

Listeriosis

Evaluation of listeriosis risk related with the consumption of non-prepackaged ready-to-eat cooked meat products handled at retail stores in Greece

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ARISTOTLE
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I. Project Identity and Objectives

This project was supported by a grant (Grant number: GP/EFSA/AFSCO/2016/04) awarded by EFSA to the “Hellenic Food Authority (EFET)”, acting as coordinator, and to the “Aristotle University of Thessaloniki (AUTH)”, acting as co-beneficiary.

At a glance

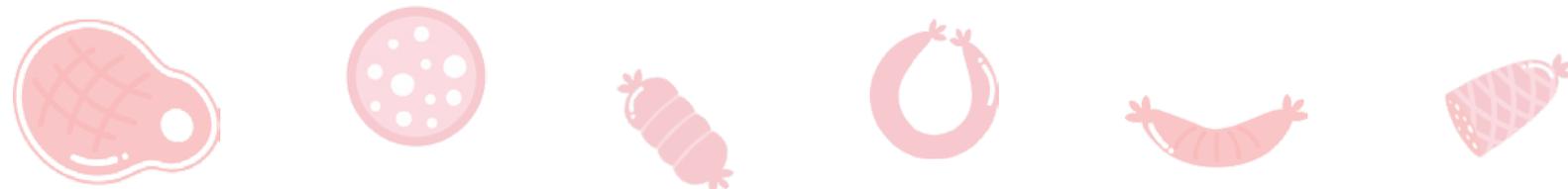
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The aim of this project was to assess the exposure of consumers to *Listeria monocytogenes*, related to the consumption of non-prepackaged ready-to-eat (RTE) cooked meat products handled at retail food service environments in Greece. These products are referred to as NP-RTE-CMP below.

The project focused on developing an exposure assessment model for the assessment of consumers’ exposure to this pathogen, based on the prevalence and the concentration of *L. monocytogenes* at retail level, *Listeria* growth during home storage and consumption of NP-RTE-CMP. This model could serve as a useful tool to evaluate strategies at both retail and domestic level (i.e. better hygiene conditions at retail level, regulation of a use-by date for NP-RTE-CMP and improvement of domestic storage temperature) for the reduction of the risk of listeriosis.



What is *Listeria monocytogenes* and which foods can support its growth?

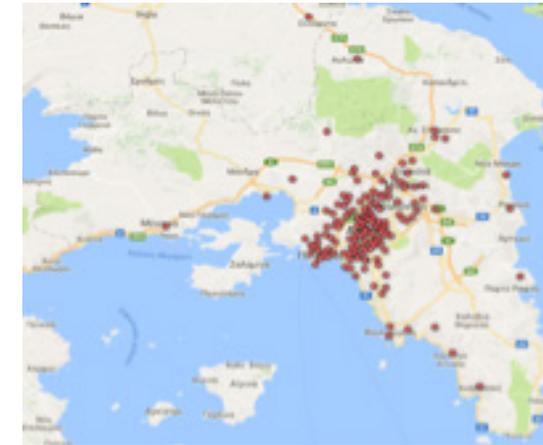
L. monocytogenes is a bacterial pathogen which can grow at refrigerator temperatures and can cause infection known as listeriosis. Although relatively rare, listeriosis can be very serious for high risk persons. Foods that can be contaminated with this pathogen and support its growth include RTE refrigerated foods such as smoked or cooked sliced meat products and smoked fish, unpasteurized (raw) milk and foods made with milk such as certain soft cheeses, and RTE pre-cut salads.

Who is a high risk person for listeriosis?

- Pregnant women and their unborn babies
- Infants, toddlers and young children below the age of 5
- Elderly persons
- People with weakened immune system such as those with cancer, diabetes, kidney disease and transplant patients

2. Methodology

2.1 Survey on *L. monocytogenes* in non-prepackaged RTE cooked meat products



A total of 886 retail points in the region of Attica, Greece, where NP-RTE-CMP are available to consumers, were identified. In each of the, in total, 351 retail points, randomly selected, two samples were collected. The following sequence was applied: a) the first sample consisted of approximately 100 g of any NP-RTE-CMP (typically parizer) sliced on the spot at the time of sampling (5-6 slices), b) the second sample was taken using a cotton swab of the entire exposed area of the cutting disk used for slicing. Samples were sealed in sterile plastic bags and transported under refrigeration to the laboratory for analysis. The cotton swab was used to determine the presence of *L. monocytogenes* on the cutting surface (ISO 16140-2). If this sample was found positive for *L. monocytogenes*, then quantitative determination was performed on the sliced product sample (ISO 11290-2:2017).

