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The Future for the Control of *Listeria* in Food and Beverage Manufacturing

Paul A. Gibbs

A Leatherhead Food Research white paper

The Future for the Control of *Listeria* in Food and Beverage Manufacturing

It may seem as though *Listeria* is winning the food safety battle, but, as Paul Gibbs describes in this white paper, the future for controlling the pathogen looks brighter as we understand more about the different strains and human susceptibility.

In Europe, there are approximately three cases of listeriosis (the infection caused by *Listeria monocytogenes)* per 100,000 people every year. Although infection is comparatively rare, typically causing gastroenteritis and fever, the mortality rate is high at 20-30% - more than *Salmonella* and *Campylobacter* combined. This is because *Listeria monocytogenes (L. monocytogenes)* can cause invasive disease, crossing the blood brain barrier and the maternal foetal barrier resulting in meningitis and foetal death. Those at particular risk of this form of the disease include pregnant women and those with impaired immunity e.g. the elderly or those undergoing chemotherapy.

Recent outbreaks have been most commonly associated with semi-preserved meats and fish (e.g. ready-to-eat and delicatessen products such as patés, frankfurters, cold-smoked fish), cheese, especially soft and mould-ripened cheeses, ice cream, raw vegetables and salad items.

What is it and where does it come from?

L. monocytogenes is a small motile bacillus that can be identified following microbial culture, using a range of biophysical and biochemical tests.

If you look for it, *L. monocytogenes* can be found everywhere and prospers in several natural environments, including waters, soils, plants and animals. *L. monocytogenes* is a great survivor and extraordinarily tolerant of external environments, such as extreme pH, temperature and low water activity. It is therefore not surprising to find it in raw and unpasteurised foods.

In food processing plants, it is believed that *L. monocytogenes* exists within thin but adherent biofilms which can resist cleaning and persist for long periods of time, resulting in prolonged outbreaks. The organism can persist in small niches and contaminate food cutting and slicing equipment. The high pressure washing of drains can dislodge cells into an aerosol (or fine spray), thereby contaminating plant and working surfaces.

How can you control *L. monocytogenes*?

The organism is not particularly heat resistant and can be eliminated by conventional pasteurisation. Treatment of potentially contaminated foods that cannot be pasteurised by heat, e.g. sliced hams and other cured meat products, can be successfully pasteurised 'in pack' by high pressure processing on a commercial scale.

However, the conventional control of food-borne listeriosis in foods by physico-chemical means e.g. temperature, pH and salt concentration is much more difficult. *L.*

monocytogenes is capable of growth at temperatures as low as 0°C, and under high salt and low pH values – conditions that are typically used to limit microbial growth. This means it is very difficult to design a safe food product that will inhibit growth of the pathogen, and still retain sensory characteristics acceptable to the consumer.

How can *L. monocytogenes* be controlled in traditional or artisanal foods?

Traditional or artisanal foodstuffs, e.g. home cured and smoked meats, cold smoked fish, mould ripened cheeses, have proven to be very difficult to produce in a safe manner.

However, in several of these foods, the 'spoilage' microflora that develop, is largely lactic acid bacteria (LAB), and it has been shown that in many cases a fraction of this LAB flora can produce antimicrobial compounds or bacteriocins – bacteriocins actively inhibit or are lethal for *L. monocytogenes*.

In cold-smoked fish, it has been demonstrated that by simply changing the time and sequence of the salting, drying and smoking regimes, the developing LAB flora can be varied to control and inhibit listerial growth. LAB flora has also been isolated and applied to lightly-preserved smoked sausages during manufacture, reducing the occurrence and growth of *L. monocytogenes*.

Another 'natural' method of control is to use anti-*Listeria* bacteriophages. Bacteriophages, also known as phages, are viruses that infect, multiply within, and kill their bacterial hosts.

Considerable reductions in the prevalence of *L. monocytogenes* in the food processing environment can be achieved using bacteriophage, resulting in a significant reduction in the potential contamination of foods and food processing surfaces. These phages can be effective in killing *L. monocytogenes* within biofilms since they infect and replicate within the pathogen itself, killing the cells while at the same time providing a continued source of infection to kill more cells.

