THE MICROBIOLOGY OF BEEF CARCASSES AND PRIMALS DURING CHILLING AND CHILLED STORAGE

Declan J. Bolton[1*], Rachel Reid[1,2], Joe Kerry[3] and Séamus Fanning[2]

[1]Department of Food Safety and Technology, Teagasc Food Research Centre, Ashtown, Dublin 15, Ireland;

[2]UCD-Centre for Food Safety, School of Public Health, Physiotherapy and Sports Science, University College Dublin, Ireland;

[3]School of Food and Nutritional Science, University College Cork, Ireland;

*Corresponding author email: declan.bolton@teagasc.ie

The objective of this study was to microbiologically characterise beef carcasses and primals during chilled storage. Total viable count (TVC), total *Enterobacteriacae* count (TEC), *Pseudomonas* spp., lactic acid bacteria (LAB), *Brochotrix thermosphacta* and *Clostridum* spp. were monitored on beef carcasses (n=30) and primals (n=105) during chilled storage using EC Decision 2001/471/EC and ISO sampling/laboratory procedures. *Clostridium* spp. (1.89 log_{10} cfu/cm^2) and *Pseudomonas* spp. (2.12 log_{10} cfu/cm^2) were initially the most prevalent bacteria on carcasses and primals, respectively. The shortest mean generation time (G) was observed on carcasses with *Br. thermosphacta* (20.3h) and on primals with LAB (G = 68.8h) and *Clostridium* spp. (G = 67h).

Key Words – beef carcasses, primals, microbiology, chilling

I. INTRODUCTION

The European Commission is currently reviewing EC 853/2004 to allow greater flexibility in beef carcass and prImal chilling. However, a fundamental understanding of the microbiology of beef carcass and primals is required if the beef industry are to benefit from any legislative change. Despite many years of research on meat microbiology, there is still very little published research on the fate of general bacterial populations (TVC and TEC) and even less on key spoilage bacteria on beef carcasses and subsequent beef cuts during chilled storage [1]. The objective of this study was therefore to microbiologically characterise beef carcasses and primals during chilling and chilled storage.

II. MATERIALS AND METHODS

Thirty (3 x 10) carcasses were sampled at times t = 0, 24, 48, 72 and 96h and primals (105 vacuum packed (BB3055x bags, CryoVac, Sealed Air Ltd) beef cuts) at times t = 0, 1, 2, 3, 4 5 and 6 weeks, using the sampling procedure described in EC Decision 2001/471/EC and the sampling method of Lasta *et al.* (1992). In the laboratory, mesophilic total viable counts (TVCm), psychrophilic TVC (TVCp), *Enterobacteriaceae, Pseudomonas*, lactic acid bacteria (LAB), *Br. thermospachata* and Clostridium spp. were enumerated and analysed as described by Reid et al. [2].

III. RESULTS AND DISCUSSION

The observed decrease in TVCm of 0.38 log_{10} cfu/cm^{-2}over the first 24h (Table 1), may be attributed to stronger attachment to the carcass and lower recovery by swab sampling. However, Kinsella *et al.* [3] reported a similar decrease (0.2 log_{10} cfu/cm^{-2}) using excision sampling suggesting the decrease was not the result of the experimental design. Interestingly both studies reported a slight increase in TEC of 0.1 and 0.2 log_{10} cfu/cm^{-2}, respectively. The initial mean *Pseudomonas* spp. count on beef carcasses was 1.14 log_{10} cfu/cm^2. Over the first 48h, *Pseudomonas* counts decreased by 0.11 log_{10} cfu/$cm^{-2}$and then increased by 0.83 log_{10} cfu/cm^{-2}between 48-96h. Fluctuating *Pseudomonas* levels on beef carcasses during chilling have been previously reported [4]. Over the 96h in the carcass chiller, the concentration of *Br. thermosphacta* increased from 0.73 to 2.16 log_{10} cfu/cm^{-2} while LAB remained at approximately 1.3 log_{10} cfu/cm^{-2}. Interestingly, *Br. thermosphacta* (G = 20.3h) grew faster than *Pseudomonas* spp. (G = 40.5h), a result that was not unexpected as Ercolini *et al*. [5] have observed that these bacteria outgrow *Pseudomonas* spp. and LAB on carcasses. The concentration of *Clostridium* spp. on the carcasses was relatively high (1.89 log_{10} cfu/cm^{-2}) upon entry to the chillers and remained at this level throughout the 96h chilling process. Being a strict anaerobe, the absence of growth under aerobic conditions was expected, although the relatively high carcass count was not foreseen.

