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Survey to Determine the Prevalence of *Campylobacter* and *Salmonella* on Raw Chicken on Retail Sale in Ireland in 2011 (11NS2)

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The aim of this survey was to determine the prevalence of *Campylobacter* and *Salmonella* in raw chicken on retail sale in the Republic of Ireland (ROI) at the time of year when contamination was expected to be highest (June to August). In the case of *Campylobacter,* the specific aim was to establish a baseline level of the concentration of *Campylobacter* on chicken (whole birds and chicken portions with and without skin). This retail level baseline could then be used to assess progress by the poultry sector following its implementation of the recommendations of the Food Safety Authority of Ireland's (FSAI) 2011 Scientific Committee report on control of *Campylobacter* in the poultry food chain.

Campylobacter was detected in 50.2% of raw chicken samples using a quantitative method, with 5.9% of samples contaminated at levels above 1,000 colony forming units per gram (CFU/g). It has been estimated at EU level, that the risk of illness could be reduced by greater than 50%, if all batches sold as fresh meat would comply with a limit of 1,000 CFU/g of neck and breast skin. A higher percentage of whole birds and chicken portions with skin were found to be contaminated with *Campylobacter* and at a higher concentration, than samples of chicken without skin. Ten percent of whole birds, 8% of portions with skin and 1% of portions without skin had counts above 1,000 CFU/g.

Whilst it appeared that samples identified as imported were less contaminated with *Campylobacter* than samples from the ROI, more of the imported samples were chicken portions without skin which would have resulted in lower *Campylobacter* levels. Analysis of samples by origin and sample type showed a statistically significant difference between ROI (37.2%) and imported (25.4%) samples for chicken portions without skin, but not for the other sample types. It is possible that this difference was influenced by a greater number of imported samples being stored in modified atmosphere packaging prior to sampling however, information on this type of packaging was not collected during the survey.

Campylobacter jejuni was the most common species identified (68.4%), followed by *Campylobacter coli* (21.9%), while a single *Campylobacter lari* was identified (0.3%). *Salmonella* was detected in 0.9% of samples using a qualitative method. *Salmonella* serovars identified included *Salmonella* Enteritidis, *S.* Java, *S.*Typhimurium and *S.* Infantis. Neither establishment type (i.e. supermarket or butcher) nor primary production method (standard, organic or free range) was found to have an impact on *Campylobacter* or *Salmonella* contamination at retail level.

A welcome development was the increase in the use of leak-proof packaging, which has more than doubled since a similar survey in 2008, to 70.5% of pre-packaged samples. However, contrary to FSAI recommendations, 9.8% of the labels on pre-packaged whole birds displayed instructions to wash the bird before cooking. Washing of birds can lead to the spread of *Campylobacter* around the kitchen in water droplets.

In conclusion, this survey shows that poultry meat remains a significant source of *Campylobacter* and emphasises the importance of implementing control measures, in order to reduce the level of contamination to which consumers are exposed.

ACKNOWLEDGEMENTS

The Food Safety Authority of Ireland (FSAI) thanks the environmental health officers, the laboratory staff of the official food microbiology laboratories of the Health Service Executive (HSE), the National Reference Laboratory Campylobacter (Food, Feed and Animal Health) and the National Salmonella, Shigella & Listeria Reference Laboratory of Ireland (Human Health) who participated in this study.

1. INTRODUCTION

Campylobacter and *Salmonella* account for a large proportion of human gastrointestinal illnesses worldwide. In the ROI, *Campylobacter* is the leading cause of bacterial gastroenteritis, while *Salmonella* is the second most common cause (Nicolay *et al.*, 2010; HPSC, 2012). In 2011, there were 2,427 and 311 reported cases of campylobacteriosis and salmonellosis, respectively in the ROI, corresponding to crude incidence rates of 52.9 and 6.8 cases per 100,000 population (HPSC, 2011). Underreporting of gastrointestinal illness is well recognised and the true incidence for both pathogens is likely to be significantly greater (de Jong and Ekdahl, 2006; Whyte *et al*., 2006; EFSA 2010a).

Chicken meat is a recognised source of *Campylobacter* and *Salmonella*. An Irish retail level survey conducted by Whyte *et al*. (2004), found that 49.9% of chicken samples were contaminated with *Campylobacter*. An EU wide study conducted in 2008 found that 71% of EU chickens and 83% of Irish chickens were colonised with *Campylobacter* on arrival to the slaughterhouse, while 76% of EU carcasses and 98% of Irish carcasses were contaminated at the end of the slaughter process (EFSA, 2010b). The study also examined *Salmonella* in carcase samples. Sixteen percent of EU carcasses and 11% of Irish carcasses were positive for *Salmonella*. None of the Irish samples were positive for *S*. Enteritidis and *S.* Typhimurium; the serotypes responsible for the majority of human illness in the ROI and Europe (HPSC, 2012; EFSA and ECDC, 2013).

