

	Number of samples		
	1989		1990
Year of survey	Pre-sale	Retail	Retail
Total	136	1698	626
L. monocytogenes isolated	24 (18%)	162* (10%)	25† (4%)
L. monocytogenes detected at:			
$< 200/g$	19	102	17
$200–10^3/g$	1	21	4
$> 10^3–10^4/g$	3	13	0
$> 10^4–10^5/g$	1	13	1
$> 10^5–10^6/g$	0	4	1
$> 10^6$	0	3	0
Total $< 10^3/g$	20 (15%)	123 (7%)	21 (3%)
Total $> 10^3/g$	4 (3%)	33 (2%)	2 (0·3%)

* Six samples levels not estimated.
† Two samples levels not estimated.

$\leqslant 7$ °C, 20% at > 9 °C, and 3% at ambient temperature. Temperature control had improved in 1990, when the figures were 83% at $\leqslant 7$ °C, 10% at > 9 °C and 1% at ambient temperature (Table 4).

The proportions of samples contaminated with *L. monocytogenes* and those

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Table 3. *Types of packaging of paté in relation to the extent and levels of contamination by* L. monocytogenes

Type of packaging	Numbers of samples: Pre-packed	Loose
1989 survey (1226 samples)		
Total	792	434
L. monocytogenes detected	65* (8%)	57† (13%)
$\leqslant 10^3$/g	52 (7%)	42 (10%)
$> 10^3$/g	9 (1%)	13 (3%)
1990 survey (618 samples)		
Total	376	242
L. monocytogenes detected	7 (2%)	18† (7%)
$\leqslant 10^3$/g	6 (2%)	15 (6%)
$> 10^3$/g	1 (0·3%)	1 (0·4%)

* Four samples levels not estimated.
† Two samples levels not estimated.

Table 4. *Temperature of paté on retail sale in relation to the extent and levels of contamination by* L. monocytogenes

Storage temperature	Numbers of samples: < 5 °C	5–7 °C	8–9 °C	10–18 °C	Ambient
1989 survey (total 844 samples)					
Total	351	225	127	153	28
L. monocytogenes isolated*	31	18	21	13	4
$\leqslant 10^3$/g	24	15	14	11	2
$> 10^3$/g	3	3	5	2	2
1990 survey (total 273 samples)					
Total	162	65	18	25	3
L. monocytogenes isolated	5	2	2	0	0
$\leqslant 10^3$/g	5	1	1	0	0
$> 10^3$/g	0	1	1	0	0

* Six samples levels not estimated.

where $> 10^3$ *L. monocytogenes*/g were recovered were greater at > 7 °C in both surveys, but the differences were not statistically significant (Table 4).

The time of sampling in relation to the remaining shelf life was recorded for 520 (31%) of the samples in 1989 and 366 (58%) in 1990. The proportion of samples at various shelf lives was comparable between the two surveys, with the majority having unexpired shelf lives of between 0 and 3 weeks (Table 5). The proportions of samples sold either after their sell-by date had expired, or with a sell-by date of > 5 weeks was also similar. In both surveys, the proportion of samples contaminated by *L. monocytogenes* was highest in those with expired sell-by dates (Table 5).

The collection of data on temperature and shelf life was available more often form national chain supermarkets than from other types of retailers. However, 17 of 24 samples in 1989, and all of the 12 samples in 1990 bought after expiry were from national 'chain' supermarkets. Moreover, two samples in 1989 were on sale

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Table 5. *Remaining shelf life given to paté at the point of retail sale in relation to the presence and extent of contamination by* L. monocytogenes

Remaining shelf life of product (weeks)	Number of samples						
	> 5	⩽ 5 to > 4	⩽ 4 to > 3	⩽ 3 to > 2	⩽ 2 to > 1	⩽ 1 to > 0	Expired
1989 survey (total 520 samples)							
Total	57	67	50	102	113	105	26
L. monocytogenes detected	5*	8*	4	4	21	15	6
$\leqslant 10^3$/g	4	6	2	4	19	11	4
$> 10^3$/g	0	1	2	0	2	4	2
1990 survey (total 366 samples)							
Total	64	16	37	53	77	106	13
L. monocytogenes detected	1	0	0	1	1	3	2
$\leqslant 10^3$/g	1	0	0	1	0	3	2
$> 10^3$/g	0	0	0	0	1	0	0

* One sample levels not estimated.

