



# The occurrence of *Listeria monocytogenes* in mass catering: An overview in the European Union

Andrea Osimani, Francesca Clementi\*

Dipartimento di Scienze Agrarie, Alimentari ed Ambientali, Università Politecnica delle Marche, via Brecce Bianche, 60131 Ancona, Italy

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## ABSTRACT

*Listeria monocytogenes* is the causative agent of the human illness called listeriosis. The data reported in the last 15 years of scientific literature concerning the relationship between this microorganism and the catering sector showed a permanent presence of the opportunistic pathogen through the years, though with low frequencies. Even though the pathogenic capacity of *L. monocytogenes* is practically circumscribed to a few risk categories as pregnant women, newborns and different kinds of immunocompromised people, given its high case-fatality rate this disease represents the second cause of death for foodborne infection in Europe. As it emerged from the reviewed literature, *L. monocytogenes* was recovered in many different food categories, which testifies the widespread of the pathogen in the food chain. The main causes of *L. monocytogenes* presence were poor microbiological quality of raw materials, cross-contamination, inadequate cleaning practices, improper storage temperature, inadequate preparation processes, and a lack in the training of staff on food hygiene. In particular, cross-contamination of foods can be reduced by hand washing, use of gloves, separation of raw materials from end products, sanitation and disinfection of equipment and food contact surfaces, hence, a structured training program of staff on these practices is essential.

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## 1. Introduction

Catering systems are complex organizations that deal with the production of foods for specific groups of consumers. Such production systems normally need of a range of inputs including: raw food items; appropriately skilled people; equipment; any necessary financing (Smith and West, 2003). In recent years, the catering industry (catering services, restaurants, hotels, bars, pubs, and cafeterias) has taken an increasingly important role in the lives of individuals who, for reasons of necessity, work or pleasure, consume meals out of the home (Garayoa et al., 2011). For this reason the quality and safety of food, daily supplied to the community of consumers, are parameters of fundamental importance, since food should be a source of nourishment and pleasure, without constituting a vehicle of transmission of diseases (Vongkamjan and Wiedmann, 2015).

The present review is focussed on the role that the catering industry can play in the diffusion of listeriosis in Europe. In the second paragraph an overview of current legislation in the European Union (EU) in matters of food safety is provided, with particu-

lar emphasis to regulations concerning the zoonosis, taking into account that listeriosis is included in the list of zoonoses that have to be properly monitored in the EU. Then, in the third paragraph, the review goes on to describe the main features of the genus *Listeria*, focussing on the species *Listeria monocytogenes* which is the responsible for the human illness called listeriosis. The core of this paper is the fourth paragraph that reports information available in the current literature concerning the occurrence of *Listeria monocytogenes* in meals served by the catering industry from 1999 to 2014. Finally, starting again from the available literature, the authors analyse and discuss the possible risk factors that could have contributed to the presence of *Listeria monocytogenes* in food preparations, and the achievable corrective actions, as well as the implementation of correct good manufacturing practices.

## 2. The regulatory framework

Following various food crisis in the European Union (EU) during the 90s, the European Commission decided to undertake a more pro-active food policy (Ghaida et al., 2014). Therefore, a massive and specific legislation on food safety was developed in order to ensure the highest possible food safety standards covering food production, processing and distribution.

\* Corresponding author.

E-mail addresses: [f.clementi@univpm.it](mailto:f.clementi@univpm.it), [a.osimani@univpm.it](mailto:a.osimani@univpm.it) (F. Clementi).

The path had been already traced by the [Directive 93/43/EC](#) on the hygiene of foodstuffs, which had pointed out the pivotal importance of risk assessment and, for the first time in the EU, had prescribed that all food business operators (but those of the primary sector) implement permanent procedures based on Hazard Analysis and Critical Control Points (HACCP) principles in order to guarantee food safety.

The subsequent milestone of EU legislative process was the publication of the Commission's White Paper on Food Safety in the year 2000; one of the main principles set out in the White Paper was the application of EU food safety rules "from farm to fork" ([Commission of the European Communities, 2000](#)).

In 2002, [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, established the European Food Safety Authority (EFSA). This European independent Agency is the keystone of EU risk assessment regarding food and feed safety. It operates in close collaboration with national authorities and in open consultation with its stakeholders, EFSA provides independent scientific advice and clear communication on existing and emerging risks ([Ghaida et al., 2014](#)).

In 2004, the EU food legislation underwent a complete overhaul, with the enactment of the so-called "Hygiene Package" which consists of four main legislative acts, applicable with effect from January 1st 2006. In particular [Regulation \(EC\) No 852/2004](#) of the European Parliament and of the Council of 29 April 2004, on the hygiene of foodstuffs, reaffirmed the responsibility of food business operators for the implementation of the measures and conditions necessary to control hazards and the necessity to do it by using the preventive approach based on the principles of the HACCP system ([Manfreda and De Cesare, 2014](#)). The other three Regulations ([Regulation \(EC\) No 853/2004](#); [Regulation \(EC\) No 854/2004](#); [Regulation \(EC\) No 882/2004](#)) completed the legislative effort fielded with the Hygiene Package providing specific rules for the sector of animal origin foodstuffs, the related official controls, animal health and animal welfare.