An Irish survey, conducted as part of the FSAI/HSE national microbiological surveillance programme in 2008, examined *Campylobacter* contamination on the surface of poultry packaging and retail shelves (FSAI, 2010c). It found that *Campylobacter* was detected on 13.2% (104/785) of the external surface of poultry packaging and 10.9% (86/785) of the surface of display cabinets in retail establishments.

It is estimated that handling, preparation and consumption of broiler meat may account for 20% to 30% of human cases of campylobacteriosis, while 50% to 80% may be attributed to the chicken reservoir as a whole (EFSA, 2010a). A case control study on the island of Ireland identified the consumption of chicken as a significant risk factor for *Campylobacter* infection (Danis *et al*., 2009). Human cases of salmonellosis have been decreasing since 2008 and it is thought that this observed reduction is mainly as a result of the successful *Salmonella* control programmes in poultry populations (EFSA and ECDC, 2013).

It has been estimated at the EU level that a public health risk reduction in campylobacteriosis of greater than 50% could be achieved if all batches that are sold as fresh meat would comply with a limit of 1,000 CFU/g of neck and breast skin (EFSA, 2011). Forty two percent of all Irish batches tested in the 2008 EU wide study would not comply with this limit (EFSA, 2010b).

As a result of the 2008 baseline study, the FSAI requested its Scientific Committee to advise specifically on a practical control programme for *Campylobacter* in the Irish broiler production and slaughter chain. The report was published in 2011 and contained a range of recommendations at farm, processing and retail level (FSAI, 2011).

In October 2011, EC Regulation 2073 of 2005 on microbiological criteria for foodstuffs was amended to introduce a microbiological criterion for *Salmonella* Enteritidis and *Salmonella* Typhimurium in fresh (i.e. chilled) poultry meat on retail sale (EC, 2005). There is currently no criterion for *Campylobacter* in EU legislation.

2. OBJECTIVES

To establish the prevalence and types of *Campylobacter* spp. and *Salmonella* spp. on fresh (i.e. chilled) raw chicken meat on retail sale in the ROI.

In the case of *Campylobacter*:

- the specific aim was to establish a baseline level of the concentration (CFU/g) of *Campylobacter* on chicken, prior to implementation by industry of the recommendations of the FSAI's 2011 Scientific Committee report
- in addition, the information gathered by way of a questionnaire in this survey was designed to serve as a follow-up to the information obtained in the 2008 poultry packaging survey

3. METHODOLOGY

3.1 Sample Collection and Sample Type

From June 2011 to August 2011, inclusive, a total of 955 fresh raw chicken samples were collected by environmental health officers (EHOs) from a variety of retail establishments including supermarkets, butcher shops, stalls and markets. Three categories of chicken were sampled in accordance with the sampling procedure: (i) whole birds, (ii) chicken portions with skin and (iii) chicken portions without skin. In the case of a whole bird, the full carcass was submitted for analysis. In the case of chicken portions, a minimum weight of 100g was submitted. In addition to sample collection, EHOs were requested to complete a questionnaire (Appendix 1) at the time of sampling, to gather additional information on the sample.

3.2 Sample Analysis

Microbiological examination took place in four different official food microbiological laboratories (OFMLs) of the HSE, namely: Dublin Public Analyst Laboratory, Sligo Public Health Microbiology Laboratory, Cork Public Health Microbiology Laboratory and Galway Public Health Microbiology Laboratory.

Quantitative determination of *Campylobacter* was carried out using the ISO/TS 10272-2:2006 method. Qualitative detection of *Salmonella* spp. was performed in accordance with EN/ISO 6579:2002. Speciation of *Campylobacter* isolates was carried out by the National Reference Laboratory Campylobacter (Food, Feed and Animal Health), Backweston, Co. Kildare. Serotyping of *Salmonella* isolates was performed by the National Salmonella, Shigella & Listeria Reference Laboratory of Ireland (Human Health), University College Hospital, Galway.

3.3 Reporting of Results

Quantitative analysis for *Campylobacter* provided an enumeration result for *Campylobacter* counts in each sample. The limit of enumeration for *Campylobacter* was 10 CFU/g. Results for *Salmonella* were qualitative and were reported as detected or not detected in 25g.

3.4 Statistical Analysis

Chi-square test analysis was performed using SPSS version 20.0. Significance was defined at the $P<0.05$ level.

4. RESULTS AND DISCUSSION

A total of 955 samples of raw chicken (whole birds and chicken portions with and without skin) were collected for this survey. Samples were collected in the summer months when levels of contamination were expected to be highest (EFSA, 2010c). Samples were analysed quantitatively for *Campylobacter* (n=897) and qualitatively for *Salmonella* (n=954). The overall microbiological results from the survey are displayed in Table 1. Quantitative results for *Campylobacter* are presented in Table 2.

Table 1: Overall microbiological results

Microorganism (Positive result)	Number of samples[1] tested	Number of positive samples	% of positive samples
Campylobacter (≥10 CFU/g)	897	450	50.2
Salmonella *(Detection in 25g)*	954	9	0.9

[1]A total of 955 samples were taken for this survey. For *Campylobacter*, 58 samples were excluded (this was because two samples were not tested for *Campylobacter* and the results for 56 samples were reported as '<100 CFU/g' which was not the limit of enumeration used for the majority of samples and therefore prevented comparison with these samples). One sample was not tested for *Salmonella*.

