THE INCIDENCE OF LISTERIA MONOCYTOGENES IN MEAT AND MEAT PRODUCTS FACTORS AFFECTING DISTRIBUTION

P.D. Lowry and I. Tiong, Meat Industry Research Institute of New Zealand (Inc.), P.O. Box 617, Hamilton, New Zealand

SUMMARY

Listeria monocytogenes was a common contaminant of both export meats [boneless beef (20%), boneless lamb (48%)], and retail meats [pork (68%), poultry (48%), beef mince (92%)]. *L.monocytogenes* was not recovered from faecal contents, refuting the view that faecal material is a significant source of listeriae contamination. Instead, animal hides and fleeces appear to be the primary source of *L.monocytogenes* on carcass meats, with 17% of beef hide and 43% of lamb fleece samples containing the organism. *L.monocytogenes* was not recovered from offals. Work surfaces and cutting equipment also contribute to the spread of *L.monocytogenes* on meat with 65% of environmental samples in a lamb cutting room and 30% in a beef cutting room containing the organism.

INTRODUCTION

Listeria monocytogenes is now well established as a food-borne pathogen. Outbreaks of food-borne listeriosis have resulted from the consumption of milk, soft cheese and coleslaw. *Listeria* mastitis causing contamination of raw milk was thought to be the primary cause of outbreaks involving dairy products. Contamination of vegetables with sheep manure was thought to be the primary cause of the outbreak involving coleslaw.

Although there is no direct evidence for transmission of human listeriosis by meat, the strong evidence supporting zoonotic transmission of *L.monocytogenes*, the role of *L.monocytogenes* as a pathogen of a wide range of domesticated food animals and the widespread occurrence of the organism in pastures and soils all suggest that *L.monocytogenes* may be a common contaminant of raw meat. Recent findings of high incidences of *L.monocytogenes* in poultry skin (47%) and minced beef (28%) support this suggestion (Skovgaard and Morgen 1988).

The presence of *L.monocytogenes* on meat is of particular concern because of its ability to grow at refrigeration temperatures. In addition, *L.monocytogenes* is relatively resistant to heat and curing salts and so may survive processing treatments for some cured meat products (Shahamat et al. 1980). As a prelude to an assessment of the role of raw or processed meats in transmission of human listeriosis, the extent of contamination of meat by *L.monocytogenes* and the factors affecting the spread of this organism were determined.

MATERIALS AND METHODS

Meat plant samples:

Samples were collected between January and May, 1988, from a meat plant slaughtering and processing both cattle and sheep. Samples were obtained from whole carcasses, boned-out meat cuts, offals, hides and pelts, visceral contents, equipment and work surfaces, and primary-treated meat plant effluent. Whole tissue samples (25-100 g), including viscera and skin samples, were aseptically removed by means of sterile instruments into sealable plastic sample bags for transport to the laboratory and the subsequent enrichment procedure. Environmental and carcass samples were collected by wiping moistened sterile gauze and cotton pads (100 x 100

Table 1. Listeria incidence in beef and lamb samples at a meat plant.

Type of sample	Number of samples	Number (%) of positive samples: Listeria monocytogenes	Number (%) of positive samples: Other Listeria spp
Beef			
- boneless cuts	25	5(20)	-
- offals	15	-	-
- hide pieces	23	4(17)	2(9)
- viscera	15(a)	-	-
Lamb			
- boneless cuts	15	9(60)	-
- carcass swabs	10	3(30)	5(50)
- offals	15	-	-
- pelt pieces	21	9(43)	3(14)
- viscera	25(b)	-	-

Other Listeria spp = L. ivanovii, L. innocua, L. welshimeri

(a) viscera samples = 13 faecal contents, 2 mesenteric lymph node.

(b) viscera samples = 20 faecal contents, 5 mesenteric lymph node.

Table 2. Listeria incidence species in environmental and effluent samples from a meat plant.

Source of sample	Number of samples	Number (%) of positive samples: Listeria monocytogenes	Number (%) of positive samples: Other Listeria spp
Beef cutting plant			
- work surfaces(a)	15	4(27)	2(13)
- knives	5	2(40)	1(20)
	20	6(30)	3(15)
Lamb cutting plant			
- work surfaces	15	11(73)	8(53)
- knives	5	2(40)	-
	20	13(65)	8(40)
Meat plant effluent	15	15(100)	8(53)

Other Listeria spp = L. ivanovii, L. innocua, L. welshimeri

(a) work surfaces = 5 samples each from perspex cutting boards, stainless steel benches, conveyor belts.

Table 3. Incidence of Listeria species in retail display meats.

Type of sample	Number of samples	Number (%) of positive samples: Listeria monocytogenes	Number (%) of positive samples: Other Listeria spp
Beef mince	25	23(92)	-
Pork cuts	25	17(68)	-
Poultry portions	25	12(48)	-

mm) over the sample surface. Effluent samples were collected aseptically into screw-capped jars, and held at 4°C for up to five days, before analysis.

Retail meat samples:

Packs of beef mince, pork cuts and poultry portions were collected over three separate sampling days from supermarket display cabinets and small retail butchers. Suitable samples (25-100 g) were aseptically removed for analyses.

