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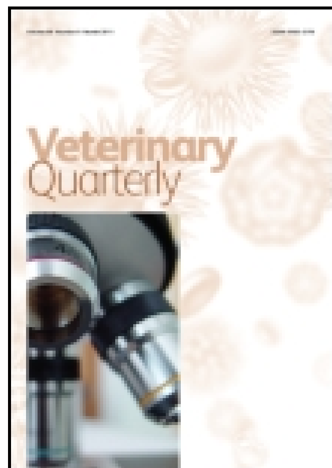


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# Critical points in meat production lines regarding the introduction of listeria monocytogenes

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# CRITICAL POINTS IN MEAT PRODUCTION LINES REGARDING THE INTRODUCTION OF LISTERIA MONOCYTOGENES

*A.M.G. van den Elzen*[1], *and J.M.A. Snijders*[1]

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## SUMMARY

**In order to elucidate critical points concerning *Listeria monocytogenes* during bovine and porcine slaughter, cutting and processing, 843 samples were obtained from carcasses, primal cuts, products at retail and from environmental surfaces. Only 2-7% of the carcasses and 0-10% of the environmental samples in the 'clean' part of the pork slaughterline were found to be positive for *L. monocytogenes*. The incidence of *L. monocytogenes* was increased after chilling and cutting. In the cutting room 11-36% of the primal cuts and 71-100% of the environmental samples were found positive for *L. monocytogenes*. Our findings indicate that contamination of pork meat with *L. monocytogenes* orginates from the processing environment of the chilling or cutting room. The incidence of *L. monocytogenes* in the bovine cutting and meat processing line (0-60%) was lower than in the porcine cutting and meat processing line (11-100%).**

## INTRODUCTION

Soft cheeses and (un)pasteurized milk were involved in the first well described cases of human outbreaks of listeriosis (3,8,11,13). Since then the dairy industry has been the center for Listeria concern to date. However, other food production areas also present the potential for Listeria foodborne disease (6). Some documented cases of listeriosis have been associated with pork or beef (1,2,21), and *Listeria monocytogenes* can be isolated regulary from carcasses, meat products and slaughterhouse environments (5,7,10,14,17). The organism has the ability to multiply at low temperatures (23) during transport, at retail and in the domestic refrigerator. Its relative resistance to heat, drying and curing salts, means that it can even survive processing treatments of some cured meat products (12,16).

Although there are indications that endemic strains of *L. monocytogenes* are an important source of infection, the exact modes of transmission at the slaughter level are unclear. To extend our knowledge on the incidence of *L. monocytogenes* during slaughtering and meat processing in the Netherlands and to elucidate the critical points during slaughter and meat processing concerning this pathogen, meat and environmental samples were taken at different points of porcine and bovine slaughter and meat processing lines and examined for the presence of *L. monocytogenes*.

## MATERIALS AND METHODS

### Sample collection and sample treatment

Samples were collected in the 'clean' part of a pork slaughterline, in the cutting room of a pork and a bovine slaughter plant, and in a distribution plant. The 'clean' part of a slaughterline included the area from the polishing machinery to the chilling room and samples were taken from e.g. the anusborer (the equipment with the highest faecal contamination) and the roll of the chopping machinery (always in close contact with carcasses). In the distribution plant the meat is sliced and packaged before it is dispatched. All samples were examined for the presence of *L. monocytogenes*.

Three pork slaughter plants with a capacity of 300-500 pigs per hour, one beef slaughter plant with a capacity of 50 cattle per hour and one distribution plant were included in this study. Each plant was visited once. In total 843 samples were obtained from carcasses, primal cuts, products at retail and from environmental surfaces such as equipment, work surfaces, hands of personnel, floors, and walls.