Table 2: Quantitative results for *Campylobacter*

Concentration of *Campylobacter* CFU/g	Number of samples	% of samples (n=897)
<10	447	49.8
10-100	259	28.9
101-1000	138	15.4
> 1000	53	5.9

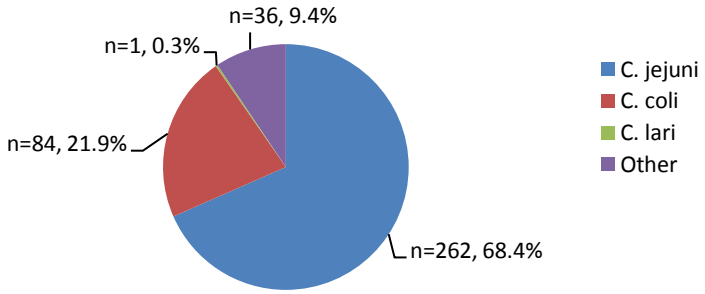
4.1 *Campylobacter*

Campylobacter was detected in 50.2% of samples using a quantitative method, with counts ranging from the limit of enumeration of 10 CFU/g, to a maximum level of 61,000 CFU/g. The percentage of samples contaminated was similar to the results of a survey of raw chicken sold in the ROI by Whyte *et al*. (2004), where *Campylobacter* was detected in 49.9% of samples, although not directly comparable as the Whyte *et al*. study used a qualitative method of detection. A more recent survey of chicken on sale in the ROI by Madden *et al*. (2011) used a combination of both methods resulting in an overall prevalence of 84.3% (52.7% by the qualitative method and a further 31.6% of samples using the quantitative method).

The European Food Safety Authority (EFSA) (2011) has estimated that a reduction of contamination in chicken at the end of the slaughter process to less than 1,000 CFU/g would decrease the public health risk by more than 50%. The 2008 EU-wide baseline study reported that 96.2% of Irish broiler carcasses were contaminated with *Campylobacter* using the quantitative method, with 41.9% of carcasses contaminated at levels of 1,000 CFU/g or more (EFSA, 2010b). In 2011, sampling by the Department of Agriculture, Food and the Marine (DAFM) found a similar result to the baseline study, with 43.8% of samples at the end of slaughter having counts greater than 1,000 CFU/g (DAFM, 2011a). *Campylobacter* concentrations on meat are highest directly after processing and decrease in subsequent stages throughout the food chain (Wagenaar *et al*., 2006). In this current study, 5.9% of retail samples were found to be above the level of 1,000 CFU/g (Table 2).

From the 450 samples that were positive for *Campylobacter*, 383 isolates were submitted to the National Reference Laboratory Campylobacter (Food, Feed and Animal Health) for speciation. Isolates of *Campylobacter* do not survive well in storage; all isolates therefore, were not available for speciation. *Campylobacter jejuni* was the most prevalent species (68.4%, 262/383), followed by *Campylobacter coli* (21.9%, 84/383) and *Campylobacter lari* (0.3%, 1/383) (Figure 1). These findings are similar to results from the study by Madden *et al*., (2011), in which prevalences of 67%, 32% and 0.5% were reported for *C. jejuni*, *C. coli* and *C. lari*, respectively.

Figure 1: Distribution of *Campylobacter* species isolated from raw chicken samples (n=383)



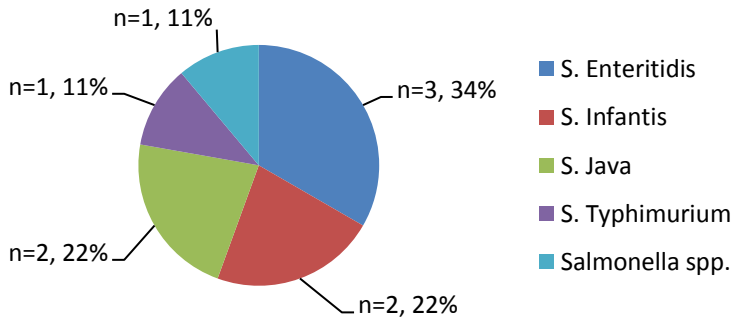
4.2 *Salmonella*

Salmonella was detected in 0.9% (9/954) of samples. This is lower than was reported by Madden *et al*., (2011) who found 5.1% chicken meat samples sampled at retail level in the ROI were positive for *Salmonella*. The 2008 EU-wide baseline study reported a prevalence of 11.2% for *Salmonella* on Irish broiler carcasses at the end of the slaughter process, while official control sampling at processing plants in 2011 found 2.5% of samples positive (EFSA, 2010b; DAFM, 2011b).

