

Cold Chain Workshop: Shelf life of Australian beef and lamb

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Outline

Product journey: Delivering quality meat to consumers

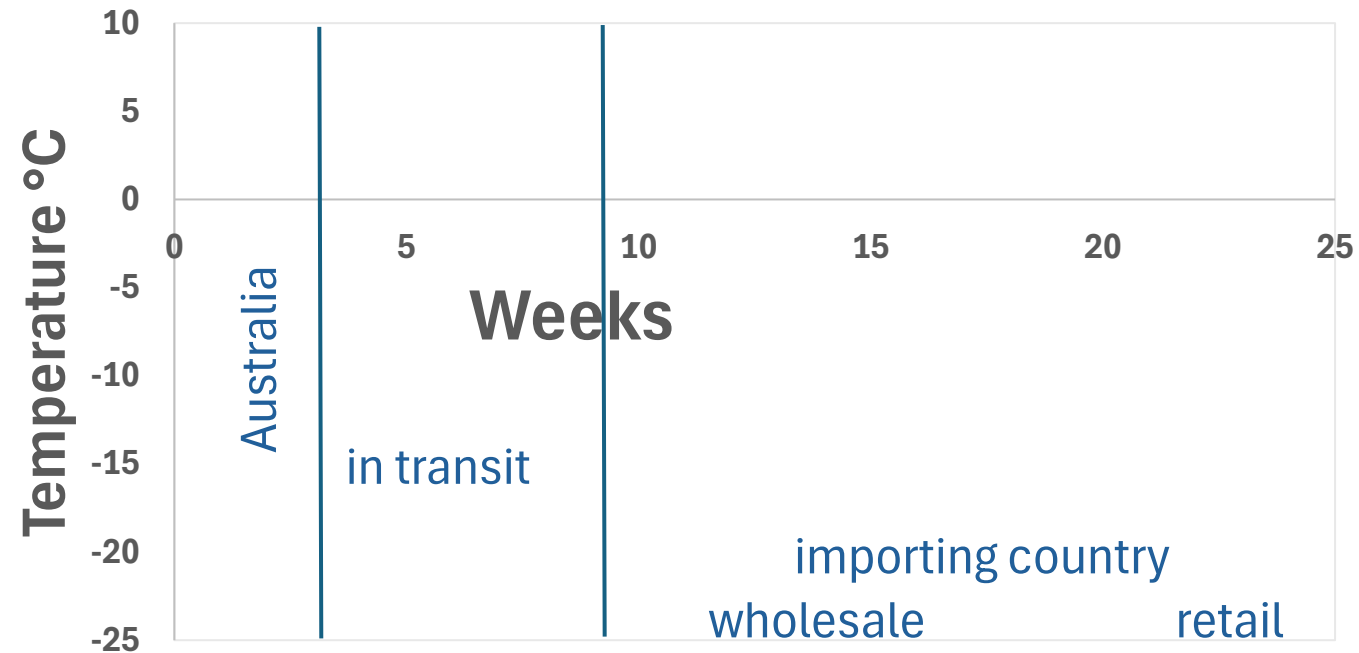
Vacuum packed chilled meat has a long shelf life

