

Listeria monocytogenes

1. What is *Listeria monocytogenes*?

Listeria monocytogenes is a bacterium which is ubiquitous in the environment. It is a Gram-positive, non spore-forming, facultative anaerobic, short rod. It is a pathogenic bacterium which causes a group of diseases which are collectively known as listeriosis. It is of major concern because of:

- 1) Its ubiquitous nature
- 2) Its ability to survive and grow at low temperatures, i.e. typical refrigeration temperature
- 3) The severity of the disease
- 4) The high case fatality rate

2. Growth and Survival Characteristics

Table 1. Growth and survival limits for *L. monocytogenes*

PARAMETER	RANGE	OPTIMAL ^d	CAN SURVIVE (BUT NO GROWTH) ^e
Temperature (°C)	-1.5 to 45	30 to 37	-18
pH ^a	4.2 to 9.5	7	3.3 – 4.2
Water Activity (a _w) ^b	0.90 to >0.99	0.97	< 0.90
Salt (%) ^c	< 0.5 to 12	N/A	≥20

^a Hydrochloric acid as acidulant (inhibition is dependent on type of acid present)

^b Sodium chloride as the humectant

^c Percent sodium chloride, water phase

^d When growth rate is highest

^e Survival period will vary depending on nature of food and other factors

N/A Not Applicable

L. monocytogenes is not unusually heat resistant compared with other Gram-positive bacteria. Typical D-values* for *L. monocytogenes* in chicken breast and beef are presented in Table 2. Resistance to heat is enhanced by 'heat shock' immediately before heating, elevated levels of solutes and alkaline conditions.

Table 2. D-values* for *L. monocytogenes* in chicken breast and beef

	D-VALUE (MIN)*	
	Chicken Breast	Beef
50°C	100	85
60°C	8.7	3.5-4.5
70°C	0.13	0.14

* D-value is the time in minutes at a given temperature to achieve a 90% reduction in the number of viable cells. ICMSF 1996 provides an extensive list of D-values for *L. monocytogenes* under different conditions and food types.

Listeria monocytogenes

3. Sources of *L. monocytogenes*

L. monocytogenes is widely distributed in the environment and has been isolated from a variety of habitats including soil, vegetation, silage, sewage, water, and faeces of healthy animals and humans. It is frequently present in foods of animal and plant origin and can become endemic in food processing environments (research has shown that individual processing establishments often harbor their own unique population of *L. monocytogenes* and that these populations are capable of persisting in the environment over time). It may also be present in cooked foods as a result of post-process contamination or inadequate heat treatment.

4. Routes of Transmission to Humans

The consumption of contaminated food is the main route of transmission of listeriosis (80-90% of cases). However, infection can also be transmitted directly from infected animals to humans as well as between humans.

Foods most often associated with human listeriosis include those which:

- Support the growth of *L. monocytogenes*
- Have a long shelf-life under refrigeration (*L. monocytogenes* can grow to significant numbers in food held at refrigeration temperatures when given sufficient time)
- Are consumed without further listericidal treatments, i.e. treatments which would kill *L. monocytogenes*, e.g. cooking

Examples of incriminated foods include certain meat, poultry and fish products, e.g. frankfurters, pate, smoked salmon, fermented raw meat sausages etc., dairy products, e.g. soft cheeses, unpasteurised milk etc., and prepared salads, e.g. coleslaw, bean sprouts etc.

It is estimated that levels of *L. monocytogenes* below 100cfu/g of food represent a very low risk of listeriosis for all population groups.

5. Nature of the Disease

Two types of disease are associated with *L. monocytogenes*, i.e. non-invasive and invasive listeriosis.

Non-invasive listeriosis (referred to as febrile listerial gastroenteritis) is the milder form of the disease. Symptoms include diarrhoea, fever, headache and myalgia (muscle pain). Symptoms occur after a short incubation period. Outbreaks of this disease have generally involved the ingestion of high doses of *L. monocytogenes* by otherwise healthy individuals. Only limited information is available regarding the public health impact of this disease.

Listeria monocytogenes

Invasive listeriosis affects 'high-risk people' (including pregnant women, cancer patients, AIDS patients, the elderly and the very young). This disease is characterised not only by the severity of the symptoms but also by a high mortality rate (Table 3):

Table 3. Invasive listeriosis

SYMPTOMS	INCUBATION PERIOD	MORTALITY RATE
<ul style="list-style-type: none"> • Mild fever (with or without slight gastroenteritis or flu like symptoms) • Myalgia • Meningitis • Septicaemia • Spontaneous abortion 	1–90 days	20–30%

Thirteen serotypes have been identified for *Listeria monocytogenes*. All of these may be associated with human listeriosis; however, most human infection is associated with the serotypes 1/2a, 1/2b or 4b.