Serotyping of the nine *Salmonella* isolates in this study identified *Salmonella* Enteritidis (n=3), *S.* Java (n=2), *S.*Typhimurium (n=1), *S.* Infantis (n=2) and *Salmonella spp.* (n=1) (Figure 2). *S.* Typhimurium and *S.* Enteritidis are the most frequent causes of salmonellosis in the ROI and Europe (HPSC, 2012; EFSA, 2013). At the time of sampling for this study, there was no legal criterion for *Salmonella* in poultry meat, however, in October 2011, an amendment was made to Commission Regulation (EC) No 2073/2005 on the microbiological criteria for foodstuffs (European Commission, 2005). From October 2011, if *Salmonella* Typhimurium (including monophasic *Salmonella* Typhimurium 1,4,[5],12:i:-) or *Salmonella* Enteritidis is detected in fresh poultry meat for retail sale, the batch should be removed from the market. However, as this study was carried out before this amendment was made, there was no requirement to remove the implicated batches from sale.

It is curious that *S.* Kentucky was not detected in this study, as it was the most common serovar isolated from Irish broiler flocks in 2011, accounting for 97% of isolates, followed by *S.* Mbandaka (2%) and *S.* Orion (1%) (DAFM, 2011b). *S.* Kentucky was also the most common serovar in isolates from raw broiler meat submitted by industry to the National Reference Laboratory Salmonella (Food, Feed and Animal Health) for typing. Of 122 industry isolates submitted, 80% were *S.* Kentucky, 12% *S.* Heidelberg, 4% *S.* Typhimurium (including monophasic), 2% *S.* Agona and 1% *S.* Infantis.

Figure 2: Distribution of *Salmonella* serovars isolated from raw chicken samples (n=9)



4.3 Analysis of Questionnaires

Questionnaires (Appendix 1) were completed by EHOs at the time of sampling to gather information on the type of establishment where the sample was sourced (supermarket, butchers, food market/stall or other); the origin of the sample (domestic, imported); the sample type (whole birds, chicken portions with or without skin); the packaging type (loose, pre-packaged); the nature of the chicken (standard, organic, free range); the presence of cooking guidelines on the external surface of the packaging; visible instructions for washing whole pre-packaged birds before cooking; the temperature of the display unit and; the position in which the product was stored (flat, upright) when sampled. The overall questionnaire return rate was 90.1% (860/955). A summary of the microbiological results for the 860 samples with questionnaires returned is presented in Table 3. A summary of the questionnaire findings (including information on sample details and microbiological results) is presented in Table 4.

Table 3: Microbiological results for samples with questionnaires returned (n=860)

Microorganism (Positive result)	Number of samples[1] tested	Number of positive samples	% of positive samples
Campylobacter (≥10 CFU/g)	805	406	50.4
Salmonella *(Detection in 25g)*	859	8	0.9

[1]A total of 860 questionnaires were returned. For *Campylobacter*, 55 samples with questionnaires returned were excluded (this was because two samples were not tested for *Campylobacter* and the results for 53 samples were reported as '<100 CFU/g' which was not the limit of enumeration used for the majority of samples and therefore prevented comparison with these samples). One sample was not tested for *Salmonella*.

Table 4: Chicken samples for which a questionnaire was returned (n=860) – breakdown by sample detail and microbiological results

Category	Subcategory	*Campylobacter*		*Salmonella*	
		Number of samples positive (total sample number[1])	% of samples positive for each subcategory	Number of samples positive (total sample number[2])	% of samples positive for each subcategory
Establishment type	*Supermarket*	284 (565)	50.3%	4 (591)	0.7%
	Butcher	112 (226)	49.6%	2 (253)	0.8%
	Food Market/Stall	7 (8)	87.5%	0 (8)	0.0%
	Other	3 (6)	50.0%	2 (7)	28.6%
	Not stated	(55)	-	(1)	-
Origin	*Imported*	50 (157)	31.8%	3 (180)	1.7%
	Irish	325 (590)	55.1%	3 (613)	0.5%
	Country not specified	31 (58)	53.4%	2 (66)	3.0%
	Not stated	(55)	-	(1)	-
Type of sample	*Whole bird*	148 (245)	60.4%	0 (249)	0.0%
	Portion with skin	141 (218)	64.7%	1 (225)	0.4%
	Portion without skin	115 (337)	34.1%	7 (379)	1.8%
	Not stated	(60)	-	(7)	-
Nature of chicken	*Standard*	244 (461)	52.9%	6 (498)	1.2%
	Free range	22 (57)	38.6%	0 (59)	0.0%
	Organic	1 (4)	25.0%	0 (4)	0.0%
	Nature not specified	139 (283)	49.1%	2 (298)	0.7%
	Not stated	(55)	-	(1)	-
Loose/Pre-packaged	*Loose*	121 (252)	48.0%	5 (289)	1.7%
	Pre-packaged	285 (553)	51.5%	3 (570)	0.5%
	Not stated	(55)	-	(1)	-
Type of packaging	*Leak-proof*	177 (377)	46.9%	3 (389)	0.8%
	Wrapped, sealed loosely underneath	76 (125)	60.8%	0 (130)	0.0%
	Other	20 (33)	60.6%	0 (33)	0.0%
	Not stated	(18)	-	(18)	-
Visible cooking instructions	*Yes*	147 (305)	48.2%	1 (318)	0.3%
	No	138 (248)	55.6%	2 (252)	0.8%
Visible washing instructions *(pre-packaged whole birds)*	*Yes*	11 (22)	50.0%	0 (22)	0.0%
	No	118 (192)	61.5%	0 (194)	0.0%
	Not stated	(10)	-	(8)	-
Temperature of storage or display	*≤ 5°C*	366 (733)	49.9%	8 (781)	1.0%
	>5°C	39 (71)	54.9%	0 (74)	0.0%
	Not stated	(56)	-	(5)	-
Display	*Flat*	354 (719)	49.2%	8 (773)	1.0%
	Upright	52 (85)	61.2%	0 (85)	0.0%
	Not stated	(56)	-	(2)	-

