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Survey of the Microbiological Safety of Refrigerated Ready-to-eat (RTE) Spreads and Dips (18NS5)

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Survey of the Microbiological Safety of Refrigerated Ready-to-eat (RTE) Spreads and Dips (18NS5)

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Glossary

CDC	Centres for Disease Control and Prevention (United States)
CFU	Colony forming units
DAFM	Department of Agriculture, Food and the Marine
ECDC	European Centres for Disease Prevention and Control
EFSA	European Food Safety Authority
EHO(s)	Environmental Health Officer(s)
EN/ISO	European Standard International Organisation for Standardisation
EU	European Union
FSAI	Food Safety Authority of Ireland
HPSC	Health Protection Surveillance Centre
HSE	Health Service Executive
n	Number of sample units
RASFF	Rapid Alert System for Food and Feed
RTE	Ready-To-Eat

Summary

In recent years a number of ready-to-eat (RTE) spreads and dip have been linked to foodborne illness worldwide. The aim of this survey was to investigate the prevalence of *Listeria monocytogenes*, *Salmonella* spp., *Campylobacter*, *Enterobacteriaceae*, and *Escherichia coli* (an indicator of faecal contamination) in commonly consumed, refrigerated, RTE spreads and dips.

A total of 1,063 samples of RTE refrigerated, vegetable, meat and fish-based spreads and dips were collected over a 4-month period in 2018 by Environmental Health Officers (EHOs) in the Environmental Health Service of the HSE. Samples were taken from distributors and transporters, manufacturers and packers, primary producers, retailers and the services sector in the Republic of Ireland. The microbiological analyses were performed by seven accredited official food microbiology laboratories operating under the Food Safety Laboratory Service of the HSE[1] .

The results revealed that 4 samples (1 batch (3.3%), 3 single (1.4%) were unsatisfactory due to the presence of *L. monocytogenes* detection, 1 (0.1%) sample was unsatisfactory for *Salmonella* detection, while 5 (0.9%) samples had unsatisfactory levels of *E. coli* and 10 (3.4%) samples had unsatisfactory levels of *Enterobacteriaceae*. These findings indicate that while small numbers of refrigerated RTE spreads and dips are contaminated with microbial pathogens, overall these products are of high microbiological quality and suggests good hygienic practices are carried out along the Irish food chain.

RTE spreads and dips are popular with consumers due to their healthy image, they are eaten without further cooking and as discussed in this report, can be capable of supporting the growth of *L. monocytogenes*. The growth of *L. monocytogenes* is of particular concern given the long shelf-life on some of these products in conjunction with the poor knowledge among some Irish consumers on their correct storage and use. This report includes examples of international outbreaks associated with the consumption of RTE spreads and dips and highlights the importance of ensuring that these products are produced to a high standard of hygiene and that the cold chain is maintained.

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[1] (i) Public Health Laboratory, Limerick; (ii) Public Health Laboratory, Sligo University Hospital, Sligo; (iii) Public Health Laboratory, Waterford Regional Hospital, Waterford; (iv) Public Analyst's Laboratory, Sir Patrick Dun's Hospital, Dublin; (v) Public Health Microbiology Laboratory, St Finbarr's Hospital, Cork; (vi) Public Health Microbiology Laboratory, Cherry Orchard Hospital, Dublin; and (vii) Public Health Microbiology Laboratory, University Hospital Galway.

Introduction

Refrigerated/fresh spreads and dips such as hummus, guacamole, meat and fish pâtés are popular ready-to-eat food items. New products enter the market regularly to facilitate consumer's lifestyles for on-the-go snacking and portion control. However, many of these products are capable of supporting the growth of *Listeria monocytogenes* and undergo no further cooking by the consumer prior to consumption, making them high risk foods.

Plant-based dips such as fresh salsa and guacamole contain raw produce. These are often made in large batches and if made under poor hygienic conditions and poorly refrigerated are a risk for the growth of foodborne pathogens (Kendall *et al*., 2013). Since those products are generally not cooked, their microbiological quality relies on the combination of several hurdles including pH, presence of organic acids, use of preservatives and storage temperature. Ingredient quality also has a major effect on the final product safety. Chefs may choose to use lower grade ingredients (e.g. bruised tomatoes) reserving higher quality for foods in which they are visible to the consumer (Kendall *et al*., 2013). Dicing or pureeing produce, typical for preparation of salsa and guacamole, creates a large cut surface area that can spread contamination and increases availability of nutrients that can support the growth of pathogens (Asplund *et al*., 1991; Weissinger *et al*., 2000). Plant-based food items are projected to become more and more popular with vegetarian and vegan consumers looking for a good source of protein in order to meet their nutritional needs. However, foodborne outbreaks particularly with *Salmonella* have been linked to these types of products worldwide (Appendix 1).

Meat and fish spreads, such as chicken liver pâté and smoked salmon pâté and pastes are popular spreads. Within the meat category, liver pâtés are amongst the most popular with chicken/duck livers being the major ingredient. There are multiple recipes for the manufacture of these types of spreads with the cooking of the livers being a critical control point. However, if appropriate cooking processes are not applied, pathogens if present can survive and potentially grow to harmful levels in these types of products. For example, smoked fish such as salmon, trout or mackerel, used in the production of fish spreads, have been occasionally contaminated with *Listeria monocytogenes* and can survive if the cooking process is insufficient (Rørvik et al., 2000).

