

Listeria Monocytogenes in Frankfurters and Ready-to-eat Sliced Meat Products

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SUMMARY: The occurrence of Listeria monocytogenes (*L.monocytogenes*) in frankfurters and ready-to-eat sliced meat products was studied. Four categories of meat products were selected: a) cooked frankfurter sausages, b) raw, cured, smoked, sliced pork loin ($a_w > 0.95$), c) cooked, cured, sliced, rolled sausages, and d) cooked, cured, sliced ham. A total of 304 samples were examined qualitatively as well as quantitatively shortly after packaging, and at the end of declared storage life for *L.monocytogenes*. At this point a test was made also for lactic acid bacteria.

In category a) 4 samples (6%) were positive for *L.monocytogenes* at packaging date and 8 (13%) at expiry date; in category b) 18 samples (23%) were positive at packaging date and 17 samples (21%) at expiry date; in category c) and d) 8 samples (10%) were positive at both production date and expiry date. With 3 exceptions, the quantitative tests were negative (less than 100 *L.monocytogenes*/g). The highest figure found was 4000 *L.monocytogenes*/g at expiry date in a frankfurter sausage.

Lack of growth of *L.monocytogenes* in the storage period can be explained by inhibitory effect of lactic acid bacteria. However, the finding of *L.monocytogenes* in cooked and ready-to-eat products is cause for concern since a naturally occurring inhibitory factor is not a reliable control parameter. This observation is supported by the fact that the lactic acid bacteria count was low in the 3 samples found positive by the quantitative test. For effective reduction or elimination of *L.monocytogenes* from meat products the HACCP-concept is recommended.

INTRODUCTION: *Listeria monocytogenes* is a food-borne pathogenic bacteria which has caused a number of disease outbreaks with high mortality. Dairy products (soft cheese: James et al., 1985, Bille und Glauser, 1988 and pasteurized milk: Fleming et al., 1985) and vegetables (coleslaw: Schlech et al., 1983) have been connected with some of the disease outbreaks. Sporadic occurrence of human listeriosis is not well elucidated, but contaminated foods appear to be an important epidemiological link. Thus, the Centers for Disease Control, USA, has reported a case of listeriosis associated with consumption of turkey franks (Barnes et al., 1989). And in UK a case was associated with consumption of cooked chicken (Kaczmarek and Jones, 1989). Considering the ubiquitous nature of the organism it is not surprising that *L.monocytogenes* is a common contaminant of raw, ready-to-eat meat and poultry (Skovgård and Morgen, 1988 and Leistner et al., 1989). This includes raw, ready-to-eat meat products (Breuer and Prändl, 1988; Nicolas and Vidaud, 1987). But also cooked, ready-to-eat meat products have been found contaminated (Gilbert et al., 1989, Billaux, 1988, Leistner et al., 1989 and Tiwari and Aldenrath, 1990).

The presence of *L.monocytogenes* in meat is of particular concern because of the psychrotrophic nature of the organism, and its relative resistance to heat and curing salts (Doyle, 1988).

The main purpose of this study was to examine the incidence and evaluate the significance of *L.monocytogenes* in sliced ready-to-eat meat products and in frankfurters.

MATERIALS and METHODS:

Materials: The occurrence of *L.monocytogenes* was studied in commercially packaged Danish meat products. Four categories of meat products from eight different establishments were selected for the investigation: a) cooked frankfurter sausages, b) raw, cured, sliced pork loin ($a_w > 0.95$), c) cooked, cured, sliced, rolled sausages and d) cooked, cured, sliced ham.

The products from category a generally is re-heated before consumption. Category b, c and d represent ready-to-eat products. A total of 304 samples were examined qualitatively as well as quantitatively shortly after packaging, and at the end of the declared storage life.

During storage the products were kept at 4-5°C, and at the end of the declared storage life a test was made also for lactic acid bacteria.

Methods: For detection of *L.monocytogenes* a 25 g sample was homogenized in 225 ml UVM-broth for 2 minutes in a Stomacher. After incubation at 30°C for 24 hours 0,1 ml was transferred to Fraser-broth (Fraser and Sperber, 1988). After incubation at 37°C for 24-48 hours 0.1 ml was spread on the surface of Oxford-agar, which was incubated at 37°C for 24-48 hours. Subsequent isolation and confirmation procedures were as described by Mc.Clain and Lee, 1987.

For quantitative determination of *L.monocytogenes* direct surface-inoculation of 0,1 ml on Oxford agar was made followed by decimal dilution.

A representative number of isolated strains was sent for serotyping at the Danish State Serum Institute.

Lactic acid bacteria were determined on Man-Rogosa-Sharpe-agar (MRS; pH 6.2), incubated at 25°C for 48 hours.

RESULTS and DISCUSSION: The total number of samples in each category and the number of positive samples for *L.monocytogenes* at packaging date and at expiry date are shown in table 1.