Listeria methodology:

Listeria was isolated and identified by the two-stage enrichment method described by McClain and Lee (1987). To optimize recovery, the primary plating medium LiCl-phenylethanol-moxalactam agar (LPM) was supplemented by a second plating medium, Modified McBride Agar (MM), described by Lovett et al. (1987). The plates were examined by Henry's Oblique Light System (Henry 1933). *Listeria* colonies appeared pale- or purple-blue and characteristically showed a "lacey" irregular surface pattern. Two or three presumptive *Listeria* colonies were picked from each 'positive' plate and streaked onto horse blood agar for purity.

Listeria confirmation tests:

Biochemical differentiation of the species of *Listeria* was based on the criteria of McLauchlin (1987) and McClain and Lee (1987). Cultures from meat tissue samples, identified as *L.monocytogenes*, were further confirmed by rapid slide serological identification against *Listeria*-O-antiserum Type 1 and Type 4 (Difco).

RESULTS

Listeria in beef and lamb samples: *Listeria monocytogenes* was the only species of *Listeria* recovered from boneless beef (20%) and boneless lamb (60%) samples (Table 1). This species was isolated from 48% of all lamb meat samples, lamb carcasses having a lower incidence (30%) than boneless lamb samples. A second species, *L.ivanovii*, was found on 50% of carcass swabs. *L.monocytogenes* was the predominant species on lamb, making up 71% of isolates. No *Listeria* was recovered from beef or lamb offals.

None of the viscera samples (faecal contents; lymph nodes) contained *Listeria*, but 17% of beef hide samples and 43% of lamb pelt samples contained *L.monocytogenes* (Table 1). Two other species, *L.ivanovii* (1 sample) and *L.welshimeri* (1 sample) were isolated from beef hide strips. Two lamb pelt pieces yielded *L.ivanovii* and one, *L.welshimeri*.

Listeria in the meat plant environment: *L.monocytogenes* was a common contaminant of work surfaces and boning knives, with 30% of samples from the beef cutting plant and 65% of samples from the lamb cutting plant containing the organism (Table 2). There was no significant difference in incidence on the different work and equipment surfaces. *L.ivanovii* was a common contaminant (40% of samples) in the lamb cutting plant but not the beef cutting operation where *L.ivanovii, L.innocua* and *L.welshmeri* were isolated from one sample each.

All samples of primary-treated meat plant effluent contained *L.monocytogenes* (Table 2). Three other species were isolated from effluent, *L.ivanovii* (5 samples), *L.welshimeri* (2 samples) and *L.innocua* (1 sample).

Listeria in retail display meats:

L.monocytogenes had a high incidence in retail meats, being greatest in beef mince samples (92%) followed by pork cuts (68%) and poultry (48%) (Table 3). No other *Listeria* species were isolated. Most isolates from meat were serotype 4 (90%); 10% were serotype 1.

DISCUSSION

The isolation method used for *L.monocytogenes* also enriched successfully for other members of the listeriae. Of the three *Listeria* spp., other than *L.monocytogenes*, that were recovered, only *L.ivanovii* has been associated pathogenically with domestic animals. *L.ivanovii* was a relatively common contaminant of lamb processing operations in this study, suggesting that this species may be a significant cause of ovine infection. However, *L.ivanovii* has only rarely been implicated in human infection (McLauchlin 1987).

The high incidence of *L.monocytogenes* observed in both retail and export raw meats from all animal types examined, confirms the view that this organism is a frequent contaminant of meat. Although *L.monocytogenes* was present in a high proportion of meat samples, no indication of the numbers of listeriae present was obtained. The recent development of primary plating media, which are claimed to enable direct enumeration of *L.monocytogenes* from foodstuffs (Buchanan et al. 1987), should permit more comprehensive evaluation of the extent of contamination of meat by *L.monocytogenes*.

It is widely believed that *L.monocytogenes* is frequently associated with latent infections of the gastrointestinal tract of both domestic animals and humans, and that the faecal-oral route of transmission, via food, is a common mode of spread of the organism (Ralovich 1984). Given the widespread recovery of *L.monocytogenes* from meats in this study, the failure to detect this organism in any of the visceral content samples indicates that latent infection of the gastrointestinal tract is not common and that the direct contamination of carcass meats with faecal material during carcass dressing procedures does not constitute a significant source of *L.monocytogenes* on meat.

The recovery of *L.monocytogenes* from beef hides and lamb pelts at almost the same incidence observed for the organism on respective meat tissues indicates that the animal hide or fleece is the principal source for contamination of meat with *L.monocytogenes*. The widespread occurrence and persistence of *L.monocytogenes* in the pasture environment ensure that a significant proportion of stock presented for slaughter will carry this organism as a normal component of the transient microflora of the hide or fleece. Further indirect evidence supporting the role of the animal hide or fleece as the primary source of contamination with *L.monocytogenes* during carcass dressing derives from the observation that only carcass tissue meats, and not offals, which are encapsulated within the body cavity

during hide removal, were contaminated with *L.monocytogenes*.

The high incidence of *L.monocytogenes* on cutting and conveying equipment, particularly in the lamb cutting room, indicates that equipment and work surfaces may contribute significantly to the spread of the organism. The increased incidence of *L.monocytogenes* on boneless lamb compared with lamb carcasses, and the much greater incidence of *L.monocytogenes* in minced beef (92%) compared with beef cuts (20%), strongly supports the role of processing equipment in the widespread distribution of the organism.

Some transfer of the external microflora of an animal to carcass meats is inevitable, irrespective of hygiene standards adopted during dressing and processing. Therefore, for regulatory purposes, it must be accepted that raw meat tissues are likely to contain *L.monocytogenes*, and that microbiological surveillance to establish the presence of this organism is unwarranted.

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