[1,2]Total numbers of samples with questionnaire information on the subcategory that were tested for *Campylobacter*[1] or *Salmonella*[2]. Some of the questionnaires returned did not have all questions answered which were relevant to the sample submitted.

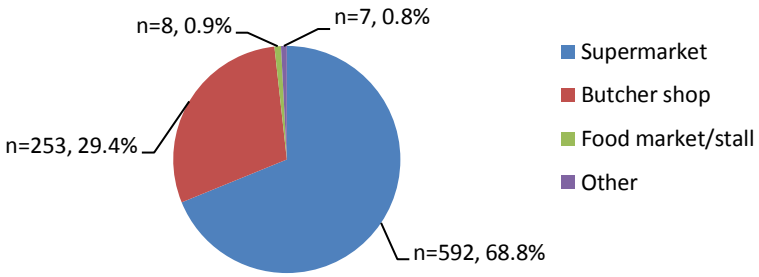
4.4 Establishment Type

The majority of samples were obtained from supermarkets (68.8%, 592/860), followed by butcher shops (29.4%, 253/860), with a small percentage being obtained from food markets/stalls (0.9%, 8/860) and other retail establishments (0.8%, 7/860) (Figure 3).

Campylobacter was detected in 50.3% (284/565) of samples taken from supermarkets; 49.6% (112/226) of samples taken from butcher shops; 87.5% (7/8) of samples from food markets or stalls and; 49.9% (3/6) of samples from 'other' establishment types. There was no statistical difference in *Campylobacter* prevalence between the establishments (P≥0.05).

Salmonella was detected in 0.7% (4/591) of supermarket samples, 0.8% (2/253) of butcher shops samples, 28.6% (2/7) of samples from 'other' establishment types, but not in any samples taken from food markets or stalls.

Figure 3: Distribution of samples by establishment type (n=860)



4.5 Type of Sample

Three types of samples were selected for the study: whole birds (29.2%, 249/854); portions with skin (26.3%, 225/854) and; portions without skin (44.5%, 380/854) (Figure 4). *Campylobacter* was detected in more whole birds (60.4%, 148/245) and portions with skin (64.7%, 141/218), than portions without skin (34.1%, 115/337). This difference was statistically significant (P<0.05). Whole birds and portions with skin had higher *Campylobacter* counts compared to portions without skin (Table 5). Feather follicles and crevices on chicken skin provide a suitable environment for *Campylobacter* to survive which may contribute to the higher contamination levels observed on chicken skin (Chantarapanont *et al*., 2003; Davis and Conner, 2007).

Salmonella was not detected on any whole bird samples, but was detected on a single chicken sample with skin (0.4%, 1/225) and on 1.8% (7/379) of chicken samples without skin.

Figure 4: Type of sample (n=854)

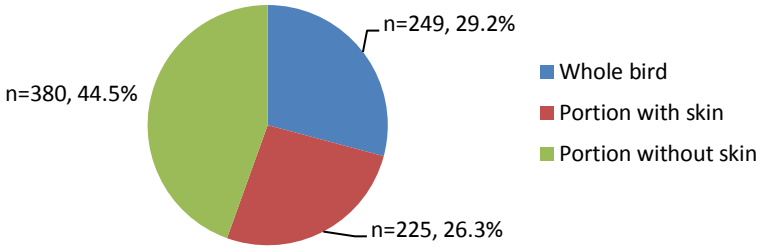


Table 5: Number of samples (% of total) within each sample type and corresponding *Campylobacter* concentration

Campylobacter (CFU/g)	Sample Type Whole bird n=249	Portion with skin n=225	Portion without skin n=380
<10	101 (40.6)	84 (37.3)	265 (69.7)
10-100	66 (26.5)	67 (29.8)	95 (25)
101-1000	56 (22.5)	55 (24.4)	16 (4.2)
> 1000	26 (10.4)	19 (8.4)	4 (1.1)