Frozen carton meat has a long shelf life

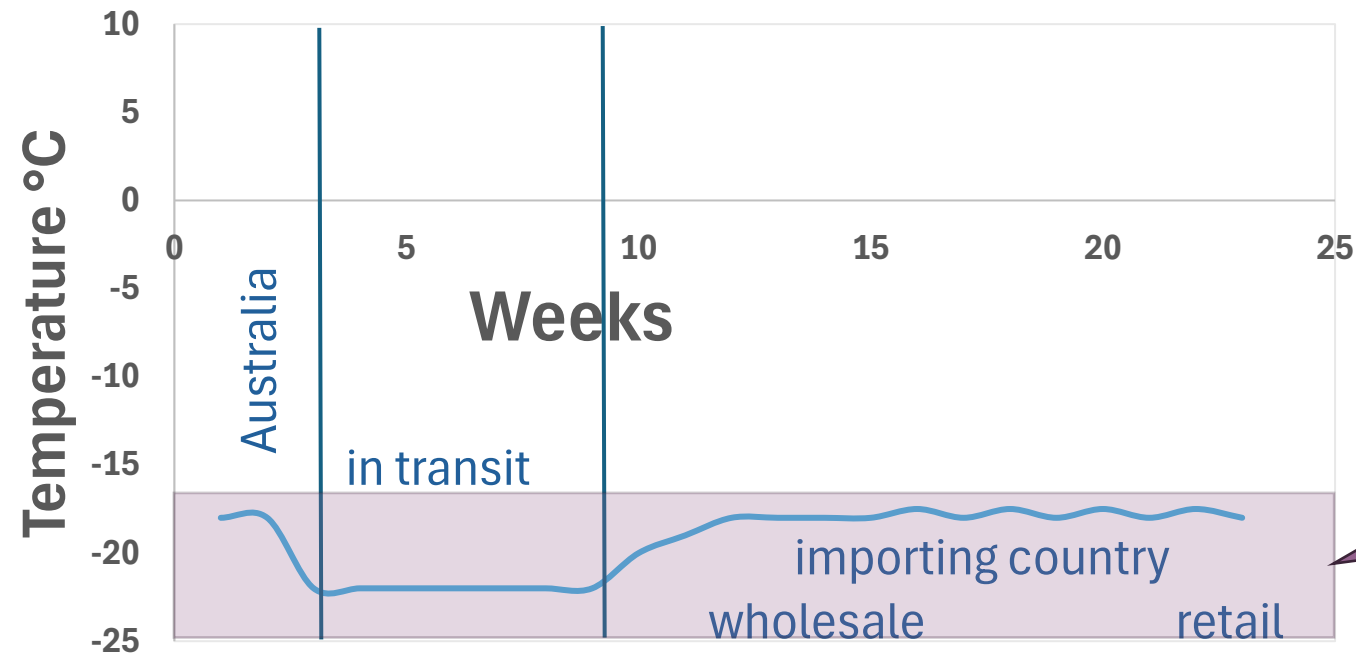
Freezing chilled meat

Chilled meat for retail sale

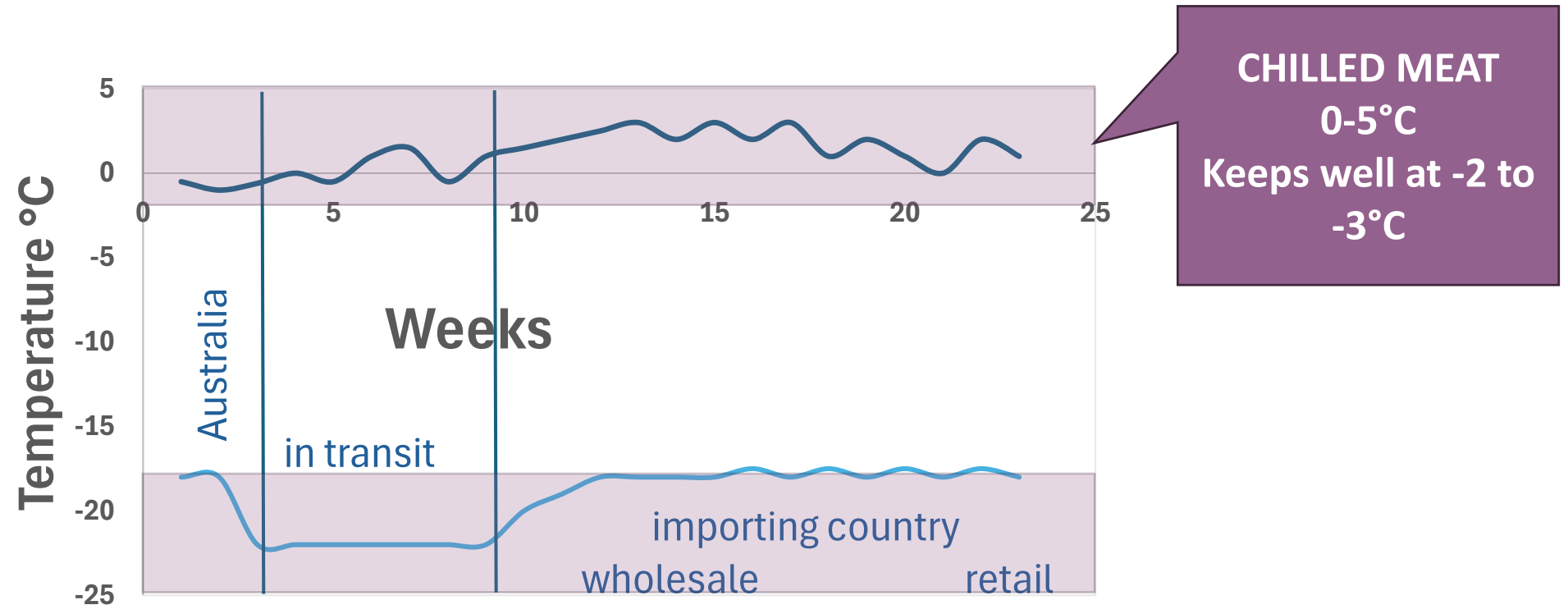