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Table 1. The recovery of *Listeria monocytogenes* from a porcine slaughter, cutting and processing line.

| Sample source | Examined (n) | Positive(%) |
|---|---|---|
| Clean' part of slaughterline (three abattoirs) | | |
| Meat | | |
| Carcasses outside | 45 | 7% |
| Carcasses inside | 45 | 2% |
| Processing area | | |
| Door Polmach[a] | 30 | 0% |
| Anusborer | 30 | 0% |
| Roll Chopmach[b] | 30 | 0% |
| Knives | 82 | 0% |
| Hands | 60 | 10% |
| Cutting room (two abattoirs) | | |
| Meat primal cuts[c] | | |
| Hams | 44 | 27% |
| Bellies | 44 | 11% |
| Shoulders | 44 | 36% |
| Necks | 44 | 36% |
| Cutting room (one abattoir) | | |
| Processing area | | |
| Floors | 6 | 83% |
| Conveyor belts | 11 | 100% |
| Machines | 7 | 71% |
| Other surfaces | 5 | 80% |
| Distribution plant (one) | | |
| Meat primal cuts | | |
| Loins | 20 | 45% |
| Bellies | 20 | 95% |
| Shoulders | 20 | 45% |
| Consumer units from; | | |
| Loins (chops) | 20 | 45% |
| Bellies (bacon) | 20 | 30% |
| Shoulders | 20 | 25% |
| Processing area | | |
| Meat boxes | 13 | 15% |
| Tables/equipment | 7 | 29% |

[a] *Polishing machine*
[b] *Chopping machine*
[c] *Cork-borer method (15 cm²)*

Most samples from meat and the environment were taken using a swab technique using swabs made from disposable diapers (Billies, Mölnlycke B.V., Amstelveen, the Netherlands). The diapers were cut in half, sealed with tape, packed in aluminium foil and sterilized for 15 minutes (121ºC). After the foil was removed, each swab was put in a stomacher bag (Model 400, Genuine Seward medical, London, UK). The swabs were moistened with 50 ml of buffered peptone water (BPW; containing 0.1% Tween 80) just before sampling. With a sterile disposable glove a swab was taken from the bag, rubbed across the sampling area, and put back in the bag. The total sampling area of each carcas, meat and environment sample was at least 400 $cm^2$. All samples (swabs) were transported to the laboratory where 50 ml of BPW (containing 0.1% Tween 80) was added to each sample. The samples were homogenized with a Colworth 400 Stomacher (Lab Blender, London, UK) for 2 minutes. The homogenate fluid was squeezed from the swab, and the swab was discarded with forceps.

When indicated, samples consisting of 3 tissue discs (total surface area 15 $cm^2$) were taken from the meat surface with a sterile cork-borer (20). To each tissue sample 45 ml of BPW was added and each sample was homogenized as described above.

The homogenates from swab and tissue samples were used for the isolation of *L. monocytogenes*.

**Isolation and identification of *L. monocytogenes***

Isolation of *L. monocytogenes* principally followed the revised USDA-FSIS protocol (22), except that 10 ml of sample homogenate was added to 10 ml of double-strength UVM (University of Vermont, USA) broth (Difco #0223-17). This was incubated at 30ºC for 24 hours, then 0.1 ml was transferred into 10 ml of Fräser broth (9). After incubation at 37ºC for 24 to 48 hours, tubes exhibiting darkening were spread onto MOX agar (22) and plates were incubated at 37ºC for 48 hours. Fräser broth tubes which had not darkened after 48 hours were assumed negative for *L. monocytogenes* and discarded. Colonies characteristic for *L. monocytogenes* were tested for catalase production, then spread onto Brain Heart Infusion (Oxoid #CM 225) agar. Confirmation tests for *L. monocytogenes* included ß-hemolysis on 5% sheep blood agar, the CAMP test, umbrella motility in motility agar (Difco #0105-01) at 20ºC, Gram staining and rhamnose and xylose fermentation. Suspected strains were also confirmed serologically using polyvalent antiserum (Difco #2302-50).

## RESULTS AND DISCUSSION

*L. monocytogenes* was isolated from the carcasses in the 'clean' part of one pork abattoir (Table 1). No strains were isolated from the anusborer (n=30) which indicates that faeces are not an important source of *L. monocytogenes* contamination. These findings are supported by Skovgaard and Norrung (18) and Skovgaard (19) who found that only 2% of the pigs fed with dry feed excreted *L. monocytogenes* in their faeces. Skin or hide (10,14) are considered sources of *L. monocytogenes*, however, only a few strains were isolated from the outsides of carcasses in this study.