For further information on listeriosis, please consult the Health Protection Surveillance Centre (HPSC) website: <http://www.hpsc.ie/hpsc/A-Z/Gastroenteric/Listeriosis/Factsheets/>

6. Incidence of the Disease

In Ireland, 10 cases of listeriosis were reported to the HPSC in 2009. There was 1 pregnancy related case. There were no reported deaths among cases. Isolates for 8 of the notified cases were typed at the National Salmonella Reference Laboratory. Four of the isolates were serotype 1/2 and the other 4 isolates were serotype 4b. There were 13 and 21 cases reported in 2008 and 2007, respectively.

In the EU, a total of 1,645 confirmed cases of listeriosis were reported from 26 Member States in 2009. The overall incidence was 0.4 cases per 100,000 population.

It is important to note that although the number of cases of listeriosis is small, the high mortality rate associated with this infection makes it of significant public health concern.

7. Foodborne Outbreaks of Listeriosis

Listeriosis outbreaks are often diffused and spread over a wide geographic area. Outbreaks of both invasive listeriosis and gastroenteritis listeriosis have been reported in the EU. Foods implicated with these outbreaks include processed meat products, cheese, processed fish products, butter, rice salad and corn salad.

In 2009, 3 verified outbreaks were reported in the EU (Austria, Czech Republic and Germany). The identified food vehicles were cheese and pig meat. These outbreaks resulted in 40 cases (including 11 deaths). One of the outbreaks was multinational, involving cases in all 3 countries. It was caused by 2 different clones of *L. monocytogenes* serotype 1/2a. The implicated foodstuff was 'Quargel', a curd cheese produced by an Austrian manufacturer.

In 2008, a significant outbreak was reported in Canada causing 57 illnesses and resulting in 22 deaths. The outbreak was linked to contaminated deli meats produced by Maple Leaf Foods, Inc. Further investigation determined the most probable contamination source as the commercial meat slicers (despite cleaning according to manufacturer's instructions, meat residues which were trapped inside the slicers provided a reservoir and breeding ground for *L. monocytogenes*).

Listeria monocytogenes

8. Legislation

All food business operators have a legal responsibility to produce safe food (Regulation 178/2002)¹. The safety of foodstuffs is ensured by a preventative approach, i.e. the implementation of a food safety management system based on the principles of Hazard Analysis and Critical Control Point (HACCP). This system enables hazards to be identified and controlled before they threaten the safety of food. All food business operators, with the exception of primary producers, are legally obliged to put in place, implement and maintain a permanent procedure or procedures based on HACCP principles (Article 5 of Regulation 852/2004)². Furthermore, all food business operators, including primary producers, are legally obliged to implement good hygiene practices (GHP). Regulation 852/2004 lays down hygiene requirements for all foodstuffs; while Regulation 853/2004³ lays down more specific hygiene requirements for foods of animal origin.

Regulation 2073/2005⁴ lays down microbiological criteria for various combinations of food commodities and microorganisms, their toxins or metabolites. It requires food business operators to take measures, as part of their procedures based on GHP and HACCP principles, to ensure compliance with the relevant microbiological criteria. Food business operators should test against these criteria, as appropriate, when validating and verifying the correct functioning of these procedures.

The Regulation differentiates microbiological criteria into:

- 1) Process hygiene criteria:** These criteria indicate if the production process is operating in a hygienic manner. They are applicable to foodstuffs at various stages throughout their production processes. There is no process hygiene criterion set for *L. monocytogenes*
- 2) Food safety criteria:** These criteria define the acceptability of a foodstuff in terms of its microbiological safety. They are applicable to foodstuffs placed on the market during their shelf-life. Food safety criteria are established in this Regulation for *L. monocytogenes* in ready-to-eat food (Table 4)

Regarding environmental monitoring, the Regulation requires food business operators manufacturing ready-to-eat foods which may pose a risk of *L. monocytogenes*, to sample the processing areas and equipment for this pathogen as part of their sampling scheme.

Please note: Food business operators should be aware of their obligations in these and other pieces of legislation. It is the responsibility of the food business operator to keep up-to-date with all amendments to legislation. For further information on the legislation, please consult the Food Safety Authority of Ireland (FSAI) website: http://www.fsai.ie/legislation/food_legislation.html.

¹ Regulation (EC) No 178/2002 of The European Parliament and of The Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety

² Regulation (EC) No 852/2004 of The European Parliament and of The Council of 29 April 2004 on the hygiene of foodstuffs

³ Regulation (EC) No 853/2004 of The European Parliament and of The Council of 29 April 2004 laying down specific hygiene rules for food of animal origin

⁴ Commission Regulation (EC) No 2073/2005 of 15 November 2005 on Microbiological Criteria for Foodstuffs