The journey from processor to customer



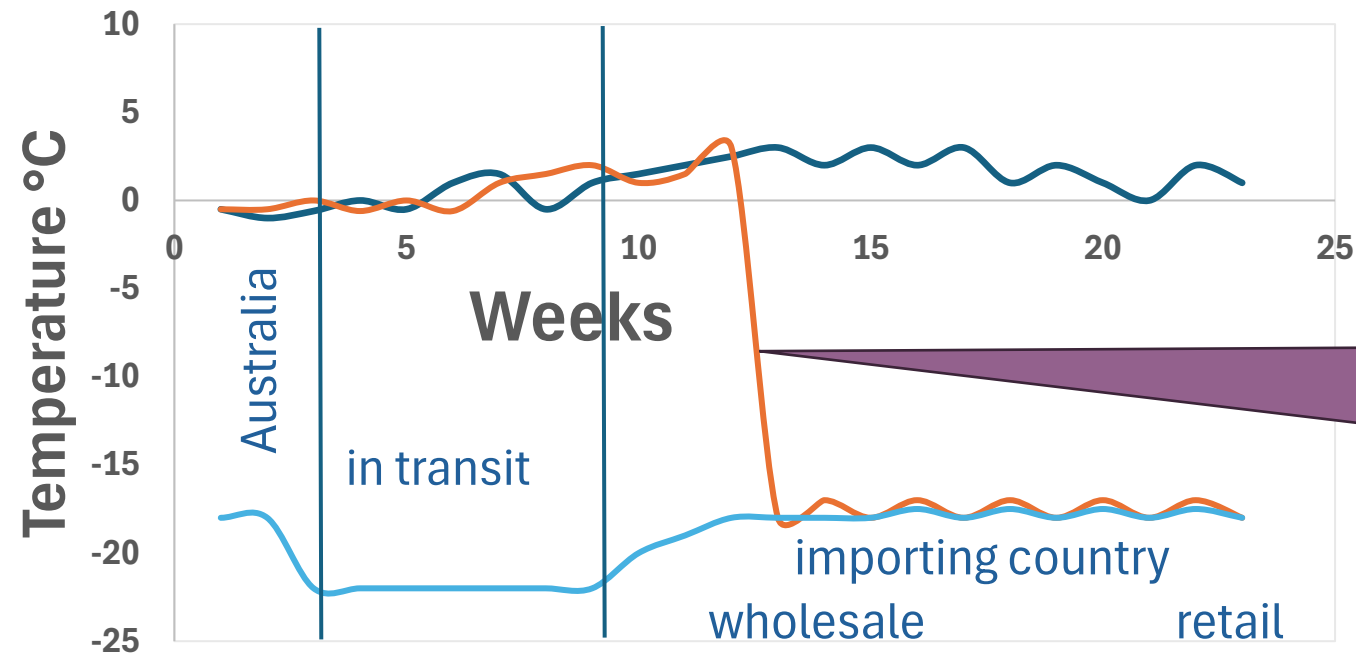
The journey from processor to customer **is about temperature**



