

New Product - Technical worked example of approach to determining the shelf life of a ready-to-eat food in relation to *Listeria monocytogenes* (*L. monocytogenes*)

Cold-Smoked Salmon and Fresh Watercress Sandwich



This is an example of the supporting evidence that may be gathered following the guidance document “*Shelf life of Ready to Eat food in relation to L monocytogenes – Guidance for Food Business Operators*”¹. The ‘Boxes’ referred to in the text below relate to the boxes in the flow chart (Figure 2) on page 6 of the above document.

This product consists of: cold-smoked salmon; shredded watercress; sliced wholemeal bread and butter. The completed sandwich has a proposed 3 day chilled shelf life.

Box 1 Requirements for safe manufacture of Ready to Eat foods

The sandwich manufacturer (Food Business Operator (FBO)) has adopted GMP and GHP by for example, introducing and monitoring effective cleaning of equipment and staff personal hygiene. The FBO has HACCP in place for the manufacture of the sandwiches and *L. monocytogenes* is considered as a potential hazard in the HACCP study.

Box 2 Ingredients

The highest quality ingredients available are used, and are obtained from reputable suppliers. These supply a ‘certificate of compliance’ (to the FBO’s requirements) for each batch of ingredients supplied. The details of the ingredients are:

- Salmon which is supplied in 1kg packs with a 10 day chilled shelf life. The salmon is cold-smoked by a process of 30°C for 16 hours and has a salt content of 3.5%
- Fresh shredded watercress, supplied in 500g packs with a 7 day chilled shelf life
- Sliced wholemeal bread, supplied in 800g bags with a 7 day ambient shelf life
- Butter, supplied in 2kg tubs with a 6 week shelf life

Box 3 Ensuring ingredients are Ready to Eat

The shredded watercress is washed in potable water prior to its use in the sandwiches by the FBO. The other ingredients are RTE as supplied.

Box 4 Final product's characteristics

The pH and water activity (a_w) of the sandwich ingredients are:

Component	pH	a_w
Salmon	6.0	0.95 (3.5% salt)
Watercress	6.5	0.98
Bread	6.1	0.97
Butter	6.6	0.96 (aqueous phase)

NB the values used here are for illustration purposes only

From Regulation (EC) No. 2073/2005, products are not considered to support the growth of *L. monocytogenes* if:

- pH is no more than 4.4, or
- a_w is no more than 0.92, or
- pH is no more than 5.0 and the a_w is no more than 0.94
- shelf life is less than 5 days

("Bread" is one of the foods specifically mentioned as being excluded in the Regulation).

The pH and a_w values of the ingredients suggest that *L. monocytogenes* would grow in them if present. Although the proposed shelf life of the completed sandwich is less than 5 days, the age of one or more of the ingredients may be older than this.

The following points have to be considered:

1. The 'heat process' used in the cold-smoking of **salmon** (30°C for 16h) is not sufficient to inactivate *L. monocytogenes*. (A process equivalent to 70°C for 2 minutes is required for this). Also, the salt concentration of 3.5% is not sufficient to control growth as *L. monocytogenes* can grow in the presence of salt at 10%, and survive in conditions of 25% salt. Some protection may be afforded by the preserving effect of the smoking, and competitive effects of the indigenous microbiological population of the component.
2. Cold-smoked salmon has been shown to be contaminated by *L. monocytogenes* at frequencies of 2-21% (McLauchlin and Nichols, 1994). Levels were generally less than 100 cfu/g with the highest count between 100 and 1000 cfu/g. This is in line with findings by the Food Standards Agency, where 1,344 samples of cold smoked fish were sampled at retail during 2006. Nearly 300 (282, 20.5%) of samples contained *Listeria* spp, and 236 (17.4%) *L. monocytogenes* with all levels at below 100 cfu/g (www.food.gov.uk/multimedia/pdfs/fsis0508.pdf).
3. Since *L. monocytogenes* is a relatively common bacterium in the environment, **watercress** might be expected to be occasionally contaminated with it. Washing the watercress in chlorinated water will help to reduce the level of *L. monocytogenes*.

Bell & Kyriakides (2005) mention a survey of 11 samples of watercress, 2 of which were found to be contaminated with *Listeria*. (One was found to be *L. welshimeri* the other was not identified.)

4. Bread has no history of being contaminated with *L. monocytogenes* as it is prevented from growing on it because appropriate nutrients are not available.
5. Butter has been associated with listeriosis, but this is the exception rather than the rule, and came about as a result of incorrectly made butter. (Butter is an emulsion of water droplets in a fat matrix. *L. monocytogenes* is normally controlled by the water droplets being of insufficient size to physically allow growth.)

