P-02-26 **5:40 PM**

Notes

Shelf-life and microbial community dynamics of vacuum packaged beef during long term super-chilled storage
(#397)

Xue Chen[1], Yimin Zhang*[1], David Hopkins[2], Xiaoyin Yang[1], Pengcheng Dong[1], Xin Luo[1]

[1] Shandong Agricultural University, College of Food Science and Engineering, Taian, China; [2] NSW Department of Primary Industries, Centre for Red Meat and Sheep Development, Cowra, Australia

Introduction
Super-chilled storage with an intense microbial growth delay, less protein denaturation and structural damage, is considered as an advantageous technology for meat products. Currently, this technology has been successfully applied in the preservation of beef, extending the shelf life up to 20 to 30 weeks[1]. Microbial growth and following metabolic activity are the main factors which lead to the deterioration of fresh meat. Previous work showed that the microbial composition and the dominant bacteria of samples at 16 weeks and 30 weeks, played an important role in extending the shelf-life . However, the initial bacterial level, and the microbial composition in the early stage may play a more important role in affecting the shelf-life of the long term super-chilled storage meat. Therefore, the objective of this study was to monitor the growth of bacteria of vacuum packaged beef from two abattoirs during prolonged super-chilled storage for 20 weeks, especially, to investigate the bacterial community of samples during the entire storage.

Methods
Beef M. *longissimus lumborum* (LL) were obtained from two commercial abattoirs (A and B). In each abattoir, ten left LL were collected. Thereafter, each loin was individually portioned into 7 cuts (about 5 cm thick, total of 70 cuts per abattoir) and these were subsequently vacuum-packaged. After transportation to the laboratory (at -1 °C), all samples were stored super-chilled (-1 ± 0.5°C) for up to 20 weeks. Within samples from each abattoir, a total of seven cuts from each carcase were randomly allocated to seven storage times (0, 3, 6, 9, 12, 15, and 20 weeks post-fabrication). Total volatile basic nitrogen (TVBN), microbial counts and microbial diversity were determined for each sample as previously described by Chen et al[2]. The data were analysed using a MIXED model. Storage time, abattoir and their interaction were regarded as fixed factors and carcase was regarded as random factor. Differences in predicted means (PM) for all traits were tested using the PDIFF option, and significance was when $P < 0.05$.

Results
Different initial number and growth rates of TVC and LAB were observed between the two abattoirs (Table 1). The microbial counts of abattoir B samples exhibited a higher rate of increase than abattoir A samples, exceeding 7 lg CFU/cm^2 at week 6. TVBN, as a direct quality indicator of meat freshness/deterioration, which is officially used in China, indicated that the shelf-life of abattoir A and B samples were less than 12 weeks and 9 weeks, respectively (threshold was ≤ 15 mg/100g).

Based on the sequencing data, at genus level, the initial bacterial community and microbial succession during storage were different in samples from the two abattoirs (Fig. 1, the relative abundances > 1%). *Carnobacterium* spp. and *Lactobacillus* spp. alternately dominated in abattoir A samples and *Carnobacterium* spp., *Serratia* spp. and *Lactococcus* spp. alternately dominated in abattoir B samples throughout week 3 to 9; and *Lactobacillus* spp. and *Carnobacterium* spp. were the most predominant genus in abattoir A and B samples at the end of storage, respectively. Moreover, *Serratia* spp. was observed at all storage time points, with a relatively high prevalence (8.9% ~ 18.1%) except at 20 weeks and *Pseudomonas* spp. showed an increase at 20 weeks (15.3%) in abattoir A samples. Meanwhile, the relative abundance of *Serratia* spp. was significant (10.8%~20.3%) at the final stage of storage in abattoir B samples. The results indicate that *Lactobacillus* spp. might be more efficient to extend the shelf-life of super-chilled storage beef than *Carnobacteria* spp. The dominant bacteria after the TVC number reached 6 lg CFU/cm^2, may play an important role in determining the shelf-life of super-chilled stored meat, since the dominant position of *Lactobacillus* spp. and *Carnobacteria* spp. in abattoir A and abattoir B achieved at 6 weeks and 3 weeks, respectively, when the TVC were up to 6 lg CFU/cm^2, coincidentally. However, their direct relationship and effects on the final shelf-life need further exploration.