Table 1. Mean bacterial counts on beef carcasses (time in hours) and primals (time in weeks) during chilling in a commercial slaughter plant.

	Bacterial counts (log_{10} cfu/cm^2)						
Time	TVCp	TVCm	TEC	*Pseudomonas* spp.	LAB	*Br. thermosphacta*	*Clostridium* spp.
	Carcasses						
	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0	2.01	2.04	0.04	1.14	1.42	0.73	1.89
24	1.63	1.53	0.14	1.06	1.01	0.95	1.47
48	1.83	1.81	-0.20	1.03	1.07	1.24	1.55
72	2.22	2.13	-0.14	1.34	1.17	1.72	1.71
96	2.83	2.65	0.55	1.86	1.26	2.16	2.15
[1]G (h)	35.5	47.8	57.1	40.5	[2]NA	20.3	111.6
	Primals						
0	2.46	2.47	[2]ND	2.12	1.79	1.09	1.55
1	3.05	3.11	ND	2.76	2.25	1.82	2.41
2	4.03	3.90	-0.21	3.62	3.72	2.64	3.58
3	4.97	4.91	-0.06	3.51	4.68	3.80	4.87
4	5.43	5.33	0.10	4.02	5.14	4.14	5.14
5	6.51	6.39	2.13	4.65	6.70	4.68	6.36
6	6.52	6.74	1.75	4.42	6.23	4.76	6.11
[1]G (h)	75.2	71.5	174.5	132.6	68.8	83.2	67.0

[1]G (h) = Estimated mean generation time in hours

[2]NA = not applicable

IV. CONCLUSION

This study provides data on the initial concentrations and growth of bacteria, including key spoilage bacteria, on beef carcasses and primals during routine commercial aerobic (carcasses) and anaerobic (vacuum packaged primals) chilled storage. The data suggests that *Br. thermosphacta* may be a more important spoilage organism that previously considered and controls need to be introduced to reduce the concentration of *Clostridium* spp. on beef carcasses.

ACKNOWLEDGEMENTS

The funding for this research was provided by the Food Institutional Research Measure (FIRM) administered by the Department of Agriculture, Food and the Marine (Ireland) and by Teagasc core funding.

REFERENCES

1. EFSA, (2014). Scientific Opinion on the public health risks related to the maintenance of the cold chain during storage and transport of meat. Part 1 (meat of domestic ungulates). Europen Food Safety Authority. *EFSA J* 12(3):3601, 81 pp.
2. Reid, R., Fanning, S., Whyte, P., Kerry, J., Lindqvist, R., Yu, Z. and Bolton, D. J. (2017) The microbiology of beef carcasses and primals during chilling and commercial storage. Food Microbiology, 61: 50-57.
3. Kinsella, K. J., Sheridan, J. J., Rowe, T. A., Butler, F., Delgado, A., Quispe-Ramirez, A., Blair, I. S. and Mcdowell, D. A. (2006). Impact of a novel spray-chilling system on surface microflora, water activity and weight loss during beef carcass chilling. Food Microbiology 23: 483-490.
4. Crowley, K. M., Prendergast, D. M., Sheridan, J. J. and Mcdowell, D. A. (2010). Survival of Pseudomonas fluorescens on beef carcass surfaces in a commercial abattoir. Meat Science 85: 550-554.
5. Ercolini, D., Russo, F., Torrieri, E., Masi, P. and Villani, F. (2006). Changes in the spoilage-related microbiota of beef during refrigerated storage under different packaging conditions. Applied and Environmental Microbiology 72(7): 4663-4671.