

**THE EFFICIENCY OF THE FOOD SAFETY MANAGEMENT PLAN
FOR *LISTERIA MONOCYTOGENES* CONTROL:
A MEAT PROCESSING FACILITY EXAMPLE**
EFICIENȚA PLANULUI DE MANAGEMENT AL SIGURANȚEI ALIMENTELOR
PENTRU CONTROLUL *LISTERIA MONOCYTOGENES*:
UN EXEMPLU DE UNITATE ROMÂNEASCĂ DE PROCESARE A CĂRNII

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ABSTRACT | REZUMAT

The paper aims to highlight the degree of efficiency of the Food Safety Management System (FSMS) in a meat processing facility, focusing on the microbiological hazard represented by *Listeria monocytogenes*, in the current context of the national and global recurrence of the infections caused by these bacteria.

The data for the analysis were gathered through a gap analysis (i.e. a newly developed checklist, based on the national authority guidelines and international specific guidelines), in order to evaluate the degree of compliance with general and specific requirements for an adequate *Listeria* spp. control. As means of verification of efficacy of the already implemented food safety management plan, against *Listeria* spp., a microbiological analysis of finished-products and environmental samples was conducted. For the meat processing facility under investigation, the prevention methods against *Listeria monocytogenes* are considered acceptable, provided that all identified non-complying items be resolved before re-inspection.

Keywords: food safety management system, *Listeria monocytogenes*, meat processing, prevention

Lucrarea urmărește să evidențieze gradul de eficiență al sistemului de management al siguranței alimentelor (FSMS) într-o unitate de prelucrare a cărnii, concentrându-se pe pericolul microbiologic reprezentat de *Listeria monocytogenes*, în contextul actual al recurenței naționale și globale a infecțiilor cauzate de aceste bacterii. Datele cercetate în acest studiu au fost colectate cu ajutorul unui formular de analiză a lipsurilor (ex.: o listă de verificare dezvoltată pe baza ghidurilor autorităților naționale și internaționale specifice) ce a urmărit evaluarea gradului de respectare a cerințelor generale și specifice controlului adecvat al *Listeria* spp. Ca mijloc de verificare a eficacității planului de management al siguranței alimentelor deja implementat împotriva *Listeria* spp, a fost efectuată analiza microbiologică a produselor finite și a probelor de mediu. Pentru unitatea de prelucrare a cărnii care face obiectul anchetei, metodele de prevenire împotriva *L. monocytogenes* sunt considerate acceptabile, cu condiția ca toate elementele de neconformitate identificate să fie soluționate înainte de re-inspecție.

Cuvinte cheie: sistemul de management al siguranței alimentare, *Listeria monocytogenes*, prelucrarea cărnii, prevenție

Listeria monocytogenes is widely spread in fresh meats - the raw materials for ready-to-eat meat based products, being also detected in the finished products on market. It is one of the most significant causes of food-borne infections and under continuous monitoring in the European Union and Romania (9, 10, 11, 15, 17, 20, 21, 26).

The tolerance for acidic pH of this pathogen and its ability to develop under the conditions of a reduced water activity rate, allows for its survival and prolifera-

tion in meat products (12, 19).

The risk is based on the probability of occurrence, which is correlated with the increased production of meat and meat products in Romania and strongly associated with the average associated consumption.

Other ready to eat, raw ingredient-type products, such as raw milk cheeses have also been targeted for the development of specific food safety management plans (9, 10).

Ready-to-eat (RTE) foods have a relatively high stability due to the combination of processes for acidification, decreased level of oxygen and the addition of growth compounds promoters of desirable microorganisms, but the variables that can influence the

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stability of the meat products are numerous. Such examples include the type of meat, the quantity of fat, the starter culture used (where applicable), the conservation mix (the level of nitrates, salt concentration, spices, etc.), the fermentation method, the temperature used for the heat treatment and aging, the diameter, the final pH, water activity and the recommended storage temperature (6, 16, 19).

Extensive literature reports draw the attention of the scientific community and of the industry on the high occurrence of *Listeria* spp. contamination of RTE products (3, 13, 17, 22). The microbiological quality and safety of the raw ingredients is essential (23, 24).

Any variation of these parameters can trigger the multiplication of the pathogen in RTE products, emphasizing the risk by the lack of a subsequent preparation (8, 25).