In an outbreak in England, testing confirmed the presence of *L. monocytogenes* at 180 cfu/g in a batch of butter although it was only detectable at low levels (less than 20 cfu/g) in other batches (ACMSF, 2003).

Box 5 Historical testing data

Historical data show that the results of microbiological testing of supplied ingredients; sandwich-manufacturing environment; and finished product throughout shelf life could contain *L. monocytogenes*. Although information and data on *Listeria* and *L. monocytogenes* is of prime importance, other microbiological data, for example Aerobic Plate Counts, can be used to indicate if production is generally under control.

Useful information can be obtained from suppliers, such as evidence of absence of *L. monocytogenes* in the environment and ingredients they are supplying. The level of confidence increases with the amount of data available. Ideally, this should cover eventualities of variability such as seasonality of ingredient/component supply. Data acquired from one supplier is not applicable to another or all potential suppliers of the same component.

Evidence of the absence of *L. monocytogenes* in ingredients where this microorganism can grow (such as salmon and watercress), is important to show that the sandwich produced is acceptable. Counts of *L. monocytogenes* at less than 100 cfu/g at end of life of the sandwich are useful, as is evidence that counts of *L. monocytogenes* are 'less than 10 cfu/g' or 'less than 20 cfu/g' at the start of life of the sandwich or its ingredients. This is however not evidence that *L. monocytogenes* will not grow to levels above 100 cfu/g by the end of life of the product and therefore necessitate being withdrawn from sale. It does however strongly suggest that the controls in place are working.

Occasional counts of *L. monocytogenes* are to be expected in this type of product, as ingredients and factory environments will be contaminated from time to time. Positive results of this sort indicate that sampling procedures and testing methods are working.

Having established that there is a real possibility that *L. monocytogenes* could be present in the sandwich at the point of sale, the task now is to be certain that the count does not exceed 100 cfu/g at the end of the proposed shelf life. There are three generally accepted methods of checking this.

Box 6 Additional data

Predictive Microbiology

The behaviour of *L. monocytogenes* should it be present in the sandwich ingredients, can be predicted using appropriate commercially-available models such as ComBase (www.combase.cc). This software is designed to give an idea of how the pathogen might behave, it does not take into account factors such as: the anti-microbial effects of smoking the salmon; competing microflora in the salmon or watercress; and so on.

The predictions for the ingredients discussed in this example indicate that if *L. monocytogenes* were present at a level of 10 cfu/g in the salmon or watercress at start of life of each component, even if they were kept at 5°C, the number is likely to reach 100 cfu/g (2 logs) before the end of life of the ingredients and probably the sandwich made from them.

Durability studies

Durability studies are generally not relevant to determining the growth of pathogens in a foodstuff, as there is no guarantee that they will be naturally present. If such a study were carried out, replicate samples would need to be taken of the ingredients and sandwich over life. The temperatures that these foodstuffs were held at would need to replicate what would happen in reality. The samples would be tested for *L. monocytogenes* and a plot of number over time would give an indication of whether this organism would grow to a level of 100 cfu/g by the end of life of the sandwich.

To reflect reality, the sandwich would need to be made from the ingredients when the salmon was no more than 7 days old and the watercress no more than 4 days old – so that the 3 days shelf life of the sandwich could be taken into account.

Challenge test

A challenge test study may be used to determine the behaviour of a pathogen in a foodstuff over life. As for the durability study, the number of the relevant organism is determined over the life of the foodstuff.

The advantages of a challenge test over the other methods of shelf life determination mentioned here, is that a known number a particular species of microorganism can be added at the start of the study. And units initially inoculated at the start of the study, can be analysed at end of life.

Conclusion

If the results of these tests are satisfactory, then it may be concluded that the three day shelf life proposed is valid. If this is the case, it would still be recommended that ingredients are used early in their life to minimise any potential growth of *L. monocytogenes* that might already be present.

If the tests indicate that the 100 cfu/g were to be exceeded, then either the shelf life must be reduced or further precautions taken with the ingredients and processing (e.g. use 'hot-smoked' or 'canned' salmon instead of 'cold-smoked') to eliminate the risks during production.

References

Advisory Committee on the Microbiological Safety of Foods (ACMSF) (2003) Information paper. Recent Trends in Listeriosis in the UK. ACM/667. London, UK.

Bell, C and Kyriakides, A (2005) *Listeria*: a practical approach to the organism and its control in foods, 2nd Edition. Wiley-Blackwell.

McLauchlin, J and Nichols, G L (1994) *Listeria* and seafood. *PHLS Microbiology Digest* 11(3), 151-154.