Listeria contamination and identification of potential growth niches in a ready-to-eat manufacturing small and medium sized enterprise (SME): A case study

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Introduction

The most important post-processing contaminant of ready-to-eat (RTE) foods has been identified as *Listeria monocytogenes,* being the cause of multiple listeriosis outbreaks

The contamination of RTE foods is very difficult to control due to the ubiquitous presence of the pathogen in the natural environment and the ability of the organism to persist in the processing environment for very long periods of time[1].

The link between environmental contamination in the processing plant with the pathogen and contamination of RTE foods has been established[2]. Molecular subtyping in longitudinal studies further support the idea that environmental contamination is the main source of RTE foods contamination[3,4].

The pathogen can often be found in growth niches, which are areas that allow its growth and survival even after sanitation procedures. Sometimes growth niches are termed "harbourage sites", however, these are defined as growth niches inhabited only by a specific pathogen or organism of interest[1].

Strategies for environmental control include environmental sampling, S&D processes[1], pathogen environmental monitoring programs[5], and better hygienic equipment and plant design. In the UK, a risk-assessment based approach Listeria Management Plan, incorporating the '5 point'-plan to control Listeria[6] is recommended.

Purpose

This study aims to evaluate *Listeria* spp. contamination and identify potential growth niches in a RTE meals manufacturing SME.

Methods

Description of food manufacturer involved in the case study

- The manufacturer is a small to medium enterprise, manufacturing a large range of RTE meals (*n*≥100), under a single production site, supplying some of the UK's leading retails chains and the food service sector.
- Their product range includes: meat, dairy and vegetables based dishes, pasta and curries. This increases the odds of listeria presence.
- The manufacturer has agreed to share their own product and environmental sample results based on routine sampling over the course of 6 years.

Product and environmental sampling

- Microbiological results from 2012-2018 were reviewed to determine *Listeria spp.* detection and identification.
- In total, 4401 test results were collected and analysed including product (*n*=2548), raw materials (*n*=136), and environmental samples (*n*=1717).
- Presumptive listeria positive samples have been sent to an accredited contract laboratory for further identification.
- In conjunction with laboratory results, cleaning validation reports and monthly microbiological results reports were reviewed.

Results

The influence of cleaning operatives' food safety culture in the identification and control of Listeria harbourage sites

A number (*n*=14) of environmental *Listeria spp.* positives, including one *L. monocytogenes*, resulted in the identification of two distinct growth niches during two separate time intervals. Investigations indicated such growth niches were potentially attributed to an uncleanable location and a damaged floor, with a total period of 2 and 6 months, respectively, elapsing since an increase in unattributed Listeria positive samples have led to investigative actions and until mitigation. A number of 3 *Listeria spp.* product positives have been reported prior to the mitigation of the first niche compared to none for the second one.

Niche A – Caused by a hard to clean area and lack of training

The detection in a drain next to a piece of equipment of two index organisms, *L. innocua* and *L. welshimeri*, during scheduled swabbing, triggering a "not for-cause" investigation (Figure 1):

- This increased the scope and frequency of swabbing, to include the common footpath around the drain. Troubleshooting procedures were triggered by additional *L. welshimeri* positive samples (*n*=2). Daily deep-cleaning in the area and the addition of extended sampling locations to include the floor on two sides of the equipment, in low and high risk areas, resulted in identification of *L. welshimeri* positive samples (*n*=2) on the newly included sampling locations, and an additional positive in a remote location.
- Negative results immediately post-sanitizing followed by a positive result on the floor in the vicinity of the equipment after a longer period allowed the identification of the underside of the framework of the equipment, overlapping the low to high risk physical barrier, as the possible harbourage site. This has been confirmed visually and by subsequent negative tests following addressing the issue.
- Positive product samples (*n*=3) have been recorded during this period.