Since microbiological criteria also give guidance on the acceptability of foodstuffs and the hygiene of their manufacturing and distribution processes, the use of such criteria should form an integral part of the implementation of HACCP-based procedures and other hygiene control measures ([Peran i Sala et al., 2015](#)). As an application of the concept expressed above, [Regulation \(EC\) No 2073/2005](#) of 15 November 2005 provided microbiological criteria for some foodborne bacteria, microbial toxins and metabolites in certain foods and food processes. In particular, Annex I (as amended by the [Regulation \(EC\) No. 1441/2007](#)) summarizes the microbiological criteria, the analytical methods, and the sampling plans into two different tables (Chapter 1 and Chapter 2) concerning food safety criteria and process hygiene criteria, respectively, whereas Annex II concerns the studies to be accomplished by the food business operators in order to assure compliance with the legal criteria throughout the shelf-life.

Most of the EU legislation on food safety is aimed at protecting human health against zoonoses, also called zoonotic diseases (which are diseases that can be passed from animals to humans), both to avoid human suffering and reduce severe economic losses for the community ([Ammon and Makela, 2010](#)). With this aim, the European Commission promotes cooperation and exchange of information and evaluating trends at European level; in accordance, Member States (MSs) are responsible for data collection (through their monitoring systems) and for epidemiological investigation on zoonoses outbreaks. As a priority, the monitoring concerns the following diseases and causative agent thereof: brucellosis, campylobacteriosis, echinococcosis, listeriosis, salmonellosis, trichinellosis, tuberculosis due to *Mycobacterium bovis*, and infections due to verotoxigenic *Escherichia coli*.

Measures for protection against specified zoonoses and specified zoonotic agents in animals and products of animal origin were established since 1992 with the [Council Directive 92/117/EEC](#) of 17 December 1992 when the monitoring system for certain zoonoses both at the level of MSs and at Community level began. Subsequently, the Scientific Committee on Veterinary Measures relating to Public Health pointed out the necessity of improving the specific control. As a direct consequence the [Directive 2003/99/EC](#) of the European Parliament and of the Council of 17 November 2003 on the monitoring of zoonoses and zoonotic agents was issued in order to ensure that zoonoses, zoonotic agents and related antimicrobial resistance are properly monitored, and that foodborne outbreaks receive proper epidemiological investigation, to enable the collection in the Community of the information necessary to evaluate relevant trends and sources.

Since 2004, an annual Community report on zoonotic agents in animals, feedingstuffs, foods, and humans in the EU is published by the European Commission; in 2005, EFSA received the mandate regarding the monitoring of zoonoses and, therefore, since that year the above cited report entitled "The European Union summary report on trends and sources of zoonoses, zoonotic agents and foodborne outbreaks" is jointly compiled by EFSA, and the European Centre for Disease Prevention and Control (ECDC).

### 3. *Listeria monocytogenes* and listeriosis

The genus *Listeria* includes Gram-positive, non-sporeforming rods (0.5–2.0  $\mu\text{m}$ ), facultatively anaerobic bacteria with eight apparently apathogenic species namely, *Listeria marthii*, *Listeria innocua*, *Listeria welshimeri*, *Listeria seeligeri*, *Listeria grayi*, *Listeria rocourtiae*, *Listeria fleischmannii*, and *Listeria weihenstephanensis*, and the two pathogenic species *Listeria ivanovii* and *Listeria monocytogenes* ([Suh et al., 2014](#)). Recently, five new species have been identified: *Listeria aquatica*, *Listeria floridensis*, *Listeria cornellensis*, *Listeria grandensis*, and *Listeria riparia* ([Bakker et al., 2014](#)).

The species *L. marthii*, *L. innocua*, *L. welshimeri*, *L. seeligeri*, *L. ivanovii*, and *L. monocytogenes*, capable to grow within higher vertebrate hosts, are known as *Listeria sensu strictu* ([Chiara et al., 2015](#)). Among the species of *Listeria*, *L. monocytogenes* is known to be an opportunistic foodborne pathogen which can cause a foodborne infection called listeriosis, a disease associated with high mortality rates. *L. monocytogenes* is an intracellular pathogen able to grow at temperatures ranging from  $-0.4^\circ\text{C}$  to  $45^\circ\text{C}$  (with optimum at  $30\text{--}37^\circ\text{C}$ ), at pH values from 4.0 to 9.6 (with an optimum ranging between 6 and 8), and at a 0.90 minimum of water activity ( $a_w$ ). The pathogen has been isolated from a wide range of matrices such as: various foodstuffs (cheese, fermented meat, ice cream, raw milk, raw and cooked meat, raw vegetables, raw and smoked seafood), sewage, silage, soil, water, and faecal material ([Álvarez-Ordóñez et al., 2015](#); [Petruzzelli et al., 2010](#)).

The infection (listeriosis) caused by *L. monocytogenes* is a rare but severe disease in susceptible individuals with a mortality rate of 20–30% despite adequate antimicrobial treatment. The major part of the reported cases of the invasive form of listeriosis present in one of three clinical syndromes: (i) maternofetal listeriosis or neonatal listeriosis, (ii) blood stream infection, and (iii) meningoencephalitis. Moreover, listeriosis may present as a focal infection which commonly involve the peritoneum, joints, the endocardium, or the eyes. Listeriosis may also present with non-specific symptoms such as febrile gastroenteritis with frequent spontaneous remission ([Swaminathan and Gerner-Smidt, 2007](#)).

Though listeriosis can occur in subjects with no known predisposing factors, invasive listeriosis typically occurs in elderly people, immunocompromised, as well as pregnant women ([Swaminathan and Gerner-Smidt, 2007](#)). Pregnancy is indeed known to be associ-

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