4.6 Origin of Sample

The majority of samples (71.4%, 614/860) originated from the ROI, while 20.9% (180/860) were imported. The origin of the remaining 7.7% (66/860) of samples was not specified (Figure 5). *Campylobacter* was detected in 55.1% (325/590) of ROI samples and in 31.8% (50/157) of imported samples. This difference was not a surprise, given the fact that the majority (68%) of ROI samples were samples with skin (i.e. whole birds and portions with skin), compared to 21% of imported samples. As *Campylobacter* was detected in more skin-on samples than portions without skin (Table 5), the sample type is likely to be an influencing factor in the difference between imported and domestic samples. Analysis of samples by origin and sample type (Table 6), showed that within the three different sample types, chicken portions without skin was the only sample type where there was a statistically significant difference between ROI and imported samples ($P<0.05$). Within this sample type, *Campylobacter* was detected in 37.2% (70/188) of ROI samples compared to 25.4% (31/122) of imported samples. It is possible that this difference may have been influenced by a greater number of imported samples being stored in modified atmosphere packaging,

which depending on the gas mix and the length of storage can reduce *Campylobacter* concentrations on meat (FSAI, 2011). Information on modified atmosphere packaging however, was not collected during this survey. More than half of the samples (53.4%, 31/58) that had no specified origin were contaminated with *Campylobacter*.

Salmonella was detected in 0.5% (3/613) of samples from the ROI, 1.7% (3/180) of imported samples and in 3% (2/66) of samples where the origin was not specified.

Figure 5: Sample origin (n=860)

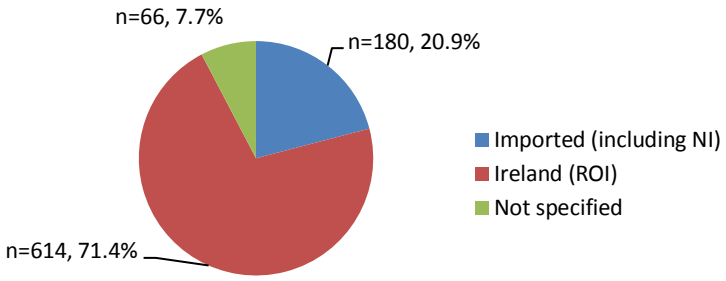


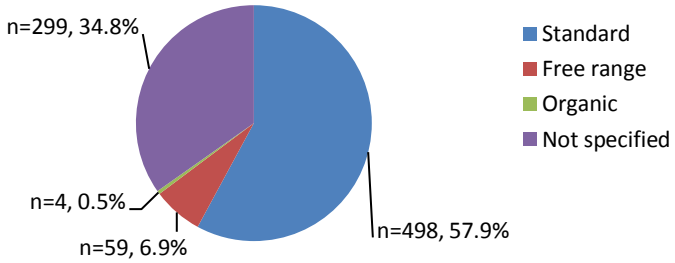
Table 6: Proportion of *Campylobacter* positive samples by origin and type of sample

Origin	Whole bird	Sample Type Portion with skin	Portion without skin
Republic of Ireland (n=588)	131/212 (61.8%)	123/188 (65.4%)	70/188 (37.2%)
Imported (n=154)	11/20 (55.0%)	7/12 (58.3%)	31/122 (25.4%)
P-value	0.60	0.50	0.03

4.7 Primary Production Practice

Over half of the samples taken were from a standard (i.e. intensive) production practice (57.9%, 498/860), 6.9% (59/860) were described as free range and 0.5% (4/860) as organic (Figure 6). The remaining 34.8% (299/860) of samples did not specify this information. *Campylobacter* was detected in over half (52.9%, 244/461) of samples from standard production practices, 38.6% (22/57) of free range samples, 25.0% (1/4) of organic samples and in 49.1% (139/283) of samples with unspecified primary production practice. *Salmonella* was detected in 1.2% (6/498) of samples from standard production practice and in 0.7% (2/298) of samples where the nature was not specified. *Salmonella* was not detected in free range (0/59) or organic (0/4) chicken samples. There were no statistically significant differences in the prevalence of *Campylobacter* or *Salmonella* between production practices (P>0.05).

Figure 6: Type of primary production practice (n=860)

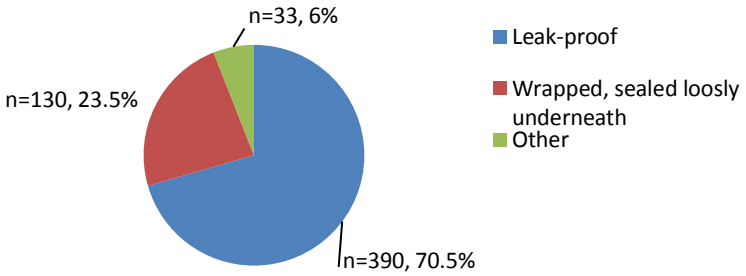


4.8 Type of Packaging

Two thirds of chicken samples were pre-packaged (66.4%, 571/860), while the remaining 33.6% (289/860) were sold loose (Figure 7). Most of the pre-packaged samples were from supermarkets (87.7%, 501/571), while the majority of chicken sold loose was obtained from butcher shops (65.7%, 190/289). *Campylobacter* was detected in 51.5% (285/553) of pre-packaged chicken and in 48.0% (121/252) of chicken sold loose. *Salmonella* was detected in 0.5% (3/570) of pre-packaged chicken and in 1.7% (5/289) of chicken sold loose.

