EVALUATION OF SLICED READY TO EAT HAMS FROM PORTUGAL FOR VARIOUS TYPES OF MICROBIAL CONTAMINATION

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Keywords
Food safety, Ready to eat sliced hams, Microbial contamination, *Listeria monocytogenes*.

Background
Food safety strategies worldwide recognise the need to address hazards that arise throughout the food chain continuum, from farm to table. The proposals of The White Paper on Food Safety of the EU Commission are based on the principle that the food business operators have the primary responsibility for food safety (Daelman, 2000). It is therefore important to identify the safety and wholesomeness of ready to eat meat products not only during and after processing but also in storage, transportation and retail sale stages of the food production chain (often referred as the "in- distribution" stage).
Cooked hams following heat treatment are handled extensively prior to slicing and final packaging both at the meat companies or at the deli counters of supermarkets. During this time, the products could be contaminated with pathogenic and spoilage microorganisms.
Listeria monocytogenes is one of the pathogens that have become a concern to the meat industry wordwide. Epidemiological investigations of both sporadic illness and outbreaks of listeriosis include foods from deli counters, such as ready to eat meats (Farber and Peterkin,1999, Tompkin et. al., 1999).

Objectives
The aim of the study reported here was to evaluate the microbial contamination of sliced cooked hams, produced by the major Portuguese Meat Companies and available at the major Portuguese Supermarkets. Levels of contamination were compared between samples sliced by meat companies or supermarkets, between two regions of Portugal and between two seasons - Summer and Winter.

Material and Methods
We analysed 246 samples of ready to eat sliced cooked hams - for Total Plate Counts, Total Coliforms and *Escherichia coli*, *Staphylococcus aureus* and *Staphylococcus aureus* enterotoxin, *Listeria* spp., and *Listeria monocytogenes*.

Samples were studied in two separated groups: those that were sliced and packaged by the meat companies and those same brands prepared and sliced at the supermarkets deli counters. We studied 14 ham brands, which represent the products of the major Portuguese meat companies. Some of the hams were sold as supermarket brands. The samples were bought at 7 major supermarkets, in two different regions of the country - Centre (Lisbon area) and South (the Algarve). As much as possible the ham brands and the supermarkets were the same in both regions. The study was carried out during 4 weeks at the Summer and the Winter time.
All samples (weighing each between 100 to 250 g) were immediately stored in ice-cooled insulated containers. They were then transported to the laboratory and analysed within 1h and 3 h, respectively, for samples bought in Lisbon or the Algarve.

For each sample a 25 g portion was weighed, placed in a stomacher bag and diluted with 225 ml of peptone water (0.1%). Samples were mechanically shaken for 2 min in a stomacher (Lab Blender 400, Seward Med, England) and 10 fold dilutions were prepared with sterile peptone water (0.1%).

Total Plate Counts were obtained on Plate Count Agar (BioMérieux 51072), incubated at 30ºC for 48 hours. The number of Total Coliform organisms and *E. coli* was counted using a Chromocult Coliform Agar (Merck 1.10426), incubated at 37ºC for 48 hours. *Staphylococcus aureus* were enumerated using Baird Parker agar with Rabbit Plasma Fibrinogen (BioMérieux 44003), incubated at 37ºC for 48 hours. All the plates were run in duplicate. The original count in the samples was expressed as log CFU/g for calculation of means and standard deviations. *Listeria, L. monocytogenes* and *S. aureus* enterotoxin were detected using Enzyme Linked Fluorescent Assay in an automatic system (miniVIDAS – BioMérieux 99090), using the test sets and the preparation of the samples recommended by the manufacturer.