2.2 Survey on RTE meat product characteristics affecting *L. monocytogenes* growth

In total 87 NP-RTE-CMP sliced at retail points were analyzed for pH, water activity, nitrites (NaNO_2) concentration and concentration of lactic acid bacteria (LAB). The selection of products was based on consumer's preference according to sales data of known chain stores in descending order of preference. The 87 products tested represent at least 80% of the total sales in Greece.

2.3 Validation of mathematical predictive models for the growth of *L. monocytogenes*

The Food Safety and Spoilage Predictor (FSSP, <http://fssp.food.dtu.dk/>) model was validated against observed growth of *L. monocytogenes* in NP-RTE-CMP sliced in the Greek retail market. Three products (A: boiled turkey, B: boiled ham, C: smoked turkey) from different producers were selected for validation representing a high, medium and low NaNO₂ concentration. The validation experiment was conducted at three static (4, 7 and 12°C) and two dynamic temperatures simulating temperature conditions during domestic storage.



2. Methodology

2.4 Consumer survey on food handling practices and consumption of non-prepackaged RTE meat products

A nationally representative sample of 800 Greek households purchasing NP-RTE-CMP participated in the consumer survey via telephone interview. The respondent was the main person responsible for either buying or handling RTE meat products (e.g. preparing a sandwich or placing these products in the refrigerator). Information was collected on the demographic characteristics of the other members of the household (e.g. total number of persons living in their household, number of “high-risk” persons). The questionnaire was validated before its start in February and March 2018. The 800 participating households, including 2419 persons, were representative of all households in Greece in terms of geographical and urban-rural distribution of households. Of these, 474 persons were considered at “high-risk” for listeriosis with the majority (402 out of 474) being elderly. Most respondents were females and between 35-65 years of age.



2. Methodology



2.5 Survey of consumer refrigerators temperature conditions

The temperature of 90 domestic refrigerators in North Greece was recorded. Data loggers were used which were programmed to record the temperature every 15 min for 24 h and were located at the middle shelf of the refrigerators. Temperature data were combined with those from a previous survey (100 domestic refrigerators) in Greece.

2.6 Risk Assessment

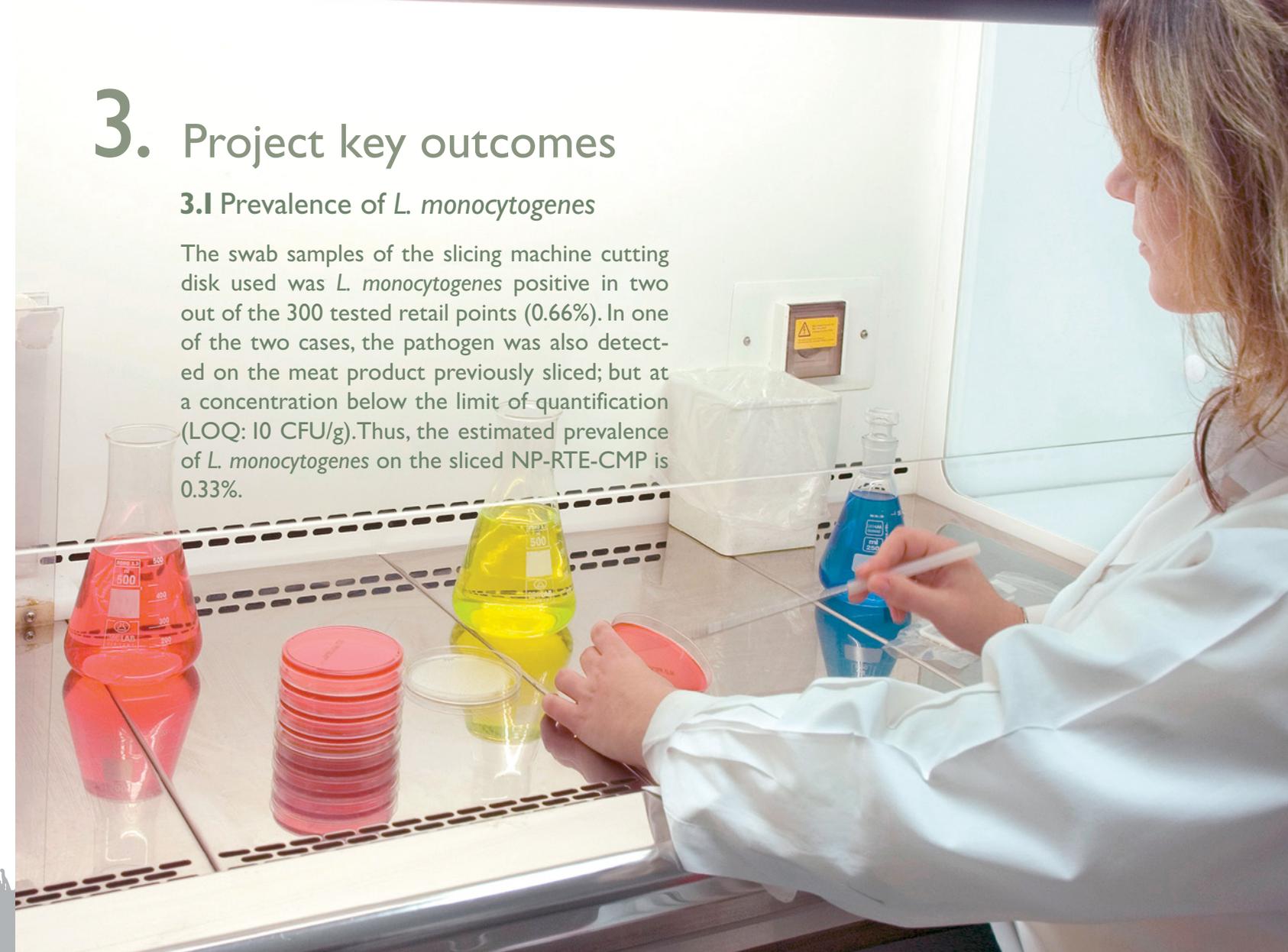
The data collected and the validated model were used to develop a quantitative microbial risk assessment (QMRA) model predicting the risk of listeriosis related to the consumption of NP-RTE-CMP handled at retail stores in Greece. The model was used to predict the risk per serving for each of the 87 tested products and the annual listeriosis cases for each product category (i.e. Mortadella, Parizer, Boiled turkey, Smoked turkey, Boiled Ham, Smoked Ham, Smoked steak, Boiled Chicken and Smoked Chicken) for consumers <65 and >65 years old. The model was also used to assess two scenarios as potential interventions to reduce the risk of listeriosis. The first scenario refers to setting a use-by date in NP-RTE-CMP. The second one to reduce the temperature of domestic refrigerators. For both scenarios the input variables related to the respective intervention was changed and the model rerun.