Outbreaks and notifications linked to spreads and dips

Several countries have reported *Salmonella* spp. outbreaks linked to imported tahini and hummus products (Appendix 1). Three outbreaks of *S.* Montevideo infection were identified between 2002 and 2003 in Australia and New Zealand, which involved 68 infections due to consumption of tahini (Unicomb *et al*., 2005). In the USA in 2013, tahini contaminated with *S.* Montevideo and *S*. Mbandaka infected 16 people and caused one death (CDC, 2013).

More recently, a sesame-based product contaminated with a new *Salmonella* serotype not previously described was linked to 40 cases of salmonellosis in four separate European countries (ECDC, 2017). Other plant-based dips have been the source of outbreaks such as basil pesto sauce contaminated with *Shigella sonnei* involving 46 cases in Norway in 2011 (Guzman-Herrador *et al*., 2011) and a dip containing salsa and guacamole which caused illness in 406 people in the USA in 2000 (Kimura *et al*., 2004) (Appendix 1). Chicken and duck liver pâté have been linked to a significant number of outbreaks worldwide involving *Campylobacter* spp. (Appendix 1). Little *et al*. (2010) indicated that 25 out of 114 campylobacteriosis outbreaks linked to poultry meat that were reported to the Health Protection Agency (UK) between 1992 and 2009 were associated with liver pâté. Most of these incidents have been associated with chicken liver pâté or parfait prepared in catering settings, and the reason appears to be related to using undercooked livers (Little *et al*., 2010). *L. monocytogenes* is another pathogen commonly associated with meat and fish spreads. According to a simulation presented by EFSA (2018) on the risk for human health in the European Union (EU) from RTE foods contaminated with *L. monocytogenes*, pâté presented the highest listeriosis risk among RTE meat products. Based on the quantitative risk characterisation of *L. monocytogenes* in various RTE food categories in the EU, pâté would be responsible for 158 cases of human listeriosis yearly in the EU (6.8% of the total cases).

Appendix 2 shows the notifications in the European Rapid Alert System for Food and Feed (RASFF), where it has been issued due to the presence of *Salmonella* spp. in hummus/tahini products (n=7) and meat spreads (n=9) as well as the presence of *L. monocytogenes* in meat spreads (n=8). In the last two years, FSAI has issued four food alerts relating to: *Listeria monocytogenes* in hummus (FSAI, 2017a), the possible presence of *Salmonella* in guacamole dip (FSAI, 2016a), the presence of *L. monocytogenes* in trout pâté (FSAI, 2017b) and regarding the lack of procedures in place to prevent the growth and toxin production of *Clostridium botulinum* in several varieties of chicken and pheasant liver pâtés (FSAI, 2016b).

Prevalence and microbial growth potential in spreads and dips

Although popular food items, the number of studies on the microbiological quality of spreads and dips is limited, especially for plant-based dips. A survey undertaken in 1997 on non-dairy (containing <70% of dairy products) and dairy dips of different flavours available on the Australian market (ACT Gov., 1997) reported that total aerobic counts were greater than 106 CFU/g in 18% of the samples (n=14/76), *Escherichia coli* was detected in 4% of samples (n=3/76). All of them were non pre-packaged dips which strongly indicates that contamination occurred during production and/or handling and storage of the product. Coagulase positive staphylococci were not detected in any of the samples analysed (counts <50 CFU/g).

The growth of foodborne pathogens in RTE spreads and dips is affected by both intrinsic and extrinsic characteristics of the food. A study by Iturriaga et al. (2002) showed that *L. monocytogenes* was unable to grow in processed guacamole (average pH = 5.3) during storage at 22 °C for 48 h or at 4–7 °C for 15 days, which was attributed to the addition of citric acid and disodium di-hydrogen pyrophosphate as preservatives. However, its viability was not affected by storage temperature. In fact, *L. monocytogenes* survived at least 58 weeks in processed guacamole stored frozen at -18 °C.

Osaili et al., 2015 found that populations of *Salmonella* spp. and *Staphylococcus aureus* in eggplant dip (containing ~15% tahini) were affected by the presence of citric acid (0, 0.4, 0.6 and 0.8% corresponding to pH values of 5.8, 4.3, 4.1 and 3.9, respectively). However, the presence or absence of citric acid did not significantly affect the *E. coli* O157:H7 population when stored up to 15 days at 4 °C and 7 days at 10 and 21 °C. *Salmonella* spp. and *Staphylococcus aureus* still remained viable in samples with no citric acid, at all the storage temperatures tested.

Tahini (pH = 6.76) stored at 10 °C did not support the growth of *S*. Typhimurium but the pathogen had the ability to survive up to 28 days with a reduction of up to 1.7 log CFU/g. However, hydrated tahini (pH = 6.8), used as an ingredient in products such as hummus, allowed significant growth of *S*. Typhimurium at 10, 21 and 37 °C (Al-Nabulsi et al., 2014). Similarly, *Listeria innocua*, usually used as a surrogate of *L. monocytogenes*, was able to grow by 3 $\log_{10}$ cycles in hummus (pH = 6.28) after 15 days of storage at 4 °C (Al-Holy et al., 2006).

Finally, Alali *et al*. (2012) observed that the populations of *Salmonella* spp. and *L. monocytogenes* in hummus (sodium concentrations ranging from 265 to 728 mg/100 g) (pH~4.5) stored at 4 or 10 °C for up to 27 days did not increase or decrease. The comparison of the behaviour of foodborne pathogens in different studies is sometimes meaningful because of the product composition/characteristics and the bacterial strains used, among other factors.

