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Identification and control of bacteria in food Case study - Occurrence of Listeria monocytogenes in ready-to-eat product

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Abstract
Listeria has always represented a threat to the food industry and customers` well-being.
The measures applied for the prevention of listeriosis are exclusively general, with no specific and special methods, thus special attention shall be paid to the health education of the population, as well as preventive decontamination in risk units (livestock and poultry farms, food establishments, fast food restaurants).
With the ready-to-eat food popularity growth, Listeria monitoring has transformed into a real challenge, not only due to its pathogenic nature but also due to the product's specification. This aspect intensifies the necessity of pathogen monitoring and hygiene standards during the manufacturing process.
All these goals are achieved through education aimed at raising the level of culture of the entire population, with the appropriation of hygienic and preventive skills applicable in daily practice.

Keywords: legislation; education; health; prevention; monitoring.

1. Introduction

The Food Safety Management System defines and implements corrective actions and provides analysis for new preventive measures to address future food quality or safety problems. To implement a food safety system, an organizational strategy based on customer requirements must be established to generate food safety policies and objectives (Malhotra *et al*., 2007, Leong *et al*., 2016).

Eating and living healthy is one of the essential requirements for a long life. Unfortunately, today's world has been adapted to a system of food consumption that has more adverse health effects than benefits. Lifestyle changes have taken hold of us so much that no one really thinks about whether what they eat is beneficial to the body (Russell *et al*., 2003). Globalization and urbanization have significantly affected eating habits, which is why a food education based on consumer information and awareness is required (Delarue *et al*., 2018).

This global problem of widespread fast-food consumption and its impact on health requires health care and education, which can greatly contribute to limiting consumption and shifting to healthy eating habits for a quality life (Carpentier *et al*., 2011, Ramstad, 2015).

This paper is based on the research and investigation of a case study to identify *Listeria monocytogenes* in a ready-to-eat product. An example of good practice is found in this work. Human nature has limitations in critical thinking ability and for this way, the main objectives of the topic addressed are:

- educate consumers about the importance of knowing food safety rules;
- information about the implementation of a food safety system promotes the collection of quality data because the public has only minimal

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background knowledge of nutrition and nutrition science, the media (including social media and celebrities) get in the way of people's ability to think critically and the education systems do not adequately teach critical thinking.

Listeria bacteria have always been a real danger to the food industry and consumer health (Bouayad *et al*., 2012). With the increasing popularity of ready-to-eat products, controlling and avoiding contamination with *Listeria* bacteria has become a real challenge not only because of their pathogenicity but also because of the specification of these types of products because of *L. monocytogenes* is ubiquitous in the environment and can be easily found in the food manufacturing environment (Christison *et al*., 2008, Gomez *et al*., 2015). Thus, the finished product can be contaminated by various routes such as the co-contamination of factory equipment and machinery, the raw material used, or contact with the biological materials of the operators handling the product (Leong *et al*., 2014). *Listeria* can be present in both "raw" food and heat-treated food (Ajayeoba *et al*., 2015, Chanishvili, 2012).

According to the British Retail Consortium (BRC), products that do not require additional heat treatment after purchase must be monitored microbiologically (Cruz & Fletcher, 2012, Bergis *et al*., 2021). Thus, within this unit, both finished products and all raw materials are tested in a laboratory accredited according to a plan based on microbiological risk assessment. In this way, perishable products are tested more often than the most microbiologically stable ones.

2. Materials and method

Following a routine microbiological test, on 06.05.2020 the factory technical department was alerted by the laboratory to a positive result for *L. monocytogenes* in a sandwich. The product in question is called ham on White bread (salami sandwich on white bread). Ready-to-eat product under investigation of the presence of pathogen *L. monocytogenes*, following a referral, was the 40145-EA Ham on White bread produced on 01.05.2020 on line 3 at 14:20, by a factory specializing in the production of a wide range of sandwiches in London, UK. The raw materials used to make ham on White bread are: white bread, gammon salami and margarine.

To investigate the potential source of contamination, samples were taken both from the direct contact surfaces with the product and indirectly, to carry out operative traceability of the affected product. The purpose of traceability is to identify potential sources of the pathogen, either the raw materials used or the product manufactured before the affected one. The methods of traceability verification consist of the use of procedures and internal working instructions, established by the factory technical quality department, such as (QA002) - the procedure for collecting finished products as microbiological samples, (QA006) - the collection of raw materials to assess the likelihood of contamination. The method for testing the presence or absence of *Listeria* bacteria and their counting is based on ISO 11290-1:2017.