MATERIALS AND METHODS

For the assessment of the efficiency degree related to the microbiological hazard represented by *L. monocytogenes*, an internal gap analysis was conducted in a meat processing facility which produces RTE meat products. In order to assess the efficiency of the food safety management system which was in place in the meat processing facility, against *L. monocytogenes*, three approaches were followed:

- Verification of the efficiency of implemented food safety management (FSM) plan, in controlling *L. monocytogenes*, by performing food sample analysis and environmental swabbing;
- Development of a checklist based on the ANSVSA guidelines, the European regulatory requirements and on international specific guidelines (1, 2, 4, 5, 7, 14, 18);
- Gap analysis against the newly developed checklist.

Environmental swabbing for *L. monocytogenes* was performed before the daily processing activities, by moistening the cotton swabs with a 0.1% NaCl sterile peptone solution (for humid areas – dry cotton), removing the swab from tube and wiping the selected surface (approximate 100 cm²), applying a firm pressure, from top to bottom and then inserting the swab back into the tube.

For the finished products testing, 20 samples of Smoked pork collar (coppa steak) and 20 samples of Extra Summer salami were collected by following ANSVSA sampling procedure guidelines (2). *L. monocytogenes* isolation and identification (Fig. 1, 2 and 3) were performed according to ISO 11290-1:1996/Amd 1:2004 (14).

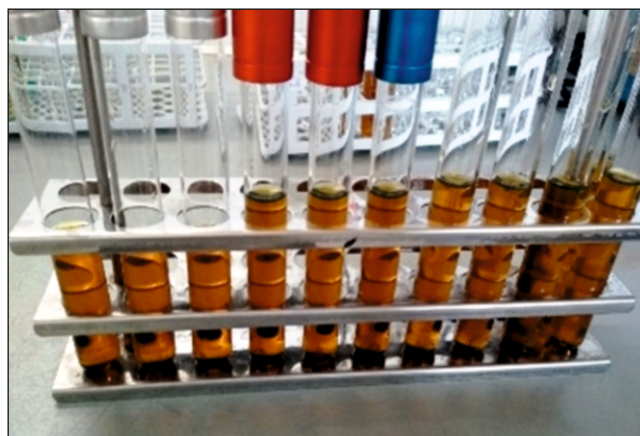


Fig. 1. *L. monocytogenes* isolation
- primary enrichment step

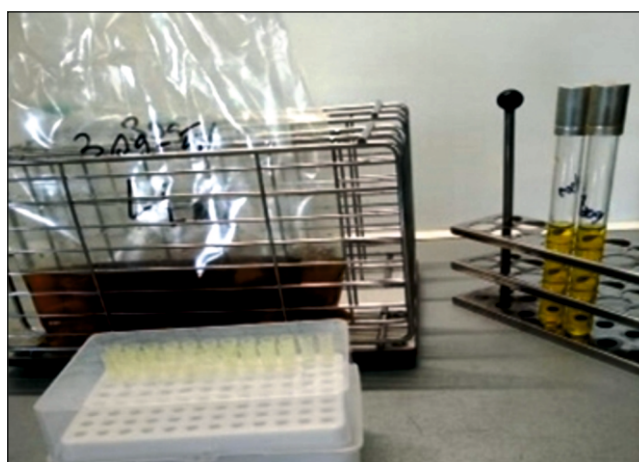


Fig. 2. *L. monocytogenes*
- secondary enrichment step

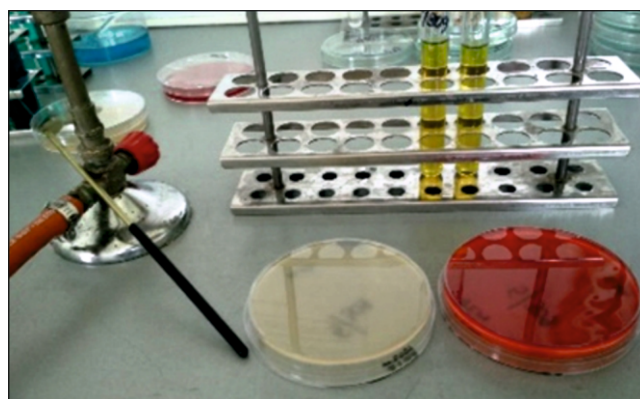


Fig. 3. *L. monocytogenes* identification

RESULTS AND DISCUSSIONS

The meat processing facility was working under a tailored HACCP-based food safety management plan and was thus observing the minimal food law requirements. No food safety international standard was yet certified.