The incidence of *L. monocytogenes* was much higher after chilling and cutting. *L. monocytogenes* was isolated from the meat primal cuts as well as from the processing area in the cutting room of the pork abattoirs (Table 1). Differences were found in the incidence of *L. monocytogenes* in the cutting room between slaughter plants. Chilling and, particulary, handling during cutting could be the cause of the increase in the number of positive samples of *L. monocytogenes* on the primal cuts. An increase in *L. monocytogenes* positive carcasses in the chilling room was found by Gobat and Jemmi (10). The increased number of positive samples could also be explained by the excellent survival of and growth conditions for *L. monocytogenes* in the cold and wet environments of the cutting rooms (12).

Lately the slaughterhouse environment has more often been implicated as a source of contamination for *L. monocytogenes* (12,15,17). This hypothesis is supported by a study by Boerlin and Piffaretti (4) who found different types of *L. monocytogenes* on live pigs and at the beginning of slaughtering compared to those found on the meat at the end of the slaughterline. Their observations suggested that animal strains of *L. monocytogenes* would not easily contaminate meat or survive during its processing and that they are replaced by strains which are presumably better adapted for survival and multiplication in the processing areas and thereafter in meat and meat products.

Our results indicate that the environment of the chilling room or the environment of the cutting room could be considered potential sources of *L. monocytogenes* in the pork abattoir. This supports the findings of Pociecha *et al.* (15) who suggested that contamination of the carcasses occured

Table 2. The recovery of Listeria monocytogenes from a bovine slaughter, cutting and processing line.

| Sample source | Examined (n) | Positive(%) |
|---|---|---|
| Cutting room (one abattoir) | | |
| Meat | | |
| Parts of carcasses | 20 | 0% |
| Primal cuts | 20 | 0% |
| Processing area | | |
| Floors/walls | 7 | 14% |
| Tables | 13 | 8% |
| Conveyor belts | 6 | 0% |
| Hands | 10 | 0% |
| Other surfaces | 13 | 15% |
| Distribution plant (one) | | |
| Meat primal cuts | | |
| Knuckles | 10 | 30% |
| Shoulder clods | 6 | 0% |
| Topsides | 11 | 9% |
| Necks | 10 | 60% |
| Consumer units from; | | |
| Knuckles | 10 | 0% |
| Shoulder clods | 6 | 17% |
| Topsides | 11 | 0% |
| Necks | 10 | 10% |
| Processing area | | |
| Meat boxes | 10 | 0% |
| Tables/equipment | 3 | 0% |

in the chilling room of a mutton slaughterhouse.

Pork primal cuts and consumer units were still contaminated in the distribution plant. Cooled transport, display in supermarkets and storage in the home could allow growth of *L. monocytogenes* above infectious levels in contaminated products. Therefore it is necessary to examine the source of the contamination more closely in order to try to prevent the survival and growth of these organisms in meat production environments.

The incidence of *L. monocytogenes* in the bovine slaughter and meat processing line (Table 2) was much lower compared to that of the porcine slaughter and meat processing line. A similar lower incidence was also found in the distribution plant. When the *L. monocytogenes* contamination in the bovine slaughter and meat processing line is also due to endemic populations, this lower incidence could be explained by different atmospheric conditions or differences in cleaning and disinfection in these working areas compared to those in the porcine slaughter and meat processing line.

In addition to *L. monocytogenes*, other *Listeria* spp. were often isolated from meat and environmental samples. In e.g. the cutting room of the beef slaughter plant, no *L. monocytogenes* strains were isolated from the hands of personnel but 50% of the hand samples were positive for other *Listeria* spp. Since *Listeria* spp. other than *L. monocytogenes* are considered non-pathogenic for man it is important to distinguish between *L. monocytogenes* and other *Listeria* spp. in research and in food control.

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