Table 6. *Total viable counts obtained from paté in relation to the extent and levels of contamination by* L. monocytogenes

Total viable count/g	Numbers of samples (%)		
	$< 10^4$	10^4–10^6	$> 10^6$
1989 survey (total 144 samples)			
Total	53	31	60
L. monocytogenes present	1 (2)	3 (10)	16* (27)
$\leqslant 10^3$/g	1 (2)	3 (10)	13 (21)
$> 10^3$/g	0	0	3 (5)
1990 survey (total 576 samples)			
Total	236	131	209
L. monocytogenes present	7† (3)	7 (5)	11 (5)
$\leqslant 10^3$/g	5 (2)	7 (5)	9 (4)
$> 10^3$/g	0	0	2 (1)

* One sample levels not estimated.
† Two sample levels not estimated.

at half price at ambient temperature (approximately 25 °C) in a national chain supermarket 8 days after their sell-by date had expired: on examination both yielded *L. monocytogenes* at $> 10^4$ c.f.u./g.

TVCs were estimated on 144 samples (8%) in the 1989 survey and 576 samples (92%) in the 1990 survey. The percentage of samples with high TVCs ($> 10^6$/g) fell from 42% in 1989 to 36% in 1990. However the TVCs obtained for paté made by Manufacturer Y, were higher than other producers in 1989. Of 12 samples from Manufacturer Y, 2 (17%) had TVCs of $< 10^4$/g, 3 (25%) were 10^4–10^6/g and 7 (58%) were $> 10^6$/g. This compares with 72 patés from other identifiable manufacturers examined in 1989, 34 (47%) had TVCs of $< 10^4$/g, 11 (15%) were 10^4–10^6/g and 27 (38%) $> 10^6$/g.

There was an association between high TVCs and the presence and higher levels of *L. monocytogenes* in both surveys (Table 6). Contamination of samples with *L. monocytogenes* was lowest in those with TVCs of $< 10^4$/g. Counts of $> 10^3$ *L.*

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monocytogenes/g were found only in samples were TVCs were $> 10^6$/g. Specimens containing *Listeria* spp. of any type including *L. monocytogenes* were also associated with high TVCs. In 1989, *Listeria* spp. were recovered from only 7 samples with TVCs of $> 10^6$/g. In 1990, *Listeria* species were recovered from 26 samples, 4 with TVCs of $< 10^4$/g, 10 with 10^4–10^6/g, and 12 with $> 10^6$/g.

DISCUSSION

In this report, data is presented on two microbiological surveys of paté in July 1989 and July 1990. The improvements in isolation techniques between 1989 and 1990 suggest that comparisons within this study and with those performed elsewhere should be drawn with a degree of caution. However, the similarity of the findings presented here derived from large numbers of samples on sale throughout England and Wales with those of smaller surveys [5, 7, 9], suggests that this study reflects the position under normal commercial conditions of storage and may indicate some areas of concern in the manufacture, distribution and retailing of paté in 1989 and 1990.

Paté is a ready to eat food normally consumed without reheating or further cooking, and the annual consumption in Britain is estimated to be about 13000 tons. Belgium is the largest supplier of paté to Britain, but a significant proportion is produced elsewhere (Table 1). The manufacture of paté typically involves chopping of raw meats, particularly pigs' liver, with water, seasoning, salt and sodium nitrite. The raw product is then filled into moulds and cooked. After cooking, decoration with glazes and spices, slicing into smaller pieces and vacuum packing may be carried out. Alternatively, paté can be filled into hermetically sealed containers, cooked and sold in this form. In both instances a minimum internal temperature of at least 70 °C for 2 min should be achieved. Paté is also prepared from fish products, some of which do not include a listericidal stage (i.e. cooking or smoking), or from vegetable products which can be sold as a 'terrine'. Most of these paté types have high water activities and a near to neutral pH, hence preservation is achieved by the elimination of micro-organisms during cooking, together with refrigeration and the addition of salts. The shelf life varies considerably depending on the methods used for preservation and packing. Vacuum packed patés have a shelf life of about 3 weeks, whilst those pasteurized in the pack can be used for substantially longer.

