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2nd Informatory Note on Refrigeration and Food

Listeria Monocytogenes in Refrigerated Foods

INTRODUCTION

Listeria monocytogenes is a pathogenic bacteria that can cause a serious disease known as "listeriosis". Until the early 1980s it was believed that listeriosis in man was contracted from contact with infected animals. However, during the 1980s several foodborne outbreaks of listeriosis were reported. It is now recognised, in the food safety context, that the presence and growth of *L. monocytogenes* must be taken into consideration during the production, storage and distribution of foods. The occurrence of *L. monocytogenes* is an international problem.

LISTERIOSIS

Food is thought to be the principal vector whereby humans are exposed to, and infected with, *L. monocytogenes*. In medical terms, listeriosis refers to a wide spectrum of illness ranging from mild flu symptoms to meningo-encephalitis. If the organism manages to infect the central nervous system, the disease carries a high mortality rate. However, such serious infection in humans is relatively rare but current estimates indicate that approximately 20% of the population has heightened susceptibility with the very young, the very old and the immuno-compromised being particularly at risk. A mild infection in a pregnant woman may pass unnoticed but can lead to an intra-uterine infection, characterised by extensive death of foetal liver and spleen tissue accompanied by septicaemia which frequently results in abortion, stillbirth or death of the newly born infant. For this reason pregnant women need to take greater care to avoid infection.

LISTERIA MONOCYTOGENES

L. monocytogenes has been recognised as a human and animal pathogen for many decades and methods for isolating, characterising and subtyping the organism have existed for a long time. However, these methods are very slow, but as a result of intensive research since the mid-1980s considerable improvements have been made, making it possible for the food industry and control authorities to examine foods for the presence of *L. monocytogenes* within a reasonable time.

The genus *Listeria* comprises six species, but only three seem to be pathogenic to man. While *Listeria ivanovii* and *Listeria seeligeri* have allegedly been associated with human listeriosis, *L. monocytogenes* has been the cause in more than 99% of cases fully investigated.

Listeria are Gram-positive, non-spore forming, microaerophilic (facultatively aerobic) bacteria of uncertain taxonomic affinity. While the optimum temperature for growth and reproduction is between 30°C and 37°C, *L. monocytogenes* can survive and multiply within the range 1°C to 45°C. There are large strain-to-strain variations but some strains seem able to grow down to about -1.5°C. Growth can occur in the presence and almost absence of oxygen, and some strains may grow in foods with a pH down to 4.5 and a water activity (a_w) down to 0.9. In common with other non-sporing Gram-positive pathogens, *Listeria* are readily destroyed by heat (pasteurisation: 72 to 75°C at the coldest point).

L. monocytogenes is an ubiquitous organism making it difficult to avoid its presence in foods that have not received a listericidal treatment in the final packaging.

The problem with *L. monocytogenes* in chilled foods is its ability to grow at temperatures around 0°C. Initially, if a food product contains a very low number of the organism, this number might well increase during storage and distribution to levels of significance with regard to causing foodborne listeriosis.

Growth of *L. monocytogenes* is not possible in frozen foods but if contamination has taken place before freezing the organism might survive to grow and multiply, to levels that represent a hazard to human health, when the food is thawed.

MINIMUM INFECTIOUS DOSE

The minimum infectious dose is one measure of the infectivity of an organism and is an expression of the lowest number of organisms required to initiate an infection in any individual under given circumstances. The term recognises that each organism has the potential to cause an infection but builds upon the variation that exists in the actual dose required, the virulence of the agent and the individuals response. For some pathogenic bacteria, the

minimum infectious dose is well established, but there is no certain figure for *L. monocytogenes* despite the considerable research undertaken since 1985.

Many surveys, carried out in several countries, indicate that *L. monocytogenes* is present in a large number of foods, but normally in very low numbers, i.e., less than one colony forming unit (cfu) per gram of food. This implies that many people are exposed to low levels of *L. monocytogenes* each and every day. Despite this, the incidence of listeriosis in humans is very low, in the order of 3-8 cases per million inhabitants per year in the industrialised countries. It is safe to conclude, therefore, that the infectious dose for the vast majority of people is greater than ten bacteria per gram of food. (Perhaps a few hundreds for most healthy adults but much less for susceptible people.)

GROWTH OF *L. MONOCYTOGENES* IN FOODS

The surveys mentioned above have shown that any food, other than those adequately heat processed in the final container, could be expected to be contaminated sporadically with some level of *L. monocytogenes*. It is therefore necessary to prevent the number of these bacteria increasing to a dangerous level.

The growth rate of *L. monocytogenes* slows with lowering temperature, as shown in the Table, which indicates the time required for the number of cells to increase from 10 to 100 per gram for a typical strain. (Growth rates may vary as much as four times from one strain to another.)

Approximate time for a typical strain of *L. monocytogenes* to increase in number from 10 to 100 cells as influenced by temperature, pH and % salt (from Food MicroModel)

pH	Salt content	1°C	3°C	5°C	8°C	10°C
6.0	1%	375 h	230 h	145 h	78 h	53 h
5.0	1%	919 h		352 h		127 h
6.0	3%	596 h		234 h		87 h

All lines of this table illustrate that the colder the temperature, the slower the rate of multiplication: e.g. a level of 100 cells is reached in about 3 days at 8°C, while it takes about 10 days at 3°C, at pH 6.0 with a salt (NaCl) content of 1%.

In order to reduce the risk of listeriosis and the risk of growth (or toxin formation) of other pathogenic organisms it is imperative to maintain the temperature of chilled foods as low as practicable throughout the storage, distribution and retail chain. Colder temperatures also reduce quality deterioration and may enable an increase in storage life.

The growth of *L. monocytogenes* can be prevented, or at least reduced, by other means, for example by reducing the pH or by increasing the salt content. The table shows that:

- for food produce with 3% salt instead of 1% and a pH still at 6.0, the time needed to increase from 10 to 100 cells is more than 50% greater;
- for a food with a pH of 5.0, instead of 6.0, and still 1% salt, the time needed to increase from 10 to 100 cells is more than doubled.

Food safety can also be enhanced by changing the product formulation in other ways, e.g., by adding nitrite, lactate, etc. This indicates that by using the so-called "Hurdle Concept" the risk of *L. monocytogenes*, and other pathogens, growth can be minimised. The use of good hygiene practices in food manufacturing is essential at all times and the implementation of well developed HACCP systems in food processing plants will increase food safety.

One possible explanation for the problems with *L. monocytogenes* in industrialised countries is the increasing trend towards prepared foods, capable of supporting the growth of the organism, which have extended storage lives at chill temperatures and which may be consumed without further cooking. In some instances these foods have been shown to be contaminated with relatively high numbers of the organism, i.e., counts greater than 1000 cfu per gram.

LEGISLATION

Several countries have chosen a zero-tolerance approach for *L. monocytogenes* in foods, based on recognition of the seriousness of listeriosis and on the fact that the minimum infectious dose is not known. This approach means that the organism must be absent from ready-to-eat foods.

Several countries use 100 cfu per gram as a tolerable level of *L. monocytogenes* in ready-to-eat foods while applying a zero-tolerance to foods that have been heat processed in the final packaging.

While it must be realised that it is extremely difficult to guarantee that most foods will be completely free from *L. monocytogenes*, if countries with a more conservative regulatory approach are to be convinced that a higher tolerance is acceptable, those countries with a higher tolerance, e.g., 100 cfu per gram, must prove that their approach is safe. This will necessitate more accurate diagnosis and reporting of foodborne disease which, in turn, will necessitate improvements in microbiological techniques.