Microbiological samples were collected according to the microbiological monitoring method of factory surfaces and machinery implemented by the factory technical department and subsequently sent to an internationally accredited laboratory.

3. Results and Discussion

The sandwich manufacturing plant in London, UK, has launched a rigorous investigation following a complaint received by the technical department about a positive result at *L. monocytogenes* in 40145-EA Ham on White bread (white bread salami sandwich). on the 06.05.2020.

Following the traceability, the data on the time, date and location of the production of the affected sandwich were identified, as well as the origin and quality of the raw materials used together with data on their shelf life, lot and supplier.

According to the internal QA002 (*QA002) working instructions, the products are collected directly from the line following packing. Before opening the packaging, a disinfection of the packaging and the knife used with a napkin

soaked with alcoholic solution is carried out. Collection is carried out using sterile gloves. The quality of the raw materials used was verified according to QA006 (*QA006).

The collection of salami used in the production of the affected sandwich was carried out using the method of the "turned bag" – dressing the collection bag on the hand and returning it after sampling, figure 1a, and in the case of margarine the method of the "spatula" – the extraction of the raw material using a sterile spatula or cups, figure 1b. Thus, the raw materials collected were numbered, placed in a labeled box and kept in a refrigeration unit until they were sent to the laboratory (ISO 11290-1:2017).

Also, a copy of a sheet containing data such as the name of the product, the date and time of production, the production line and the shelf life of the product is placed in the box. Another copy of this sheet is sent to the Technical Department. The samples are recorded in the laboratory database.

(a)

(b)

Figure 1. QA006 Instructions for collecting raw materials as microbiological samples (*QA006)

Another suspected factor that could have contributed to the pathogen in the finished product is cross-contamination from the production surfaces or parts of machinery used throughout the manufacturing process.

The affected product was manufactured on production line 3, the structure of which is shown in Figure 2, and the specific areas from which the samples were taken are:

1. butter machine (bread input tape, conveyor belt, the bottom of the belt, inside butter box);
2. belt conveyor (belt surface, bottom of belt, leveler);
3. Mellitic cutting machine (belt surface, bottom of belt, leveler, blade, alignment system);
4. Fuji film wrapping machine (tape surface, alignment and push system).

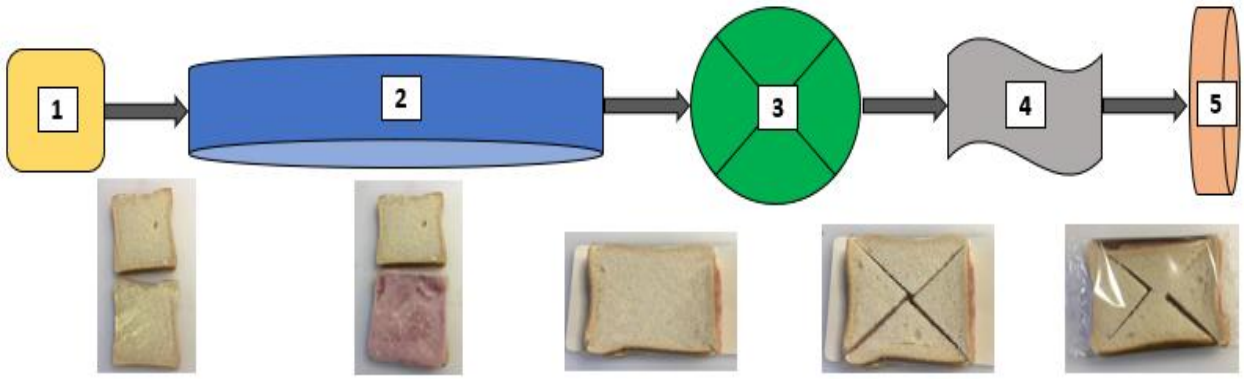

Figure 2. Production line structure 3 (1 – butter machine, 2 – tape conveyor, 3 – Millitec cutting machine, 4 – Fuji film wrapping machine, 5 – metal detector)