1. Verification of the FSM plan in control of *L. monocytogenes*.

None of the RTE samples of the smoked coppa steak and extra summer salami tested positive for *L. monocytogenes*. Moreover, the environmental swabs were also negative for *L. monocytogenes* (Fig. 4).

However, similar studies, such as the one published by Caggiano et al. (2015), communicate detection of *Listeria spp* in 8% of selected samples, of which *L. monocytogenes* counted for 77.7% and *L. innocua*, 22.2%. The lack of positive environmental swabs indicates the efficiency of the sanitation program (3).



Fig. 4. Sanitation samples - negative result for *L. monocytogenes* after the incubation of ALOA agar

Table 1

Examples of sampling sites within the priority zones

Priority	Sampling sites
Zone 1	Equipment that comes into contact with the cooked product (e.g., slicers, dicers, hoppers), spiral freezers and conveyors for cooked product, tables and benches on which product is stored or portioned.
Zone 2	Floors, walls, ceilings, drain outlets, pools of water (e.g. on the floors of a manufacturing area or cold room), condensate from refrigeration evaporators (cold rooms), chiller doors, switches, floor joints

This notwithstanding, there may be improvements of the efficiency of the sampling process, by achieving a higher grade of sample relevance, specifically for *Listeria spp*. in certain areas of interest, prioritized differently depending on the probability of the development of the microorganism, as presented in Table 1.

The samples taken in such way, must cover at least five such areas of priority, these being examined on a monthly basis. Verification of the efficiency of control measures implemented for a specific pathogen is crucially important, especially when new scientific data becomes available with regard to the new approaches in controls, new insights in the target consumer category and new findings of microbial adaptation or resistance features, against current preservation /sterilization technology (10).

2. Development of a checklist - based on the ANSVSA guidelines, the European regulatory requirements, EFSA's scientific opinion (4), the New Zealand guide (18) and the FDA guide (7). The newly developed checklist includes six sections, a total number of 17 chapters and 150 lines, compared with the ANSVSA guideline for food processing facilities evaluation checklist, which only includes 5 sections and a total of 78 lines (Table 2). Each line includes a clear requirement which is evaluated and scored per positive ranking system, as follows: accepted (2 points), accepted with revision (1 point), unacceptable (0 points) and not applicable (2 points). The scoring of the range checklist is between 0-300, the highest score indicating an efficient food safety management plan with emphasis on the control of *L. monocytogenes*. An outline of the newly developed check list which emphasizes the control of *L. monocytogenes* is presented in Table 2, in comparison with the guideline check list provided by ANSVSA for the food processing establishments. The proposed scoring system cumulates a total possible number of 300 points. Points are awarded for each descriptive grade which assesses each requirement (line), using the following criteria:

- Accepted - 2 points;
- Accepted with re-inspection - 1 point (needs minor revision);
- Not accepted - 0 points (needs major revision);
- Not applicable - 2 points.

The food safety management plan is to be considered *efficient* for the control of *L. monocytogenes* for a score > 270, *acceptable with follow-up re-inspection*, for a score of 200-270, and *inefficient* for a score <200.

3. Gap analysis against the newly developed checklist. As a result of the systematic assessment based on the audit checklist items it was noted that:

- the unit has registered / authorized means of transport for use in foodstuffs of animal origin, in

Table 2

Outline of the newly developed check list for the control of *Listeria monocytogenes*, compared with the ANSVSA guideline check list used for evaluation of food processing facilities

No.	Section name		No. of chapters		Lines / requirements		Scoring	
	NCL ¹	LCL ²	NCL	LCL	NCL	LCL	NCL	LCL
I	Sanitation requirements for food products premises		9	12	56	100	Four descriptive grades for each line; no total scoring system with points	Each descriptive grade is awarded a score, from 0-2: lowest score is 0, best score is 2. Total possible final score per check list is 300 points.
II	-	Specific sanitation prerequisites for <i>Listeria monocytogenes</i> control	0	1	0	25		
III	Specific sanitation requirements		1	1	5	8		
IV	Requirements concerning HACCP principles implementation		1	1	12	12		
V	Requirements for traceability		1	1	3	3		
VI	Requirements for objects and materials with food contact		1	1	2	2		
1 - National check list (ANSVSA); 2 - <i>Listeria</i> check list (newly developed check list)								

accordance with the Regulation 852/2004;