Listeria monocytogenes

Table 4. Microbiological criteria for *L. monocytogenes* in ready-to-eat foods

FOOD CATEGORY	SAMPLING PLAN ¹		LIMIT	ANALYTICAL REFERENCE METHOD	STAGE WHERE THE CRITERION APPLIES
	N	C			
Ready-to-eat foods intended for infants and ready-to-eat foods for special medical purposes	10	0	Absence in 25g	EN/ISO 11290-1	Products placed on the market during their shelf-life
Ready-to-eat foods able to support the growth of <i>L. monocytogenes</i> other than those intended for infants and for special medical purposes	5	0	100 cfu/g ²	EN/ISO 11290-2	Products placed on the market during their shelf-life
	5	0	Absence in 25g ³	EN/ISO 11290-1	Before the food has left the immediate control of the food business operator who has produced it
Ready-to-eat foods unable to support the growth of <i>L. monocytogenes</i> other than those intended for infants and for special medical purposes ^{4,5}	5	0	100 cfu/g	EN/ISO 11290-2	Products placed on the market during their shelf-life

¹ n = number of units comprising the sample; c = number of sample units giving values over the limit

² This criterion applies if the manufacturer is able to demonstrate, to the satisfaction of the competent authority, that the product will not exceed the limit 100 cfu/g throughout the shelf-life. The operator may fix intermediate limits during the process that should be low enough to guarantee that the limit of 100 cfu/g is not exceeded at the end of the shelf-life.

³ This criterion applies to products before they have left the immediate control of the producing food business operator, when he is not able to demonstrate, to the satisfaction of the competent authority, that the product will not exceed the limit of 100 cfu/g throughout the shelf-life.

⁴ Regular testing against the criterion is not useful in normal circumstances for the following ready-to-eat foods:

- Those which have received heat treatment or other processing effective to eliminate *L. monocytogenes*, when recontamination is not possible after this treatment, e.g. products heat treated in their final package
- Fresh, uncut and unprocessed vegetables and fruits, excluding sprouted seeds
- Bread, biscuits and similar products
- Bottled or packed waters, soft drinks, beer, cider, wine, spirits and similar products
- Sugar, honey and confectionery, including cocoa and chocolate products
- Live bivalve molluscs
- Food grade salt

⁵ Products with pH ≤ 4.4 or a_w ≤ 0.92, products with pH ≤ 5.0 and a_w ≤ 0.94, products with a shelf-life of less than 5 days are automatically considered to belong to this category. Other categories of products can also belong to this category, subject to scientific justification.

Listeria monocytogenes

9. Control of *L. monocytogenes*

Control of *L. monocytogenes* is required at all stages in the food chain and an integrated approach is required to prevent the proliferation of this pathogen in the final product. The challenges for controlling *L. monocytogenes* are considerable given its ubiquitous nature, high resistance to heat, salt and acidic pH and arguably, most importantly, its ability to grow and survive at or below normal refrigeration temperatures. The following general recommendations apply to all sectors of the food chain:

- Implementation of GHP and Good Manufacturing Practices (GMP)
- Implementation of a food safety management system based on the principles of HACCP
- Testing against microbiological criteria, as appropriate, when validating and verifying the correct functioning of the HACCP based procedures and other hygiene control measures

In addition, food business operators manufacturing food which may pose a *L. monocytogenes* risk must conduct environmental monitoring to identify and eliminate niche environments, i.e. areas which favour the establishment and proliferation of *L. monocytogenes*.

References/Further Reading

European Commission (1999) Opinion of the Scientific Committee on Veterinary Measures relating to Public Health on *Listeria monocytogenes*

http://ec.europa.eu/food/fs/sc/scv/out25_en.html

EFSA – European Food Safety Authority (2011) The Community Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in the European Union in 2009. *EFSA Journal*, 9(3), 2090

<http://www.efsa.europa.eu/en/efsajournal/pub/2090.htm>

FAO/WHO (2004) Risk assessment of *Listeria monocytogenes* in ready to eat foods – Interpretative summary. *Microbiological Risk Assessment Series 4*

http://www.who.int/foodsafety/publications/micro/mra_listeria/en/index.html

Food Safety Authority of Ireland (2005) The control and maintenance of *Listeria monocytogenes* contamination of food

http://www.fsai.ie/resources_and_publications/scientific_reports.html

Food Safety Authority of Ireland (2010) Zoonoses in Ireland. Update for 2008

http://www.fsai.ie/resources_and_publications/other_scientific_reports.html

Health Protection Surveillance Centre (HPSC) Annual Reports

<http://www.hpsc.ie/hpsc/AboutHPSC/AnnualReports/>

International Commission on Microbiological Specifications for Foods (1996) *Listeria monocytogenes* p141-182. In *Micro-Organisms in Foods. 5. Characteristics of Microbial Pathogens*. Roberts, T.A., Baird Parker, A.C. and Tompkin, R.B. eds. Published by Blackie Academic & Professional, London

Lund, B.M., Baird-parker, T.C. and Gould, G.W. (2000) *Listeria monocytogenes* p1178-1232. In *The Microbiological Safety and Quality of Food. Volume II*. Lund, B.M., Baird-parker, T.C. and Gould, G.W. eds. Published by Aspen Publishers