The affected sandwich was produced on 01.05.2020 on production line 3. The following

routine microbiological samples were also collected during that production week: 37 finished products, 18 samples from direct contact surfaces, and 23 samples from indirect contact surfaces. All samples showed satisfactory microbiological results. During the investigation process, 3 sandwiches of the same type as the one affected were collected at different production time intervals (start, middle and end). The results obtained from the laboratory have denied the presence of Listeria bacteria in the new products
The raw materials collected to investigate possible cross-contamination from the supplier did not show the presence of *L. monocytogenes*, which was also mentioned in the report by the Department of Internal Quality.
During the investigation, 19 samples were also collected from the production surfaces of both direct and indirect contact. Of the 19 samples, five confirmed the presence of *L. monocytogenes*. All five positive samples were collected from the Millitec cutting machine. These are: conveyor surface and bottom, two rollers and blade system.
At the same time, during the investigation, rapid detection samples were taken from the same surfaces, the samples that were sent to the laboratory. Two of the samples collected obtained a positive result for the presence of bacteria of the genus *Listeria*, namely one of the rollers and the bottom of the conveyor of the Millitec cutting machine.
Following the evaluation of all the laboratory results obtained, it was concluded that the main cause of the presence of pathogen *L. monocytogenes* in Ham on White sandwich intended for use by patients is cross contamination from industrial surfaces, namely the leveler, conveyor and blades of the Millitec cutting machine (figure 3).
Based on the results obtained and the determination of the cause of contamination, corrective action was immediately started to control and avoid further contamination and maintain the food quality and safety standards.
Among the corrective actions applied, the main one is the rigorous auditing of the process of daily cleaning of machinery and industrial surfaces. The audit is carried out in an unannounced manner. At the same time, the process of making swordfish is also audited, focusing on good working practices and hygiene rules imposed by the technical department.

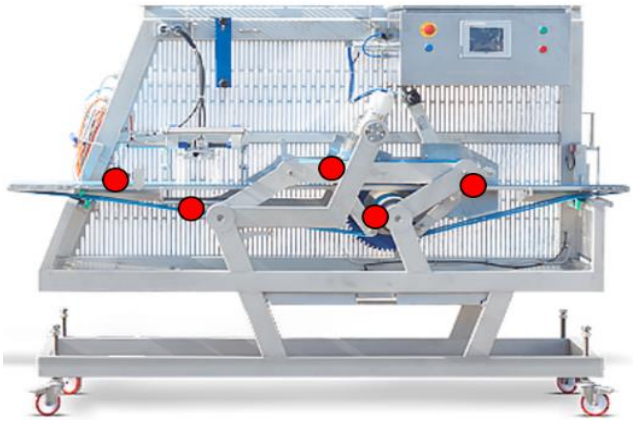

Figure 3. The presence of *L. monocytogenes* on different surfaces of the Millitec cutting machine

Another immediate corrective action is to remove the contaminated machine and thoroughly clean it according to an internal instruction. To this end, one of the factory engineers assists in this process by dismantling all affected areas for better penetration of chemicals and respectfully, better cleaning.
The cleaning of the Millitec cutting machine was supervised by a representative of the technical department. With the completion of the machine cleaning process, microbiological samples were taken from the affected surfaces to be sent to the laboratory and tested, thus validating the success of the removal of *L. monocytogenes* biofilms. The results showed that the surfaces of the previously affected Millitec cutting machine no longer show the presence of *Listeria*-like bacteria, which indicates that the sanitization has been successfully carried out. Further, the technical department monitors the correctness of the application of the sanitization rules during the manufacturing process. Microbiological monitoring shall be continued by taking the finished products, raw materials and samples from the production areas to control the presence of pathogenic bacteria in the industrial space. The routine sampling plan for microbiological samples in the affected areas was also revised so that,

following the risk assessment, they switched from a monthly collection to a weekly one. The same was done with the plan of collecting finished products that are manufactured on production line 3.

The conclusions of the present caz suggest that to maintain the safety standards, there is no need for new methods of obtaining products, but for compliance with the rules of handling that would avoid contamination, prevention and control at all stages (Álvarez-Ordóñez *et al*., 2015).

4. Conclusion

In conclusion, monitoring and control of the spread of pathogenic bacteria of the genus *Listeria* is an indispensable practice in any industrial space.

The case study achieved the following main objectives:

- educate consumers about the importance of knowing food safety rules;
- information about the implementation of a food safety system that involves the collection of quality data, ensuring data entry into the system and then focus on data validation;
- presentation of defined risk factors for products (raw materials, ingredients and packaging) and suppliers;
- knowledge of microbiological specifications that are particularly important because there is a possibility of microbiological contamination.

The presented case study can be considered an alternative to facilitating the access of the general public to a minimum level of knowledge, which cannot be provided by the national education system.

It allows the approach of education in an integrated vision to be considered a tool of the basic principle of educational policies, lifelong learning.

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