- the structure, design, construction, location and dimensions of the premises are carried out properly, with the separation of the areas in which the foods of type Ready-to-Eat are processed, displayed or stored, from the areas in which the equipment is washed;

- maintenance areas, storage of waste, offices, changing rooms, service areas, with an obvious delimitation of the clean and dirty area;

- the hygiene and the degree of maintenance of the premises are properly executed, being constructed of material which allows maintenance, cleaning and disinfection and designed in such a way as to avoid or minimize the contamination of the air and ensure a sufficient and appropriate work space;

- sanitizers are appropriately used, stored according to regulatory requirements, under restricted control;

- adequate handling and storage conditions are observed, with the possibility of adjusting the temperature and sufficient capacity for food storage in appropriate conditions;

- adequate monitoring, and record keeping procedures are followed;

- the location of the lavatories and wash basins is appropriate, in sufficient number and connected to an effective drainage system and water supply;

- ventilation is performed by appropriate and sufficient means, both natural and mechanical, avoiding the air circulation from clean to dirty areas;

- lighting is ensured in natural and artificial ways,

and the lighting fixtures are appropriate from the point of view of the design and functionality;

- sanitation products and disinfectants are stored in other areas than those in which the foodstuffs are handled;

- regarding equipment requirements, the contact surfaces with foodstuffs are non-absorbent, sealed, and inclined in certain situations (in order to ensure the free leakage);

- equipment is installed above the floor in order to prevent the contamination of foodstuffs, at the same time a preventive maintenance program being available that is designed to minimize the damage and to avoid contamination that may occur during repairs;

- the air filters changing and their examination are performed with adequate frequency, according to the recommendations of the manufacturer;

- animal wastes, inedible by-products and other wastes are eliminated with rapidity from the rooms in which the foodstuffs are being stored, in containers that can be closed, constructed in an appropriate manner, in good condition and easy to clean and disinfect;

- waste disposal is carried out in a hygienic and environmentally safe manner, in accordance with the European Community legislation;

- the sources of water supply and the sewerage system are appropriate, the facility is using clean water for washing the exterior, with appropriate plumbing of non-potable water supply, that is circulating in a separate system and properly identified, which is not con-

nected and cannot be poured in the drinkable water;

- the water that is used in processing or as an ingredient, is in agreement with the requirements for potable water;

- regarding staff inspection and hygiene, every person working in the food handling area complies with a high level of personal hygiene, wears clean and appropriate clothing and protective equipment;

- employees suffering from disease or that are carriers of a transmissible disease through food, are forbidden to enter in the area in which the foodstuffs are being handled, regardless of the situation;

- the employees handling food products are supervised and instructed, trained in the field of food hygiene;

- employees responsible for compiling and updating the procedure based on the principles of HACCP and the implementation of the applicable guides, benefited from a suitable training according to the requirements of the European Community legislation.

However, various deficiencies were noticed:

- regarding the establishment, there is no separation of the locker rooms, break areas and cafeteria for the staff that is handling RTE products and those who are handling the non-RTE products, which share the same service areas;

- the establishment does not have a dosage device and automatic distribution of disinfectant foam on the floor in the access areas in the perimeter of the processing space, - foot-baths which involve the use of a low height container and a non-stick coating are present, but not filled with liquid disinfectants, and are located in such a way that they may be easily avoided by passing around it;

- employers are seen avoiding the water-bath;

- uniforms and equipment used in the processing area and exposure cannot be differentiated by means of color coding, being the same in all departments of processing;

- the efficiency of the sanitizers is not considered for *Listeria spp* and there is no available program or procedures for minimum inhibitory concentration (MIC) or minimum bactericidal concentration (MBC) to choose the best solution for the given production facility;

- no rotation of disinfection agents is included in the sanitation program;

- personnel does not have the procedures available by the working station, but those are only made available on request;

- there are no separate washing and disinfection procedures for the refrigeration areas and there is no indication of interrupting the continuous functioning of refrigeration areas for adequate sanitation necessary for an adequate control of *Listeria spp*.