In sliced ham and sliced rolled sausages 10% of the samples were found positive for *L.monocytogenes* at packaging date and at the end of declared shelf life. In sliced smoked pork loin 23% were found positive at packaging date and 21% at the end of declared shelf life. In hot dog sausages 6% were found positive at packaging date and 13% at the end of declared shelf life.

Since products in category a, c and d should be heat-treated to temperature effective in elimination of *L.monocytogenes* its presence is considered to be due to recontamination during handling, slicing and packaging. Category b does not undergo a bacteriocidal process, therefore the microbiology of the raw material is reflected in the end product.

The results from the quantitative examination show that at packaging date *L.monocytogenes* occur in low numbers (less than 100/g.), in all samples and that during storage only on few occasions an increase in numbers is observed. The apparent restriction in growth cannot be explained by temperature, pH or a_w , but is considered to be due to an inhibitive effect from the growth of lactic acid bacteria, which usually at the end of storage reach a level of 10^7 to 10^8 /g. Such a suppression of *L.monocytogenes* by lactic acid bacteria has been shown experimentally by Kaya and Schmidt (1989).

However, it must be stressed that naturally occurring lactic acid bacteria are not a reliable parameter for the control of *L.monocytogenes*. This has been underlined by the quantitative detection mentioned in table 1. In these cases the numbers of lactic acid bacteria were low at the end of declared storage life. The results further indicate that especially in hot dog sausages a possibility for growth exists since numbers of positive samples double from packaging date to expiry date with 2 samples positive by quantitative testing. However, in evaluating hot dog sausages as a risk product it should be emphasized that this product is usually re-heated before consumption.

As far as sliced, smoked pork loin is concerned *L.monocytogenes* has not been detected by the quantitative test. The risk of growth of *L.monocytogenes* in the raw product appears negligible due to a considerable competing flora.

In respect of sliced ham and sliced rolled sausage a certain risk exists that recontamination with *L.monocytogenes* may result in growth during storage. Thus, in this examination $3,7 \times 10^3$ *L.monocytogenes*/g. was found in a sliced rolled sausage at expiry date. The product was organoleptically fully acceptable and had a low count of lactic acid bacteria.

Although the infection dose for humans is not known, there are indications that a level of 10^3 *L.monocytogenes*/g can be critical for immunocompromised persons. Occurrence of *L.monocytogenes* in heat-treated meat products, which supply

growth of this organism during storage accordingly is unacceptable.

From table 2 it can be seen that the frequency of contamination varies considerably among products as well as among establishments. From 1 establishment none of the cooked products were found positive for *L.monocytogenes*. This observation indicates that recontamination to a great extent can be avoided. However it seems obvious that what was previously considered to be good manufacturing practice is not a sufficient barrier against *L.monocytogenes*.

The majority of *L.monocytogenes* found belonged to serogroup 1, some belonged to serogroup 4.

CONCLUSION: It is concluded that meat products rather frequently are contaminated with *L.monocytogenes* in low numbers. Therefore, the public at large is being continuously exposed to intake of *L.monocytogenes*. This happens not only with ready-to-eat meat products, but also with raw vegetables, salads, ready-to-eat fish products and when raw minced beef is made into rare hamburgers or eaten as scraped raw beef.

Since listeriosis has a very low morbidity, it seems that *L.monocytogenes* in low numbers does not constitute a great risk to public health. Lactic acid bacteria appear to be an important factor in controlling growth of *L.monocytogenes*. However, this factor cannot be relied on as an effective control parameter as demonstrated by occasional findings of *L.monocytogenes* at expiry date at levels of $10^3 - 10^4/g$. It is cause for concern that the shelf life as far as safety is concerned can be considerably shorter than the organoleptic shelf life. Therefore, ready-to-eat meat products should as effectively as possible be prevented from being recontaminated. In this respect the HACCP-concept can be recommended. Since it seems extremely difficult to eliminate *L.monocytogenes* from production areas and totally avoid post-processing contamination, factors controlling the growth of *L.monocytogenes* should be studied in detail to assure safety and to reduce human exposure to *L.monocytogenes*.

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Table 1

Occurrence of *L.monocytogenes* in frankfurters and in ready-to-eat sliced meat products

Category	Product	No. of samples	No. of L.m. (%) at packaging date	No. of L.m (%) at expiry date
Cat. a	Hot dog sausages	64	4 (6)	8 (13) ^{o)}
Cat. b	Sliced smoked pork loin	80	18 (23)	17 (21)
Cat. c	Sliced rolled sausages	80	8 (10)	8 (10) ^{*)}
Cat. d	Sliced ham	80	8 (10)	8 (10)
Total		304	38 (13)	4 (14)

*) 1 sample 3700/g L.m.

o) 1 sample 4000/g L.m. - 1 sample 600/g L.m.

In all other samples L.m. could not be detected quantitatively.

Table 2

Variation on the occurrence of L.monocytogenes in 4 products
within 8 establishments (figures indicate percent)

Product	At packaging date	At expiry date
Hot dog sausages	0-20	0-40
Sliced smoked pork loin	0-90	0-70
Sliced rolled sausages	0-20	0-20
Sliced ham	0-20	0-20