A large majority (70.5%, 390/553) of the pre-packaged chicken samples were in leak-proof packaging. This was an increase of more than 50%, compared with a similar survey conducted in 2008, when 32% of samples were described as leak-proof (FSAI, 2010c). Nearly a quarter (23.5%, 130/553) of pre-packaged chicken samples were described as being loosely wrapped, 25 of which were displayed in an upright position, contrary to FSAI recommendations (FSAI, 2010a). The use of leak-proof packaging is the best way to prevent leakage of potentially contaminated juices from chicken transferring to the outer surfaces of other products or ready-to-eat foods. Where leak-proof packaging is not used, it is advised that poultry products should be stored flat at all times during storage and display.

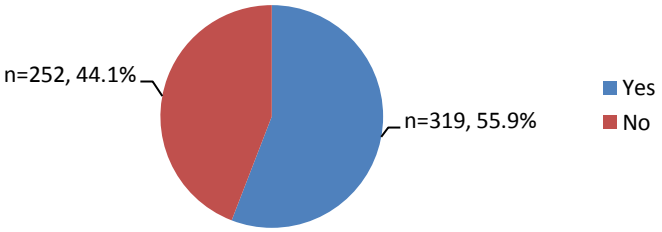
Figure 7: Description of pre-packaged retail chicken samples (n=553)



4.9 Cooking Instructions

For pre-packaged chicken samples, instructions for cooking were visible on the external label of 55.9% (319/571) of samples (Figure 8). The remaining 44.1% (252/571) did not have visible cooking instructions. This was an increase from 32% of samples in the 2008 study (FSAI, 2010c).

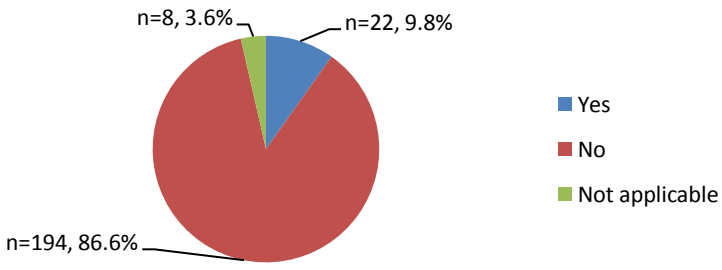
Figure 8: Presence of visible cooking instructions (n=571)



4.10 Washing instructions

For pre-packaged whole birds, instructions to wash the bird and or cavity were visible on the label of 9.8% (22/224) of samples (Figure 9). *Campylobacter* was detected in half of these samples (11/22). This instruction is contrary to current best practice advice and can lead to the spread of *Campylobacter* around the kitchen in water droplets. One sample was reported to have had instructions to wash the bird on the reverse of the label. This could encourage handling of potentially contaminated internal packaging, increasing the opportunity for cross contamination.

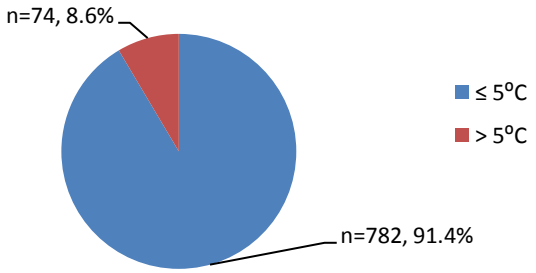
Figure 9: Presence of visible washing instructions on whole birds (n=224)



4.11 Storage Information

The majority of samples (91.4%, 782/856) were stored in units at the recommended 5°C or lower, while the remaining 8.6% (74/856) were above 5°C (Figure 10). A storage temperature of ≤5°C is recommended for chilled meats, as it slows down the growth of pathogenic and spoilage microorganisms. This is important for *Salmonella* which has been reported to have a minimum temperature for growth of between 5.2 and 7°C, but not for *Campylobacter,* which is reported to have a minimum temperature for growth of 32°C (FSAI, 2010b). All samples from which *Salmonella* was isolated were stored at or below the recommended 5°C.

Figure 10: Storage/display temperature at the time of sampling



5. CONCLUSION

The findings of this 2011 survey showed that half of retail chicken meat on sale in the ROI was contaminated with *Campylobacter,* at the time of year when contamination was expected to be highest (June to August). Five point nine percent of samples had counts greater than 1,000 CFU/g, which is a level that is considered to be significant in terms of reducing the risk of illness. A higher percentage of whole birds and chicken portions with skin were found to be contaminated with *Campylobacter* and at a higher concentration, than samples of chicken without skin. Ten percent of whole birds, 8% of portions with skin and 1% of portions without skin had counts above 1,000 CFU/g.

Whilst it appeared that samples identified as imported were less contaminated with *Campylobacter* than samples from the ROI, more of the imported samples were chicken portions without skin which would have resulted in lower *Campylobacter* levels. Analysis of samples by origin and sample type showed a statistically significant difference between ROI (37.2%) and imported (25.4%) samples for chicken portions without skin, but not for the other sample types. It is possible that this difference was influenced by a greater number of imported samples being stored in modified atmosphere packaging prior to sampling, which depending on the gas mix and the length of storage, can reduce *Campylobacter* concentrations on meat. Information on this type of packaging, however, was not collected during the survey.