With regard to the prevalence of foodborne pathogens in meat-based spreads, a study by Domínguez et al. (2001) analysed 182 samples of meat pâté at retail in Spain in 2000 for the prevalence of *L. monocytogenes*. Thirteen per cent of the samples (n=24/182) were contaminated with *Listeria* species. *L. monocytogenes* was isolated from 10 samples (5.4%) of which only one harboured >100 CFU/g. A study on the occurrence of *Campylobacter* in retail foods in Ireland performed in 2001–2002 detected only one *Campylobacter*-positive sample of 120 pork pâté samples analysed (0.8%) (Whyte et al., 2004). In a microbiological survey of RTE cooked pâtés sold at retail outlets in UK in 2007, *Listeria* spp. were detected in 12 out of the 1,648 pâté samples tested (0.82%) while *L. monocytogenes* was only detected in 4 samples with levels <100 CFU/g. *Campylobacter* spp., *Salmonella* spp., E. coli O157 and *E. coli* were not detected whereas *S. aureus* was detected in 2 pâté samples and *Enterobacteriaceae* were detected in 102 (6.12%) pâté samples, with levels ranging from 10 to 1.4×10^5 CFU/g (FSA, 2011).

Uyttendaele et al. (2004) described the growth of *L. monocytogenes* in meat pâté (pH = 6.1) packed in modified atmosphere (30% CO2, 70% N2), with very variable growth rates depending on the intrinsic and extrinsic characteristics of the product. However, the growth of lactic acid bacteria reached spoilage concentrations before L. monocytogenes crossed the 100 CFU/g legal threshold for products placed on the market during shelf-life in RTE foods.

Aim of Survey

The aim of this survey was to determine the microbiological safety of refrigerated ready-to-eat (RTE) spreads and dips on the market in the Republic of Ireland.

Method

Sample collection

Between the 1 August and 30 November (inclusive), Environmental Health Officers collected single (n=1) and batch samples (n=5) of ready-to-eat spreads and dips from the following sectors:

- Manufacturers
- Packers
- Distributors
- Wholesalers
- Retail
- Caterers

Note: Samples were not taken from retail and catering establishments where the product was purchased from another FBO, opened and served loose.

All samples were fully enclosed in sealed packaging unless they were produced at the premises where they were sold, so that in the event of an unsatisfactory test result, it would be clear that the product was contaminated at the production/packaging/catering stage and not during the distribution or retail stages. Only RTE spreads and dips were sampled for this survey. Spreads and dips were considered RTE unless they were specifically labelled with instructions that they must be cooked prior to consumption.

Sample analysis

Spreads and dips were tested for different microbiological criteria depending on the ingredients used in their production (Table 1).

Table 1: Microbiological criteria tested for by dip/spread type

		Plant-based dips	Meat-based spreads	Fish-based spreads
Pathogens of concern	*Listeria monocytogenes*	✓	✓	✓
	Salmonella spp.	✓	✓	
	Campylobacter spp.		✓ (poultry only)	
Hygiene indicators	*Listeria* spp.	✓	✓	✓
	Escherichia coli	✓		
	Enterobacteriaceae	✓*	✓	✓

* Vegetable-based dips were only tested for *Enterobacteriaceae* if it had clearly been established that the entire product had been cooked.

Subtyping isolates

Isolates of *Salmonella* or *Listeria monocytogenes* obtained during the study were sent to the relevant reference laboratory for subtyping[2].

[2] Department of Agriculture Food & the Marine Laboratories, Backweston Campus, Cellbridge, Co. Kildare.

Interpretation of results

Microbiological results for RTE spreads and dips were assessed against the relevant legal criterion in Regulation 2073/2005 as amended, or against national microbiological criteria laid down in FSAI Guidance Note 3, where no legal criterion existed in Regulation 2073/2005 as amended (Table 2).

Table 2 Interpretation of results

Regulation (EC) No 2073/2005, as amended					
***Listeria monocytogenes* enumeration**					
Sample Size	***L. monocytogenes* result**	**Test result designation**	**Test result designation basis**	**Sample designation**	**Sample designation basis**
n = 5	≤100 cfu/g in all 5 sample units	Compliant	**Category 1.2 & 1.3 Regulation (EC) No. 2073/2005 as amended**	**Satisfactory**	Regulation (EC) No. 2073/2005 as amended
n = 1	≤100 cfu/g	Compliant		**Not designated**	This single sample was taken for monitoring and surveillance purposes; therefore this single sample cannot be designated under Regulation (EC) No. 2073/2005 as amended
n = 5	≥100 cfu/g in any of the 5 sample units	Exceeds the limit		**Unsatisfactory**	Regulation (EC) No. 2073/2005 as amended
n = 1	>100 cfu/g	Exceeds the limit		**Unsatisfactory**	Regulation (EC) No. 2073/2005 as amended

***Listeria monocytogenes* detection**[3]					
n = 5	Absence in 25g in all 5 sample units	Compliant	**Category 1.2**	**Satisfactory**	Regulation (EC) No. 2073/2005 as amended
n = 5	Presence in 25 g in at least 1 out of 5 sample units	Exceeds the limit	**Regulation (EC) No. 2073/2005 as amended**	**Unsatisfactory**	Regulation (EC) No. 2073/2005 as amended

National Microbiological Criteria	
Salmonella spp.	▪ No legal microbiological criteria set in Regulation (EC) No 2073/2005, as amended. Results assessed against Guidance Note 3, Revision 3, Table 1 (FSAI, 2019). ▪ Method: EN/ISO 6579 ▪ Test: **Detection in 25 g (n=1)** ▪ Interpretation of results and sample designation: - Satisfactory: Not detected in 25 g - Unsatisfactory: Detected in 25 g
Campylobacter	▪ No legal microbiological criteria set in Regulation (EC) No 2073/2005, as amended. Results assessed against Guidance Note 3, Revision 3, Table 1 (FSAI, 2019). ▪ Method: EN/ISO 10272-2 ▪ Test: **Detection in 25 g (n=1)** ▪ Interpretation of results and sample designation:

[3] Enumeration is the default test for *L. monocytogenes*. Detection is only performed if the sample is taken under the control of the FBO that produced it **and** any of the following 3 scenarios apply: (i) The sample is able to support the growth of *L. monocytogenes* (as per Food Safety Criteria, EU Reg 2073/2005, Footnote 8) **or** (ii) the shelf life is not known **or** (iii) the Sampling officer specifically requests *L. monocytogenes* detection because the manufacturer has no shelf life studies done on the product.