3. Project key outcomes

3.1 Prevalence of *L. monocytogenes*

The swab samples of the slicing machine cutting disk used was *L. monocytogenes* positive in two out of the 300 tested retail points (0.66%). In one of the two cases, the pathogen was also detected on the meat product previously sliced; but at a concentration below the limit of quantification (LOQ: 10 CFU/g). Thus, the estimated prevalence of *L. monocytogenes* on the sliced NP-RTE-CMP is 0.33%.



3.2 Product Characteristics

The summary statistics for pH, a_w , LAB and NaNO_2 of 87 NP-RTE-CMP available on the Greek market.

	pH	a_w	LAB (log CFU/g)	NaNO_2 (ppm)
Mean	6.34	0.979	4.74	26.60
Standard error	0.016	0.000259	0.059	1.84
Median	6.35	0.98	4.7	17.04
Mode	6.35	0.982	4.6	1.4
St. Deviation	0.2908	0.0046	1.05	32.76
Range	1.55	0.028	4.25	207.4
Minimum	5.63	0.965	2.55	0.16
Maximum	7.18	0.993	6.8	207.6

3.3 Mathematical predictive models for the growth of *L. monocytogenes*

The validation experiments showed a very good performance of the FSSP model in predicting the growth of *L. monocytogenes* in NP-RTE-CMP stored at static temperature conditions.

3.4 Consumer survey

The survey indicated that the three most common NP-RTE-CMP that Greek households purchase are smoked turkey, boiled turkey and parizer. The mean frequency of its usual purchase is close to 3 times per month, whereas that of maximum purchase is close to 4 times per month.

The majority of consumers reported one slice of NP-RTE-CMP as the usual and 1-2 slices as the maximum consumption per eating occasion (e.g. lunch, snack etc.) for a specific product category or a combination of them.

The usual time between their purchase and placement in the refrigerator is less than half an hour for most of the households (82 %). The usual number of days to keep the meat slices in the fridge is between 4-7 days. Nevertheless, a small number of households (~6%) keep these products as a maximum for more than 10 days. The frequency of discarding slices and the quantity discarded are minimal.

The households reported to have experienced food poisoning in the past (less than 10%), attributed it mainly (81% of households) to food prepared out of home. Only 17 households associated food poisoning with RTE meat product consumption.