Conclusion
This study reveals that the initial bacterial level, and the bacterial community and succession plays an important role on the physicochemical properties and shelf-life of beef and that there is significant difference between abattoirs in terms of bacterial levels. The acceptable shelf life of vacuum-packed beef cuts with high initial bacterial levels was shorter than that with low initial TVC based on the TVBN values. There was a dominance of *Lactobacillus* spp. and *Carnobacterium* spp. in samples during the late storage period from abattoir A and B, respectively, Further work needs to compare the bio-protective effects of *Lactobacillus* spp. and *Carnobacterium* spp. on super-chilled storage beef cuts, and then to apply the bio-protective bacteria in practice.

References
[1]Small, A. H., Jenson, I., Kiermeier, A., & Sumner, J. 2012. Vacuum-packed beef primals with extremely long shelf-life have unusual microbiological counts. Journal of Food Protection, 75, 1524–1527.

[2]Chen, X., Zhang, Y., Yang, X., Hopkins, D. L., Zhu, L., Dong, P., Liang, R., & Luo X., 2019. Shelf-life and microbial community dynamics of super-chilled beef imported from Australia to China. Food Research International, 120, 784-792.

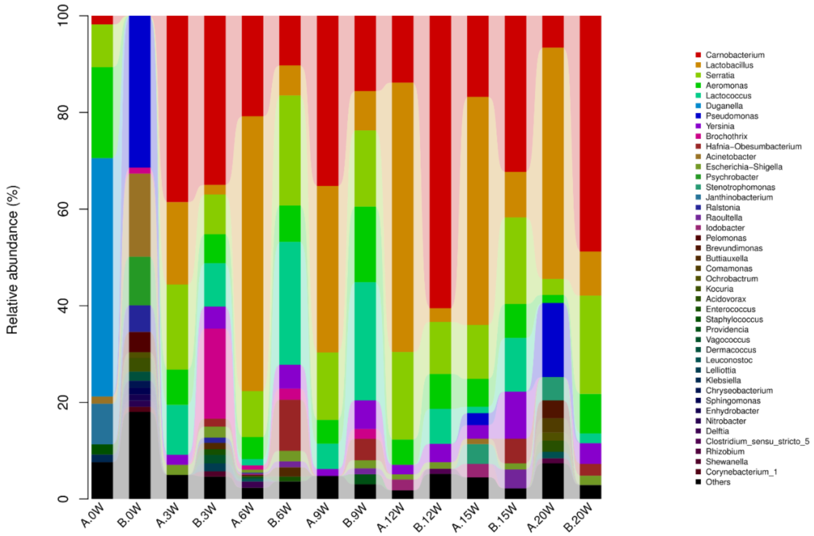

Fig. 1. Relative abundance (%) of the bacteria of vacuum-packaged beef at genus level. "Others" means the groups of other bacteria with lower abundance.

Fig. 1.

Table 1 Microbial growth and TVBN of the vacuum-packaged beef during storage

Traits	Storage time (weeks)	Abattoir		SE	*P*-value		
		Abattoir A	Abattoir B		Abattoir	Storage time	Abattoir× Storage time
TVC (lg CFU/cm^2)	0	4.15^{Db}	4.87^{Da}	0.12	<0.001	<0.001	0.038
	3	5.91^{Cb}	6.55^{Ca}				
	6	6.30^{Bb}	7.53^{ABa}				
	9	6.74^{Ab}	7.51^{ABa}				
	12	6.82^{Ab}	7.26^{Ba}				
	15	6.97^{Ab}	7.61^{Aa}				
	20	6.73^{Ab}	7.33^{ABa}				
LAB (lg CFU/cm^2)	0	2.89^{Da}	3.17^{Ca}	0.12	<0.001	<0.001	0.031
	3	5.87^{Cb}	6.47^{Ba}				
	6	6.41^{Bb}	7.46^{Aa}				
	9	6.79^{Ab}	7.43^{Aa}				
	12	6.94^{Aa}	7.26^{Aa}				
	15	7.00^{Ab}	7.52^{Aa}				
	20	6.69^{ABb}	7.25^{Aa}				
TVBN (mg/100g)	0	11.94^{Ea}	10.34^{Db}	0.40	0.001	<0.001	<0.001
	3	12.53^{Ea}	10.45^{Db}				
	6	13.56^{Da}	13.77^{Ca}				
	9	14.79^{Ca}	15.26^{Ba}				
	12	16.66^{Ba}	15.24^{Bb}				
	15	16.47^{Ba}	17.85^{Ab}				
	20	20.11^{Aa}	18.35^{Ab}				

Table 1
Means with different superscript capital letters within the columns differ at $P < 0.05$.Means with different superscript lowercase letters within the rows differ at $P < 0.05$.

Notes