Although *Salmonella* prevalence was less than 1%, two of the serotypes found (i.e. *S.* Enteritidis and *S.* Typhimurium) are of particular concern as they are the serotypes responsible for the majority of human cases. Furthermore, although not in effect at the time of sampling, the amendment made to Commission Regulation (EC) No. 2073/2005 in October 2011, would result in the samples that tested positive for *S.* Enteritidis and *S.* Typhimurium being removed from retail sale.

Neither establishment type (i.e. supermarket or butcher) nor primary production method (standard, organic or free range) was found to have an impact on *Campylobacter* or *Salmonella* contamination at retail level.

The packaging and labelling of samples had improved by comparison to a survey of poultry packaging conducted in 2008 (FSAI, 2010c). The use of leak-proof packaging in the current study was found to have more than doubled since 2008, increasing from 32% to 70.5%. This is welcome, because the use of loosely wrapped packaging can allow juices to leak onto the display cabinet, which can lead to cross contamination of other food products.

In the 2008 study, the packaging of one-third of chicken samples provided handling, preparation and/or cooking instructions (FSAI, 2010c). The current survey found over half of pre-packaged samples (55.9%, 319/571) had visible cooking instructions. However, the labels of 9.8% of whole bird samples (22/224) had instructions to wash the bird and/or the cavity before cooking. This is contrary to FSAI recommendations and can aid in the spread of pathogens from the meat in the kitchen environment.

In conclusion, this survey shows that poultry meat remains a significant source of *Campylobacter* and emphasises the importance of implementing control measures in order to reduce the level of contamination to which consumers are exposed.

6. RECOMMENDATIONS

1. Stakeholders along the food chain must continue to work to reduce the level of *Campylobacter* contamination of chicken meat. They should implement the recommendations of the FSAI's Scientific Committee report
2. Retailers still selling pre-packaged chicken in loosely wrapped packaging should change to using leak-proof packaging
3. Where chicken is sold in loosely wrapped packaging, the packs should be displayed flat rather than in an upright position, to minimise the opportunity for juices to leak from the packaging
4. Labels on whole birds or chicken portions should never advise the consumer to wash the product. In fact the label should carry explicit instructions not to wash
5. Labels should clearly display safe handling and cooking instructions on the outside of the packaging, rather than the inside of the packaging
6. Those responsible for giving food safety messages to consumers should continue to remind consumers that raw chicken may carry pathogens and must therefore, be handled in a way that prevents cross contamination of ready-to-eat foods and that the chicken must be cooked thoroughly

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APPENDIX 1: Survey Questionnaire

1. General Information:

EHO Name: _____

Date of sampling: _____

EHO Sample Reference Number *(i.e. EHO's own personal ref. no. for the sample:*_____

Laboratory Name & Reference Number *(upon receipt of lab report)*

2. Establishment Information:

☐ Supermarket or ☐ Butcher Shop or ☐ Stall/Market or

☐ Other retail establishment (*Please specify:* _____)

3. Sample information:

Brand name _____ **or Not Available** ☐

Brand address: _____ **or Not Available** ☐

County of brand address: _____ **or Not Available** ☐

Plant approval no: _____ **or Not Available** ☐

Production batch number: _____ **or Not Available** ☐

Imported: Yes **(this includes Northern IRL)** ☐ **or** No (**look for IE or IRELAND**) ☐ **or Not Available** ☐

Type of chicken: Whole bird ☐ or Portion with skin on ☐ or Portion without skin ☐

Nature of chicken: Organic ☐ or Free range ☐ or Standard ☐ or Not Specified ☐

4. Packaging & cooking/handling instructions:

Loose ☐ or pre-packaged ☐

If pre-packaged, please complete the following regarding the type of packaging:

☐ Plastic cover wrapped over and sealed loosely underneath the tray (e.g. cling film) or

☐ Plastic cover sealed onto the tray (i.e. leak proof packaging) or

☐ Other, please describe: _____

If pre-packaged, please complete the following regarding cooking/handling instructions:

Are cooking instructions visible on the external surface of the pack? Yes ☐ or No ☐

For whole birds, are there instructions (visible on the external surface of the pack) requiring the bird and/or cavity to be washed? Yes ☐ or No ☐ or N/A ☐

5. Storage information:

Storage Temperature, i.e. temperature (measured by EHO) of storage/display unit: _____ºC

Was the sample displayed in the retail establishment on the flat ☐ or in an upright position ☐?

6. Follow-up action (see section 11 of protocol, please tick as many boxes as necessary)

Notification of result: FBO ☐; DAFF ☐ **;** Local Authority ☐; FSAI ☐; No notification required ☐

Other follow-up action by EHO:

Review of hygiene practices ☐

Repeat sample: ☐ (please provide the lab reference number for the repeat sample: _____)

Other action (please provide details): _____

No follow-up action required: ☐

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