Half of the participants have heard of *Listeria*. Among those who are aware of *L. monocytogenes*, a rather small percentage could identify correctly, either spontaneously or prompted, foods that could support the growth of this pathogen and increase the risk of listeriosis.





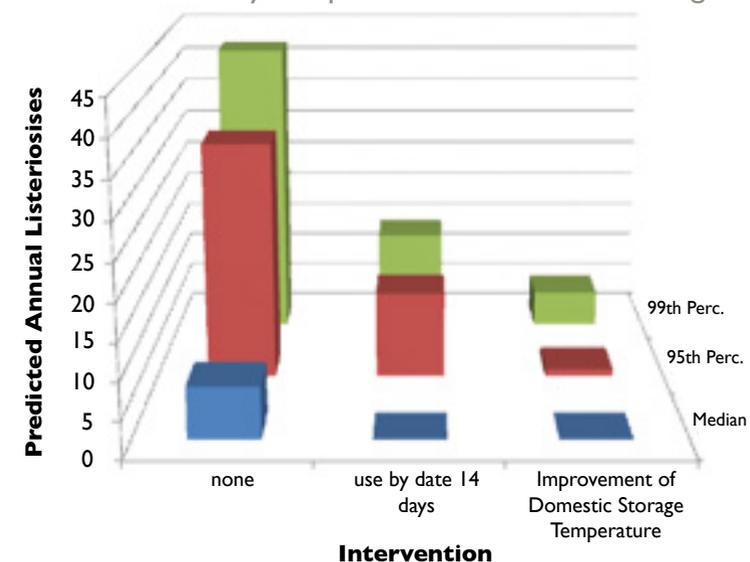
3.5 Domestic refrigerators temperature

The statistics of the mean temperature of 190 domestic refrigerators in Greece are presented in the following table.

Mean temperature of 24 h profiles	
Average	5.97
Standard error	0.20
Median	6.00
Standard Deviation	2.73
Sample Variance	7.46
Range	15.49
Minimum	-2.40
Maximum	13.09
Count	190

3.6 Risk Assessment

The QMRA model estimated the probability of illness per serving for consumers <65 and >65 years old for the 87 NP-RTE-CMP tested. In general, the probability of illness per serving was highly related to the NaNO₂ concentration; products having a low concentration showed a higher risk per serving. A sensitivity analysis showed that the initial prevalence and concentration of the pathogen immediately after slicing as well as the temperature and duration of storage in the domestic refrigerator had the highest impact on the probability of illness per serving among all parameters affecting risk. The model predicted a median number of seven cases of listeriosis per year for the total population upon consumption of NP-RTE-CMP handled at retail food service environments in Greece. The predicted 95th percentiles of the listeriosis cases totaled 33 of which 13 cases were <65 years old and 20 cases >65 years old. The higher number of cases was predicted for mortadella, smoked turkey, boiled turkey and parizer, which were the categories with the higher consumption rates.



The scenarios of setting a use-by-date of 14 days from the time of slicing and improving the storage temperature resulted in a significant decrease of the number of listeriosis cases (Figure 1) indicating that most cases are related to longer storage of the products and/or higher temperature in domestic refrigerators.

Figure 1. Impact of potential interventions on the predicted number of annual listeriosis cases upon consumption of NP-RTE-CMP handled at retail food service environments in Greece





4. Key Recommendations for Consumers

- Check the temperature of your household refrigerator regularly. If it does not have an in-built thermometer, place one inside the fridge. Set the temperature of your refrigerator at $<5^{\circ}$ C.
- Clean the inside walls and shelves of your refrigerator as frequently as possible.
- *Listeria monocytogenes* can grow at low (refrigerator) temperatures. This means that the longer you keep these products, the greater the probability of its growth to numbers that may cause infection known as listeriosis. Keep foods that can support its growth no more than 2 weeks after purchase at temperatures below 5° C.
- Wash your hands thoroughly and regularly with soap, especially before and after handling RTE (meat) products. Your hands can be a vehicle for spreading pathogens in your kitchen. By washing your hands before the handling of meat products you minimize the risk for contaminating these products with pathogens.
- Wash utensils, cutting boards and any surfaces that food touches after each use.
- Minimise the time that RTE meat products spent at room temperature. Use insulated grocery bags in hot weather conditions and when the time spent between purchase of these products and their placement in the refrigerator is expected to be longer than usual.
- For non-prepackaged RTE meat slices: if you remove RTE meat slices from supermarket wraps, pay attention to place them in a clean, well-sealed container. Try to avoid placing them in containers with other products that can carry or support the growth of *L. monocytogenes* such as soft cheese.
- For prepackaged RTE meat slices: Use foods within their use-by-date.



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