As pressure grows to reduce the levels of disinfectants used in factories, alternative biocontrol methods are gaining interest. However, in trials with commercially available phages, they have proven less successful in controlling *L. monocytogenes* in foods, possibly due to how the phages bind to the food components.

What does legislation say about *L. monocytogenes*?

Many countries, such as the USA and Russia, have a zero tolerance for the presence of *L. monocytogenes* i.e. if the organism is detected within a product, then it must be recalled.

Current legislation in Europe for Ready to Eat (RTE) products that are able to support the growth of *L. monocytogenes* does not allow the presence of detectable *L. monocytogenes* at point of manufacture. However, small traces of *L. monocytogenes* are acceptable in these kinds of products at the end of their shelf life, as long as the numbers do not exceed 100 cfu/g.

How can we beat *L. monocytogenes*?

Generally, all *L. monocytogenes* strains are lumped together as a single group of pathogenic organisms; however, the picture is

much more complex and this is where research is currently focussing its energies.

Not all strains of *L. monocytogenes* cause disease. Pathogenicity (the ability of an organism to cause disease) for humans is generally confined to certain types or serotypes of *L. monocytogenes*, particularly serotypes 1/2a, 1/2b, and 4b. The majority of foodborne outbreaks (approximately 40%) come from serotype 4b.

Legislation does not currently recognise that different strains of *L. monocytogenes* exist and possess different levels of pathogenicity. *L. monocytogenes* in the context of legislation is understood to be one organism.

We are now exploring why certain strains or *L. monocytogenes* are more pathogenic than others. Current research has revealed that certain genes are more commonly found in pathogenic strains of *L. monocytogenes* and are absent in less pathogenic strains. This may eventually allow the development of tests to further distinguish pathogenic and non-pathogenic strains. However, this is complicated since the severity of disease (i.e. virulence) is linked to individual immunity and certain people are more likely to contract listeriosis than others.

Whole genome sequencing of *L. monocytogenes*, which shows the complete DNA makeup of the pathogen, will in time enable us to develop greater knowledge about the pathogenicity of different strains of *L. monocytogenes*. With greater understanding of *L. monocytogenes* and knowledge why certain people are more susceptible to this disease, we will be able to take a more nuanced approach to dealing with *L. monocytogenes*, and ultimately limit the number of listeriosis outbreaks.

How Leatherhead can help

How well will *Listeria* grow in your products and what is a safe shelf-life? Leatherhead can help you in examining and preventing the growth of *Listeria* in your food products, as well as identifying and characterising potential sources of risk and contamination.

Leatherhead is bringing together key scientists, industry stakeholders and the Food Standards Agency to discuss practical strategies for listeria management in our 'Taking Control of Listeria' conference on 28th April 2016. Hear Professor Haley Oliver from Purdue University USA present her state of the art, published research on the whole genome sequencing of *L. monocytogenes* and how this is shaping our understanding of pathogenic and non-pathogenic strains. The day will also cover practical advice for manufacturers from Dr John Holah on how to control listeria.

About the author

Dr Paul Gibbs was Head of Food Microbiology and Special Projects Advisor in Leatherhead Food Research from 1978 – 2002 and remains as an emeritus consultant. In addition, Paul is a consultant to Escola Superior de Biotecnologia, Universidade Catolica, Porto, Portugal, where he lectures on several aspects of food microbiology and has supervised / co-supervised several PhD and MSc research programs, including many concerned with the isolation and characterisation of *Listeria monocytogenes* from cold smoked fish, raw shellfish and on cured, smoked meat products. Paul has co-ordinated several EU-funded research projects relating to the microbiological safety of foods, including the safety and spoilage of cold smoked fish, the safety of Sous Vide foods, the vacuum packaging and modified atmosphere packaging of meats and on the preservation of fresh fish.

About Leatherhead Food Research

Leatherhead Food Research provides expertise and support to the global food and drink sector with practical solutions that cover all stages of a product's life cycle from consumer insight, ingredient innovation and sensory testing to food safety consultancy and global regulatory advice. Leatherhead operates a membership programme which represents a who's who of the global food and drinks industry. Supporting all members and clients, large or small, Leatherhead provides consultancy and advice, as well as training, market news, published reports and bespoke projects. Alongside the Member support and project work, our world-renowned experts deliver cutting-edge research in areas that drive long term commercial benefit for the food and drink industry.

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