That patés was contaminated both prior to retail sale and when prepackaged indicates that contamination probably occurred during manufacture and/or the packaging state. Contamination could be due either to incomplete eradication during inadequate cooking or to cross-contamination after cooking. It is of note that fish patés were more frequently contaminated than meat patés (except those from Manufacturer Y), which may be caused by incomplete eradication of *Listeria* spp. from raw products. The association between high total viable counts and the presence of listeria may indicate poor hygiene and manufacturing practices. There is no specific information available concerning the origins of contamination of the patés examined in these surveys. The observations of de Boer and van Netten [9] that paté on sale in the Netherlands was contaminated only at surface sites

suggests post-process contamination after cooking. The characteristics of other foods involved with foodborne listeriosis also suggest that post-process contamination within the manufacturing unit is likely to be of particular importance [10–13].

L. monocytogenes was more frequently detected in paté sold as loose slices than that prepackaged, pointing to contamination also occurring at the retail outlets. Paté sold prepackaged involve less manipulation and may also be pasteurized 'in pack'. In contrast, loose slices of patés are sold from bowls in refrigerated cabinets where the utensils used in common allow ample opportunity for cross-contamination [4]. That loose slices were more often contaminated by lower levels of *L. monocytogenes* may reflect a shorter average shelf life of this product than prepackaged patés.

The Food Hygiene (Amendment) Regulations 1990 in Britain [14] requires that foods such as paté which are preserved, and certain other foods which are eaten without reheating are to be held at $\leqslant 5$ °C, with an upward tolerance of 2 °C. Though the temperature data in this study were taken from readings from thermometers in food display cabinets rather than the specific foods themselves. it is clear that some samples were inadequately stored with regard to temperature.

Comparability of the data between the 1989 and 1990 surveys is supported by similarities in such features as the proportion of patés which came from Belgium and those sold prepackaged, and the duration of the shelf life of the samples. Overall levels of contamination by *L. monocytogenes* and *Listeria* spp. decreased markedly largely accounted for by paté prepared from Manufacturer Y in 1989. There was a slight reduction in the number of samples sold after their sell-by dates had expired, and in the proportion of samples with high TVCs. However, the temperature control of paté at the point of sale had improved by 1990, and with the further implementation of the 1990 Food Hygiene Regulations this is likely to continue.

The growth rate of *L. monocytogenes* in foods will be affected by factors which include the composition of the food, the storage temperature, period of storage or display, and the activities of competing micro-organisms. Paté generally has a near to neutral pH and a high water activity which favours the growth of *L. monocytogenes* [7, 9], while the presence of sodium nitrite may inhibit competing micro-organisms which in other foods would prevent its growth.

That *L. monocytogenes* may grow in paté even under ideal refrigeration conditions makes this food a potential vehicle for infection, amply demonstrated by the associations between paté consumption and human listeriosis in both Britain [4] and Australia [15]. De Boer and van Netten (1990) estimated a doubling time of 0·8 days for *L. monocytogenes* in paté at 7 °C. It is not known what constitutes an infective dose of *L. monocytogenes* for humans. However, data from other foods implicated in human infection [10, 12, 13], and feeding experiments to primates [16] suggest that this is likely to be high. Because this organism can grow in paté even at recommended temperatures, low levels of contamination early in the manufacturing process may increase and pose an unacceptable risk to health towards the expiry of an extended shelf life.

The problems highlighted in this paper may be equally applicable to similar processed foods which have extended shelf lives at refrigeration temperatures.

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