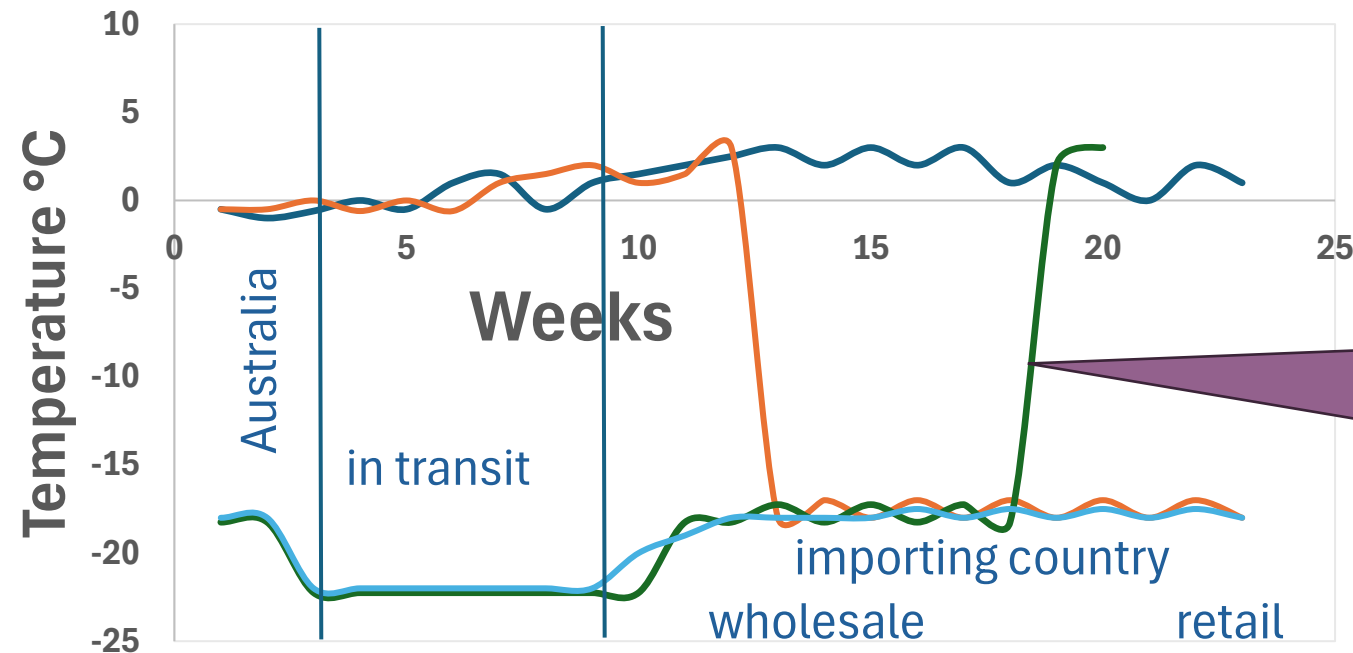
The journey from processor to customer **is about temperature**



The journey from processor to customer **is about temperature**



The journey from processor to customer **is about temperature**



FROZEN MEAT
is thawed for retail
/ food service

What is fresh?