	- Satisfactory: Not detected in 25 g - Unsatisfactory: Detected in 25 g
Escherichia coli	▪ No legal microbiological criteria set in Regulation (EC) No 2073/2005, as amended. Results assessed against Guidance Note 3, Revision 3, Table 4 (FSAI, 2019). ▪ Method: ISO 16649-1 or 2 ▪ Test: **Enumeration (n=1)** ▪ Interpretation of results and sample designation: - Satisfactory: <20 CFU/g - Borderline: 20–≤10^2 CFU/g - Unsatisfactory: >10^2 CFU/g
Enterobacteriaceae	▪ No legal microbiological criteria set in Regulation (EC) No 2073/2005, as amended. Results assessed against Guidance Note 3, Revision 3, Table 4 (FSAI, 2019). ▪ Method: ISO 21528-2 ▪ Test: **Enumeration (n=1)** ▪ Interpretation of results and sample designation: - Satisfactory: <10^2 CFU/g - Borderline: 10^2–≤10^4 CFU/g - Unsatisfactory: >10^4 CFU/g
***Listeria spp*. except *monocytogenes* in foods that <u>cannot</u> support the growth of *Listeria spp*.**	▪ No legal microbiological criteria set in Regulation (EC) No 2073/2005, as amended. Results assessed against Guidance Note 3, Revision 3, Table 4 (FSAI, 2019). ▪ Method: ISO 11290-2 ▪ Test: **Enumeration (n=1)** ▪ Interpretation of results and sample designation: - Satisfactory: <10^2 CFU/g - Borderline: 10^2–≤10^4 CFU/g - Unsatisfactory: >10^4 CFU/g

***Listeria spp*. except *monocytogenes* in foods that can support the growth of *Listeria spp*.**	▪ No legal microbiological criteria set in Regulation (EC) No 2073/2005, as amended. Results assessed against Guidance Note 3, Revision 3, Table 4 (FSAI, 2019). ▪ Method: ISO 11290-1 ▪ Test: **Detection (n=1)** ▪ Interpretation of results and sample designation: - Satisfactory: Not detected in 25 g - Unsatisfactory: Detected in 25 g

Results & Discussion

Samples collected

A total of 1,063 samples were collected in this survey. The majority of these samples were from the retail sector (n=649/1,063) followed by the service sector (n=282/1,063)(Figure 1).

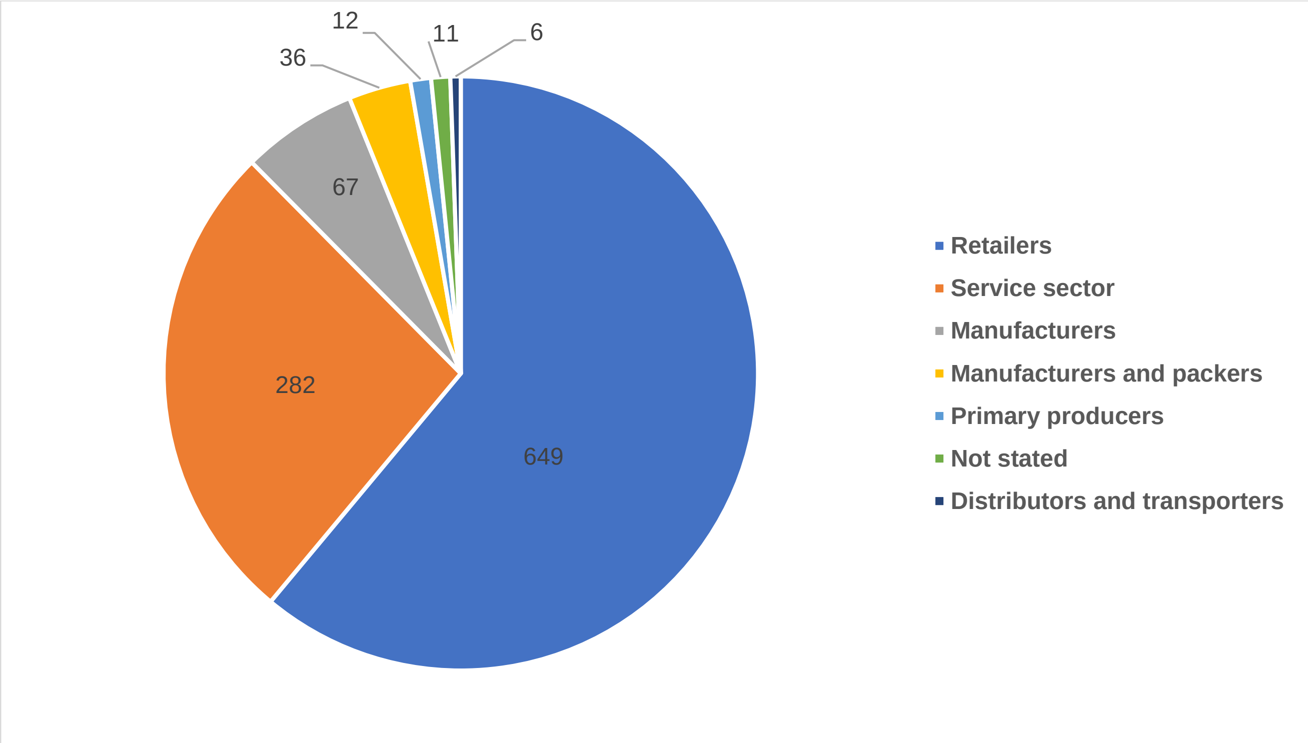

Figure 1 Breakdown of the total number of samples based on the type of establishments where they were collected.