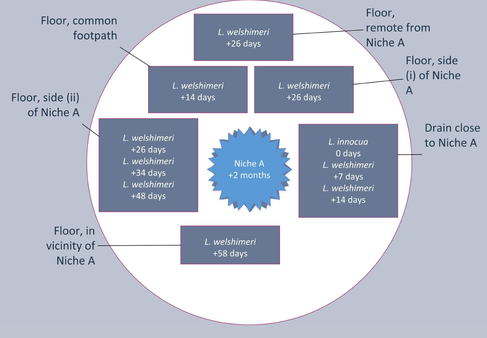

Figure 1 – Overview of positive results, detailing the time and location they have been sampled since the investigation started. Rectangular boxes represent areas where positives have been identified. Elapsed time between the first positive result (0 days) and mitigation of the niche is represented in days and months.

Niche B – Caused by damage to fabrication awaiting repair

Over a period of 6 months, several (*n*=5) *Listeria spp.* positives including *L. monocytogenes* have been identified (Figure 2), which led to investigative actions:

- Following investigations it was noted that there was a crack in the fabrication next to a piece of equipment, which resulted in the accumulation of water and other liquids during the processing and cleaning operations, contributing to the creation of a niche that allowed the growth and survival of *Listeria spp.*
- The complexity of the repair required an interim cleaning procedure based on deep cleans with increased attention to the damaged area.
- The nature of the interim cleaning procedure has not been documented, however a record that the procedure has been communicated verbally to the cleaning operatives exists.
- No further issues have been reported after renovation of the fabrication defect.

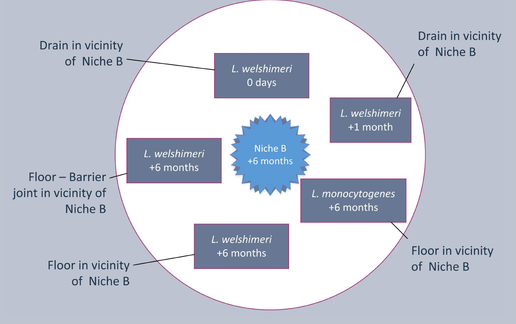

Figure 2 – Overview of positive results, detailing the time and location they have been sampled since the investigation started. Rectangular boxes represent areas where positives have been identified. Elapsed time between the first positive result (0 days) and mitigation of the niche is represented in months.

Significance of study

- The case study highlights possible product contamination via potential growth niches attributed to two different root causes, showing the impact over the environmental contamination and the need for reliable and effective implementation of strategies to identify and control growth niches.
- Niche A can be regarded as a good example of inefficient training of operatives regarding cleaning and sanitizing and the results of a weak food safety culture. Given that the equipment was installed in a high risk area, the cleaning program is required to be validated to control microbiological hazards. This may have been the case initially, but over time, and with potential failings of how the validated clean should be undertaken, harbourage has occurred. Neither of the operatives reported not being able to clean the area, showing signs of miscommunication, and did not demonstrate sufficient knowledge regarding possible risks associated with improper cleaning of the hard to reach areas.
- Product contamination could not be directly linked to Niche A as no subtyping characterization of the isolates has been done.
- Niche B can be regarded as a good example of re-work around fabrication renovation, showing the production oriented nature of most manufacturers. Interim cleaning procedures are common in this situation, however in order for them to be effective, they need to be clearly communicated. More importantly, senior management commitment should be practiced, ensuring proactive management of such issues.
- The safety standards in the RTE foods industry, in some developed countries, are relatively good in terms of best practice cleaning and sanitizing programs. However, there is a lack of longitudinal studies regarding observation of actual practices in relation to self-reported ones. Such studies could aid in the development of bespoke interventions targeting operatives' behaviour changes with the aim of improving cleaning and sanitizing efficiency.

Acknowledgements

The authors wish to acknowledge the Knowledge Economy Skills Scholarships (KESS 2) initiative part funded by the Welsh Government's European Social Fund (ESF) convergence programme for West Wales and the Valleys that enabled completion of this work.

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