Results and Discussion
Results obtained for Total Plate Counts, Total Coliforms, *Escherichia coli* and *Staphylococcus aureus* were in agreement with the standards expected for such products (Tables1-3). The results obtained suggest that total counts did not particularly differ between the samples sliced by the meat companies or by the supermarkets, but counts of Total coliforms, *E. coli* and *S. aureus* were always slightly higher in samples sliced by the supermarkets. The results obtained did not particularly differ between the samples from Lisbon area and the Algarve (Table 2) or between the Summer and Winter trial. *Staphylococcus aureus* enterotoxin was not detected in any of the samples analysed during the study.
The presence of *Listeria* spp was similar among samples sliced by the supermarkets or industry (Table 4). *Listeria monocytogenes* was found during the Summer period only in one sample sliced at the supermarkets. For the samples sliced by the meat companies we found that 27% of cooked ham samples were contaminated with the pathogen. Of the former positive samples, respectively 60% were products from one meat company clearly indicating a serious problem of contamination at this company. During the Winter period of the study the presence of *L. monocytogens* was higher in samples sliced by the supermarkets (Table 4) which might be related with the lower consumption of this product during the season and therefore with longer display times at Deli counters. The reduction in the presence of *L. monocytogens* in samples sliced by the meat companies was mainly due to a reduction in the presence of the pathogen in the brand of the meat company mentioned above.

Conclusions
The data of our investigation aimed at evaluating the microbial contamination of sliced cooked hams found no mayor differences in total bacteria. Coliform. *E. coli* or *S. aureus* counts but suggest that both supermarkets and industry can contribute to post cooking contamination with *Listeria monocytogenes*. We found *Listeria monocytogenes* in samples sliced by all the major supermarkets and by all the major meat companies.
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Table 1: Microbial (log cfu/g) populations of sliced ready to eat hams prepared by supermarkets or the meat companies, during the Summer and Winter Season.

Microorganisms	Supermarket		Industry		Anova Test	
	n	Mean (sd)	n	Mean (sd)	F-value	p-level
Total counts	126	5.1 (1.1)	120	4.8 (2.2)	0.78	0.38
Total Coliforms	126	2.9 (0.9)	120	2.1 (1.4)	32.36	0.0001
Escherichia coli	126	1.1 (0.3)	120	1.0 (0.1)	7.05	0.008
Staphylococcus aureus	126	1.0 (0.2)	120	1.0 (0.0)	5.27	0.03

Table 2: Microbial (log cfu/g) populations ready to eat hams sliced by the supermarkets or the meat companies and sold in two differente regions of Portugal during the Summer and Winter Season.

Microorganisms	Algarve		Lisbon		Anova Test	
	n	Mean (sd)	n	Mean (sd)	F-value	p-level
Total counts	94	4.6 (1.5)	152	5.1 (1.8)	7.29	0.007
Total Coliforms	94	2.4 (1.2)	152	2.5 (1.2)	1.25	0.26
Escherichia coli	94	1.0 (0.2)	152	1.1 (0.3)	1.59	0.21
Staphylococcus aureus	94	1.0 (0.2)	152	1.0 (0.1)	3.13	0.08

Table 3: Microbial (log cfu/g) populations ready to eat hams sliced by the supermarkets or the meat companies and sold in two differente regions of Portugal during the Summer and Winter Season.

Microorganisms	Summer		Winter		Student´s Test	
	n	Mean (sd)	n	Mean (sd)	T-test	p-level
Total counts	118	5.0 (1.7)	128	4.9 (1.7)	0.92	0.36
Total Coliforms	118	2.6 (1.3)	128	2.4 (1.2)	1.08	0.28
Escherichia coli	118	1.0 (0.2)	128	1.1 (0.3)	- 1.37	0.17
Staphylococcus aureus	118	1.0 (0.2)	128	1.0 (0.1)	1.90	0.06

Table 4: *Listeria monocytogenes* in ready to eat hams sliced by Supermarkets and Industry, in two differente regions and during the Summer and Winter Season.

		Supermarket		Industry	
LISTERIA SPP		27 positive out of 112 (24%)		28 positive out of 110 (25%)	
LISTERIA MONOCYTOGENES		Algarve	Lisbon	Algarve	Lisbon
	SUMMER	(0 positive out of 26) 0% positive	(1 positive out of 37) 3% positive	(3 positive out of 20) 15% positive	(12 positive out of 35) 34% positive
	WINTER	(4 positive out of 26) 15% positive	(10 positive out of 37) 27% positive	(1 positive out of 22) 5% positive	(3 positive out of 43) 7% positive
	TOTAL OF STUDY	**12% (15 positive out of 126)**		**16% (19 positive out of 120)**	