Microbiological Results & Discussion

In total, 1,420 tests were performed for *L. monocytogenes*, 753 tests for *Salmonella* spp., 118 tests for *Campylobacter* spp., 549 tests for *E. coli* and 290 tests for *Enterobacteriaceae* (Table 3).

Table 3 Microbiological Results

Parameter	Number of samples		Number (%) satisfactory	Number (%) borderline	Number (%) unsatisfactory
***Listeria monocytogenes* (enumeration)**	**Batch Samples**	67[a]	67 (100)	n/a	0 (0)
	Single Samples	720	720 (100)	n/a	0 (0)
***Listeria monocytogenes* (detection)**	**Batch Samples**	30[a]	29 (96.7)	n/a	1[b] (3.3)
	Single Samples	215	212 (98.6)	n/a	3 (1.4)
***Salmonella* spp.**	753		752 (99.9)	n/a	1 (0.1)
Campylobacter spp.	118		118 (100)	n/a	0 (0)
Escherichia coli	549		540 (98.4)	4 (0.7)	5 (0.9)
Enterobacteriaceae	290		261 (90)	19 (6.6)	10 (3.4)

[a] A batch sample consists of 5 sample units and consequently entails 5 tests and results.
[b] *Listeria monocytogenes* was detected in all 5 sample units of the batch.

Contamination of refrigerated RTE spreads and dips with bacterial pathogens appears to be low, although the detection of *Salmonella* and *Listeria monocytogenes* in a small number of products does highlight a food safety risk. Spreads and dips contaminated with pathogenic microorganisms have been implicated in multiple outbreaks worldwide (Appendix 1).

Listeria monocytogenes

Commission Regulation (EC) No. 2073/2005 as amended sets a maximum legal limit of 100 cfu/g *L. monocytogenes* for ready-to-eat foods placed on the market during their shelf-life. In this survey all samples (67 batch, 720 single) tested were below the limit of enumeration (<10 cfu/g) for *L. monocytogenes* (Table 3). However, *Listeria monocytogenes* was detected in 4 products namely green pesto, basil pesto, hummus and cumin hummus. In the case of three of the products (the 2 pesto's and the hummus) recall alerts were issued by the FSAI and the products were removed from the market (FSAI 2018a, b, c). For the remaining cumin hummus, the result was received after the foods use by date had expired and it was no longer on the market. As a precaution the FSAI notified the Health Protection Surveillance Centre (HPSC) in case any related human listeriosis clinical cases were detected.

While all positive *L. monocytogenes* samples in this survey were below the 10 cfu/g limit of enumeration; the detection of *L. monocytogenes* in refrigerated spreads and dips is still a concern for public health given the long shelf-life on some of these products and their potential to support the growth of *L. monocytogenes*. Althaus *et al*. (2017) reported that a meat pâté product was associated with a *L. monocytogenes* 4a outbreak in Switzerland involving 5 confirmed and 2 probable cases in 2016. The source of the contamination was reported to be a mincing machine used to prepare the pâté meat. As the pâté was reported as having a water activity (a_w) of 0.967 and pH of 6 suggesting it would support the growth of *L. monocytogenes;* the authors evaluated the growth of *L. monocytogenes* in implicated pâté samples over the 12 day declared shelf-life of the pâté, at 9°C to simulate temperature abuse by consumers. Initial values of ≥10 cfu/g were observed for 3 (16.6%) of the pâté samples however, by the end of shelf-life (day 12), 16 pâté samples (88.9%) exhibited concentrations above 100 cfu/g. The authors reported median concentrations of 1.3×10^6 cfu/g (range 6.4×10^3 – 7.5×10^6) of *Listeria monocytogenes* in the pâté at the end of its 12-day shelf life.

In Ireland, "A study of domestic fridges on the island of Ireland" by SafeFood in 2015 found that only a third of participants were able to identify the recommended operating fridge temperature range. The study also found that only a third of participants were able to correctly identify the meaning of a 'use by' date whilst only 50% were able to identify the correct meaning of a 'best before' date. In addition, the study found that of 100 domestic fridge temperatures sampled, the mean temperature was 4.9°C but more than 40% had temperatures above 5°C. In addition, a wide range in temperatures was observed in domestic fridges, from as low as -4°C to as high as 12.5°C. Finally, the study found that 10% of consumers fridges contained high-risk ready-to-eat foods such as cooked meats, salads, fish and dairy products that were past their 'use-by' dates. The findings of this study demonstrate the lack of knowledge some Irish consumers have regarding the proper storage and usage of high-risk food products.

The detection of *L. monocytogenes* in RTE refrigerated spreads and dips during this survey alongside the pathogens ability to potentially grow in these products as demonstrated by Althaus *et al*. (2017), highlights the risk of foodborne illness associated with these products especially given the practices of some consumers.