- there is no separate draining sanitation program, the drains being included in the regular facility sanitation program. However, high pressure cleaning and disinfecting of the drains is not included.

Regarding the provisions applicable to foodstuffs, the food business operator does not accept raw materials, ingredients or any other material used in the processing of products that is known, or there is reason to believe that they are contaminated, but does not have a specific control which requires compliance with the criteria for *L. monocytogenes*. However, for some products, subsequent measures with listericidal character are being implemented, by treating raw materials and other ingredients, during the manufacturing process. Nevertheless, there still is a large category of products for which no listericidal treatment is included in the processing technology, which is in fact another item of non-compliance according to the new check list.

The suppliers monitoring is carried out and there is a procedure of selection and approval, as well as an operational program of supplier audits in order to ensure that they have implemented procedures and programs of food safety. Although these methods of prevention exist, there are no lists of raw materials and other ingredients to which the contamination with *L. monocytogenes* is likely to occur. Similarly, there are no written procedures of sampling and testing of the samples for *L. monocytogenes*, for raw materials and other ingredients at risk.

Raw materials and ingredients are kept in good conditions, so that degradation and contamination is prevented.

The intrinsic characteristics of the products, which prevent growth of *L. monocytogenes* are based on the reduction of humidity, half-smoked products having a moisture content less than 45% and a shelf-life of 12-14 days, the semi-dry smoked products - 30 days and cured meats like cremwursts and bologna, have a moisture content of more than 65% and a shelf-life of 48-72 hours with the use of certain substances that are microbial inhibitors. However, pH and a_w are currently considered choice parameters for controlling *Listeria spp*. growth in foods (pH should be less than 4.4, a_w should be less than 0.92, or if combined, pH must be

kept below 5.0 and a_w below 0.94) (13).

The operator complies with the microbiological criteria that are applicable to foodstuffs by analysis of the food product type and documentation of a sampling plan that includes the number of samples, the number of non-compliant samples that would determine the failure of the microbiological analysis, the limits and qualitative testing. Regarding the general sanitation program, it was developed for minimizing the potential for contamination of RTE products, and is efficiently implemented by appropriate procedures.

Concerning the packing of RTE products, the materials that are used for this purpose are not a source of contamination, being stored properly.

The requirements concerning the hazard analysis and critical control points are observed, developed at the level of the unit, implemented and used in multiple procedures based on HACCP principles.

In total, 13 items of non-compliance with specific requirements listed in the newly developed check list were found, which amounted to a penalty of 26 points. However, some of the requirements were not considered totally acceptable, minor revision being needed for 17 items of sections I, II, III and IV, leading to an additional 17 points penalty. The total score was 257, falling into the *acceptable with follow-up re-inspection* category.

Even though the microbiological load in finished products fits the requirements provided by (EC) Reg. 2073/2005 and all environmental swabs turned out negative, we were still able to identify risk areas in terms of operational and sanitation procedures, by using a specific checklist, improved with targeted requirements for the control of *L. monocytogenes*.

CONCLUSIONS

Regarding the compliance with the items presented in the audit checklist, the unit shows a good overall degree of conformity from the point of view of the following aspects: compliance with the general and special sanitary requirements, conformity of the general sanitation program, meeting the sanitary requirements applicable to the premises used for the production of foodstuffs, for meat processing premises, the requirements for equipment, the requirements concerning the waste supply, water supply and sewerage system, staff control and personal hygiene, vocational training, the provisions applicable to the raw materials

and ingredients, those concerning packaging and wrapping of food products, the heat treatment, requirements concerning the hazard analysis and critical control points, those focusing on carrying out activities relevant to processing control, those concerning the traceability of the products and the requirements relating to materials and articles intended to come into contact with foodstuffs.

At the same time, chlorine-based sanitizers and quaternary ammonia based sanitizers should be used for all equipment that comes into direct contact with RTE products.

A listericidal control should be considered either as a formula, through application of pasteurization, or, in case of processing technology restrictions, through the evaluation and continuous control of the intrinsic chemical and physical characteristics of these products.

Finally, a revision of the food safety management plan is strongly recommended, as the identification of critical control points for *L. monocytogenes* would guarantee an efficient control of this pathogen and could integrate the additional control measures into a sustainable, adequately tailored, implemented plan.

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