Salmonella

There are no legal microbiological criteria set for *Salmonella* spp. in RTE spreads and dips in Commission Regulation (EC) No. 2073/2005 as amended. *Salmonella* was included in the current survey considering the significant amount of foodborne illness associated with *Salmonella* spp. and associated with the consumption of uncooked RTE foods or their ingredients such as fruits or vegetables. In addition, in recent years a number of *Salmonella* outbreaks have been associated with tahini and hummus (CDC, 2012; 2013; Unicomb *et al.*, 2005; Paine *et al.*, 2004; Appendix I).

FSAI's Guidance Note 3 (GN3) 'Guidelines for the Interpretation of Results of Microbiological Testing of Ready-to-Eat Foods Placed on the Market' (FSAI, 2019) sets out a national limit of 'no detection of *Salmonella* in a 25-gram sample' for RTE foods on the market in Ireland. Of the 753 samples tested, *Salmonella freetown* was detected in one sample (0.1%) of green pesto which resulted in a recall of three products due to them all sharing a common potentially contaminated ingredient (Table 3) (FSAI 2018d, e, f).

There is a wealth of evidence that spreads and dips can harbour enteric bacteria and serve as vehicles for pathogenic bacteria causing foodborne illnesses (Appendix I & II). However, the results from this survey suggest that contamination of RTE spreads and dips on the Irish market with *Salmonella* spp. is relatively low. RTE spreads and dips are made with a wide range of ingredients such as meat, fish, dairy, nuts, seeds, vegetables and fruits and in many cases are prepared without cooking. As many of these products are uncooked, the raw ingredients used in their preparation can pose a risk for *Salmonella*. Previous FSAI surveys on the 'microbiological safety of pre-packaged ready-to-eat nuts, seeds and dried fruit' found that 0.2% (n=2/890) of samples in 2015 and 0.3% (n=3/891) in 2010 were positive for *Salmonella* (FSAI, 2018g; FSAI, 2012). In addition, the 2015 survey reported that for 2015 the European Commission's Rapid Alert

System for Food and Feed[4] (RASFF) issued 69 notifications for *Salmonella* in sesame seeds (64), nigella seeds (1), melon seeds (1), tahini (1), pine nut kernels (1) and roasted chopped hazelnuts (1). Interestingly, another FSAI survey on 'the Microbiological Safety of Ready-To-Eat Fresh Produce' carried out in 2016 found that none out of 838 samples of fresh produce such as tomatoes, cucumbers, peppers, strawberries, blueberries, raspberries and blackberries were unsatisfactory for *Listeria monocytogenes*, *Salmonella* spp*.* or *Escherichia coli* (FSAI, 2019b). The results of this study indicated that the surveyed categories of fresh produce produced and used as ingredients in RTE spreads and dips in Ireland is of good microbiological quality and suggests that good hygiene practices are carried out along the Irish food supply chain. The high microbiological quality of the raw ingredients used in RTE spreads and dips in Ireland may explain the low number of samples unsatisfactory for *Salmonella* spp. found in this survey.

Campylobacter

None of the 118 samples tested for *Campylobacter* spp. in this survey were found to be unsatisfactory (Table 3). There are no legal microbiological criteria set for *Campylobacter* spp. in RTE spreads and dips in Commission Regulation (EC) No. 2073/2005, as amended. FSAI's Guidance Note 3 (GN3) 'Guidelines for the Interpretation of Results of Microbiological Testing of Ready-to-Eat Foods Placed on the Market' (FSAI, 2019) sets out a national limit of 'no detection of *Campylobacter* in a 25-gram sample' for RTE foods on the market in Ireland. Little *et al*. (2010) indicated that 25 out of 114 campylobacteriosis outbreaks linked to poultry meat that were reported to the Health Protection Agency (UK) in 1992–2009 were associated with liver pâté. Most of these incidents have been associated with chicken liver pâté or parfait prepared in catering settings, and the reason appears to be related to using undercooked livers (Little *et al*., 2010).

Escherichia coli and *Enterobacteriaceae*

There are no legal microbiological criteria set for *Escherichia coli* or *Enterobacteriaceae* in RTE spreads and dips in Commission Regulation (EC) No. 2073/2005, as amended. FSAI's Guidance Note 3 (GN3) 'Guidelines for the Interpretation of Results of Microbiological Testing of Ready-to-

[4] Source: RASFF portal at https://webgate.ec.europa.eu/rasff-window/portal/?event=SearchForm&cleanSearch=1

Eat Foods Placed on the Market' (FSAI, 2019) sets out national satisfactory, borderline and unsatisfactory limits for *E. coli* and *Enterobacteriaceae* in ready-to-eat foods.

In total, 549 samples were tested for *E. coli* and 290 were tested for *Enterobacteriaceae* during this survey based on the cooked status of the product, plant-based spreads and dips were tested for *E. coli* only unless the label indicated they had been cooked. Meat and fish-based products were tested for *Enterobacteriaceae* as these products should have received some form of heat treatment (e.g. cooking) (Table 1). *E. coli* is part of the *Enterobacteriaceae* family. The *E. coli* test is used to assess the hygiene status of a food product and can indicate that faecal pathogens could be present. *E. coli* are killed by adequate heat processing and should not be present in heat processed food. *E. coli* are also removed from the food processing environment by effective cleaning and sanitisation. *Enterobacteriaceae* are considered an indicator for hygiene, process failure and/or post-process contamination of heat processed foods. However, as fresh fruit, vegetables, herbs and salad vegetables (or foods which contain these as ingredients, e.g. spreads and dips) naturally contain high levels of *Enterobacteriaceae*, it is not useful to test these foods for *Enterobacteriaceae* unless they have been cooked (FSAI, 2019).

Of the 549 samples tested for *E. coli*, 540 (98.4%) were satisfactory, 4 were borderline (0.7%) and 5 (0.9%) were unsatisfactory for the limits in Guidance Note 3. Samples that were unsatisfactory for *E. coli* included vegetable dips (2), hummus (1), pesto dip (1) and cumin hummus (1). The presence of *E. coli* in RTE spreads and dips indicates that faecal pathogens may also be present or that poor hygienic practice occurred during/post-processing. For example, the cumin hummus sample that was unsatisfactory for *L. monocytogenes* detection was also unsatisfactory for *E. coli*.

Of the 290 samples tested for *Enterobacteriaceae*, 261 (90%) were satisfactory, 19 (6.6%) were borderline and 10 (3.4%) were unsatisfactory for the limits in Guidance Note 3. Samples that were unsatisfactory for *Enterobacteriaceae* included chicken liver pâté (3), meat spread (2), smoked mackerel pâté (2), salmon sensation (1), cream dip (1) and crab mix (1). The presence of borderline and unsatisfactory levels of *Enterobacteriaceae* in cooked spreads and dips indicates that either inadequate cooking, poor hygienic practices or post-processing contamination occurred.

In the case of all unsatisfactory or borderline *E. coli* and *Enterobacteriaceae* results, Environmental Health Officers followed up with the business in accordance with the actions required under Table 5 of FSAI's Guidance Note 3 (FSAI, 2019).

Conclusion

The results of this survey indicate that the contamination of the surveyed refrigerated RTE spreads and dips with pathogenic bacteria (*L. monocytogenes*, *Salmonella* spp.) and *E. coli*, as an indicator of faecal contamination, at levels representing a risk to public health is low. These findings indicate that refrigerated RTE spreads and dips on the market in Ireland are typically of good microbiological quality and suggests that practices along the food chain (from primary production of raw ingredients to handling practices by producers) are generally good for these kinds of products. Nevertheless, the detection of pathogens in this survey alongside the number of reported outbreaks and RASFF notifications for pathogens in these types of products, emphasises the need for control of contamination during processing and for producers to use high quality raw ingredients in order to mitigate the risks associated with foodborne illness from refrigerated RTE spreads and dips.

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Appendix 1: Selected outbreaks linked to contaminated Spreads and Dips (1999-2017)

Vehicle	Year	Countries	Pathogen(s)	Location	No. cases / people ill	Reference
Sesame-based product (imported sesame seeds)	2016-2017	Greece, Germany, Czech Republic and Luxembourg	New *Salmonella* serotype (antigenic formula 11:z41:enz15)	Multi-state (imported sesame seeds)	40 cases	ECDC, 2017
Meat pâte	2016	Switzerland	*Listeria monocytogenes* 4b	Local gourmet meat producer	5 cases (+2 probable)	Althaus *et al*. (2017)
Chicken liver pâté	2013	Australia	*Campylobacter jejuni*/*coli*	Catered function at a university residential college	56 cases	Moffatt *et al*. (2016)
Imported tahini paste (from Turkey)	2013	USA	*Salmonella* Montevideo and *S*. Mbandaka	-	16 people ill (1 death)	CDC (2013)
Duck liver pâté	2012	UK	*Campylobacter jejuni*/*coli*	Catered wedding	45 cases	Young *et al*. (2013)
Chicken liver pâté	2012	Australia	*Campylobacter* spp.	Restaurant	15 cases	Parry *et al*. (2012)
Imported tahini (Turkey)	2012	New Zealand	*Salmonella* Montevideo, *S*. Mbandaka and *S*. Maastricht	-	27 cases	Paine *et al*. (2014)
Chicken liver pâté	2012	Sweden	*Campylobacter* spp.	Wedding reception	17 cases (44 ill)	Lahti *et al*. (2017)

Homemade olive and tuna pâté	2011	Spain	*Clostridium botulinum*	Family home	2 cases	Lafuente *et al*. (2013)
Tahini paste used in hummus	2011	USA	*Salmonella* Bovismorbificans	-	23 people ill	CDC (2012)
Basil pesto sauce	2011	Norway	*Shigella sonnei*	-	46 cases	Guzman-Herrador *et al*. (2011)
Chicken liver pâté	2011	UK	*Campylobacter jejuni/coli*	Wedding reception	49 cases	Edwards *et al*. (2014)
Duck liver pâté	2011	UK	*Campylobacter jejuni/coli*	Catering college restaurant	8 cases	Abid *et al*. (2013)
Chicken liver pâté	2009	UK	*Campylobacter* and *Salmonella*	National conference	59 cases	Wensley and Coole (2013)
Liver pâté	2006	France	Hepatitis A virus	Secondary school canteen	15 cases	Schwarz *et al*. (2008)
Chicken liver pâté	2006	Scotland	*Campylobacter* spp.	Restaurant	46 cases	O'Leary *et al*. (2009)
Chicken liver pâté	2005	Scotland	*Campylobacter jejuni*	Annual farmers' dance	162 ill	Forbes *et al*. (2009)
Imported tahini (from Lebanon)	2003	New Zealand	*Salmonella* Montevideo	-	10 cases	Unicomb *et al*. (2005)
Imported tahini (from Lebanon)	2003	Australia	*Salmonella* Montevideo	-	3 cases	

Imported tahini (from Egypt)	2002	Australia	*Salmonella* Montevideo	-	55 cases	
Poultry pâté	2002	France	Shiga toxin-producing *Escherichia coli* (STEC) O148	Wedding reception	10 cases	Espié *et al*. (2006)
Dip (bean, salsa, guacamole, nacho cheese and sour cream)	2000	USA	*Shigella sonnei*	Nationwide	406 cases in 10 states	Kimura *et al*. 2004
Rillettes (pâté-like product)	1999	France	*Listeria monocytogenes* 4b	Nationwide	10 cases	de Valk *et al*. (2001)

Appendix 2: RASFF Notifications for Microbiological Contamination of Spreads and Dips (1983-2018)

No.	Date	Reference	Notification Type	Notified By	Subject
1	05/03/2018	2018.0568	Information for Follow-Up	Denmark	Sandwich spread from Lithuania infested with **moulds**
2	03/08/2017	2017.1156	Alert	France	***Listeria monocytogenes*** (<10 CFU/g) in chilled sausages for spreading from France
3	07/07/2017	2017.0984	Alert	Belgium	***Salmonella*** (present /25g) in meat spread from Belgium
4	27/01/2017	2017.0119	Alert	Netherlands	***Listeria monocytogenes*** (<10 CFU/g) in tomato and basil cheese spread from the Netherlands
5	16/03/2016	2016.0307	Alert	Netherlands	***Listeria monocytogenes*** (>3000 CFU/g) in raw meat spread from the Netherlands
6	07/12/2015	2015.1543	Alert	Netherlands	***Salmonella enterica* ser. Typhimurium** (type MLVA: 2-23-8-8-212) in beef spread (filet américain) from the Netherlands, with raw material from Belgium, the Czech Republic, Denmark and Poland
7	18/08/2015	2015.1077	Information For Follow-Up	Slovakia	Suspicion of **botulinum toxin** in chickpea spread from Slovakia
8	22/05/2015	2015.0629	Alert	UK	***Campylobacter*** (presence /25g) in chicken liver parfait from Ireland
9	01/04/2015	2015.0408	Alert	Italy	***Clostridium perfringens*** (5600 CFU/g) in vegan paté from Italy

10	27/11/2013	2013.1556	Alert	Poland	***Listeria monocytogenes*** (presence /25g) in onion flavoured meat spread from Poland
11	15/11/2013	2013.1510	Alert	France	***Listeria monocytogenes*** (< 10 CFU/g) in tuna mayonnaise from Belgium
12	19/07/2012	2012.1021	Alert	Poland	***Listeria monocytogenes*** (presence /25g) in meat spread from Poland
13	03/07/2012	2012.0912	Alert	Germany	***Salmonella enterica*** (presence /25g) in tea sausage spread from Germany
14	06/06/2012	2012.0768	Information For Attention	Netherlands	***Salmonella enterica*** (presence /25g) in tahini liquid from Syria
15	06/06/2012	2012.0769	Information For Attention	Netherlands	***Salmonella enterica*** (presence /25g) in tahini from Syria
16	06/06/2012	2012.0770	Information For Attention	Netherlands	***Salmonella enterica*** (presence /25g) in tahini from Syria
17	25/05/2012	2012.0712	Information For Attention	Netherlands	***Salmonella enterica*** (presence /25g) in tahini from Syria
18	20/02/2012	2012.0265	Alert	France	***Salmonella enterica*** (presence /25g) in chilled ready to eat sausage spread from France
19	20/10/2011	2011.1468	Information For Attention	Germany	***Salmonella*** (presence /25g) in raw sausage spread with onions from Germany
20	08/09/2011	2011.1221	Alert	France	***Clostridium botulinum* type A** in sundried tomato spread from France
21	06/09/2011	2011.1203	Information For Attention	France	***Clostridium botulinum* type A** in olive-almond spread from France

22	16/03/2010	2010.AMG	Border Rejection	UK	***Bacillus subtilis*** (1.7x10^5; 2.5x10^5; 2.1x10^5; 2.4x10^5; 3.3x10^5 CFU/g) in fermented bean paste from Taiwan
23	15/07/2008	2008.0852	Alert	Belgium	***Salmonella*** (presence /25g) in meat spread from Belgium
24	25/04/2008	2008.0475	Information	UK	***Salmonella*** in various houmous preparations from the United Kingdom
25	03/04/2008	2008.0392	Alert	France	***Listeria monocytogenes*** (1200 CFU/g) in goose liver spread from France
26	02/08/2007	2007.0521	Alert	France	***Salmonella enterica*** (presence /25g) in spreadable sausages from Germany
27	16/02/2007	2007.0125	Alert	UK	***Salmonella*** in houmous from the UK
28	16/02/2007	2007.0126	Alert	UK	***Salmonella*** in houmous from the UK
29	20/07/2004	2004.BPR	Information	Germany	***Salmonella* Typhimurium** (presence) in uncooked sausage for spreading
30	01/09/2003	2003.BRQ	Information	Germany	***Salmonella* Typhimurium** in fresh spreadable farmers meat sausage "bauernmettwurst"
31	19/09/2002	2002.316	Alert	France	***Listeria monocytogenes*** (presence in 25 g) in Meat spread
32	30/03/2000	2000.027	Alert	Austria	***Listeria monocytogenes*** in Meat spread
33	17/03/2000	2000.023	Alert	Austria	***Listeria monocytogenes*** in Meat spread
34	09/09/1997	1997.33	Alert	UK	***Salmonella* Manhattan** in Meat spread
35	11/04/1983	1983.08	Alert	Belgium	**Botulism** in Paste for spreading

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