Freshness - meat quality

Appearance

- **Colour**
- Presence of liquid (drip)

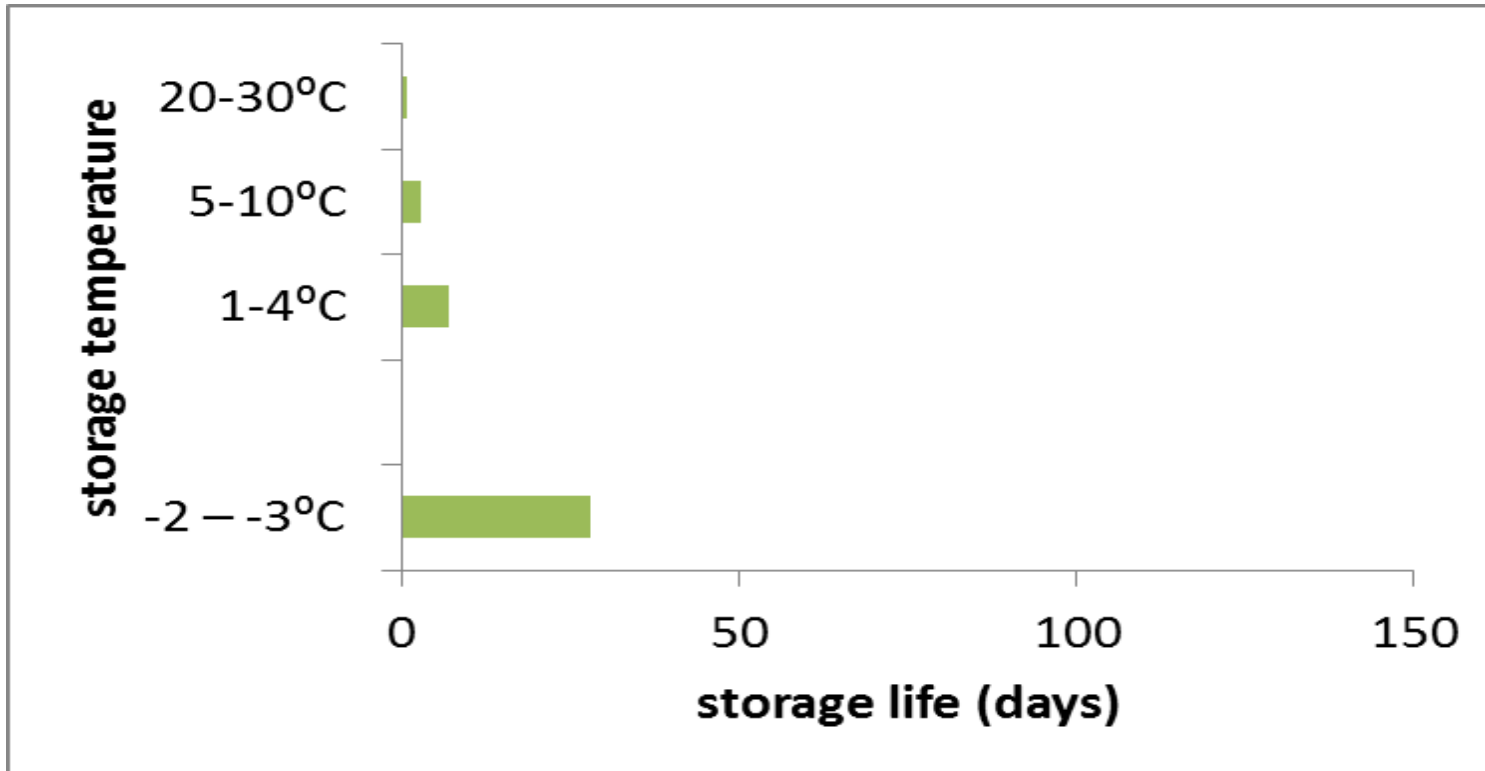
Odour

Eating quality

- Tenderness
- Juiciness
- **Flavour**



Overview of fresh meat shelf life



Short shelf life even at very low temperature

Zhang - ICoMST 2010

Vacuum-packed chilled meat



Vacuum packing

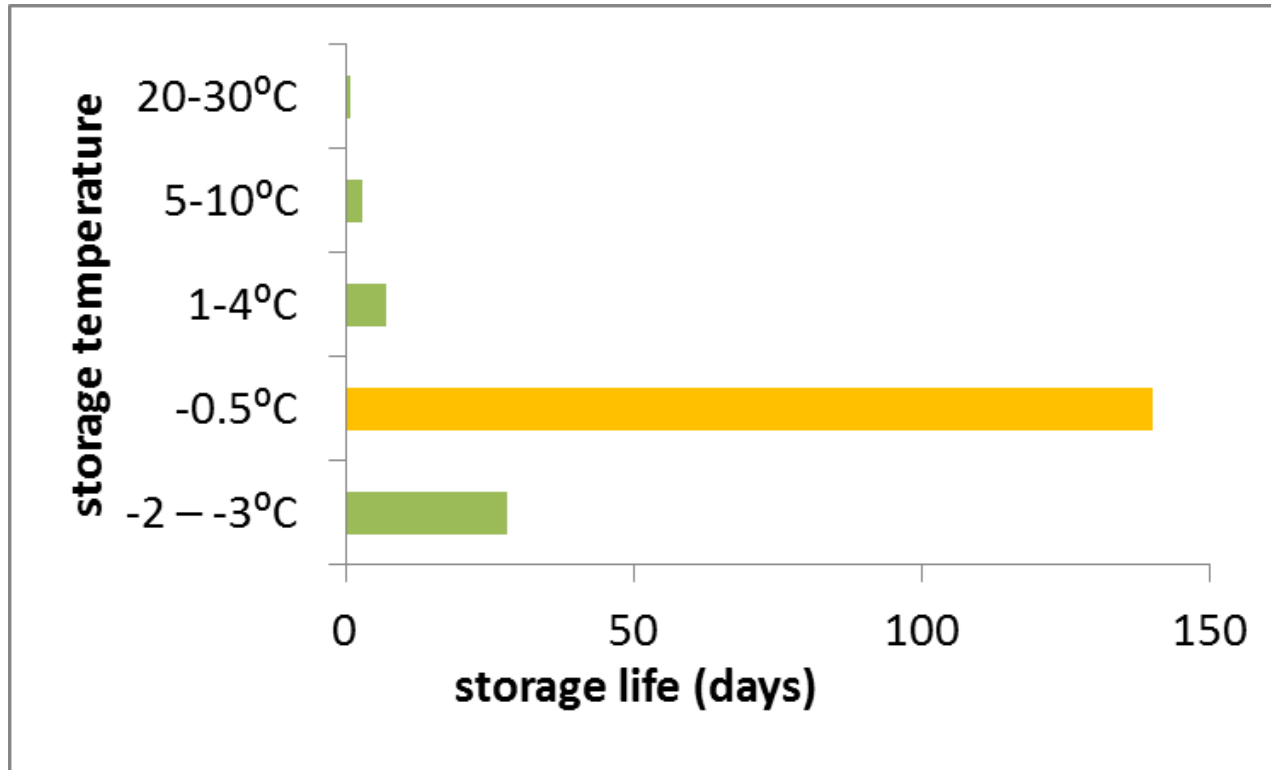


- Changed bacterial ecology
- Long shelf-life
- Acceptable quality

- Removal of oxygen
- Build up of carbon dioxide (muscle respiration)
- chilled



Vacuum packed, chilled meat has a long shelf life



Zhang - ICoMST 2010

Expected shelf life

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Research Note

Vacuum-Packed Beef Primals with Extremely Long Shelf Life Have Unusual Microbiological Counts

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Research Note

Unusual Compositions of Microflora of Vacuum-Packaged Beef Primal Cuts of Very Long Storage Life

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MS 14-190: Received 26 April 2014/Accepted 18 July 2014

Review

Factors affecting microbial spoilage and shelf-life of chilled vacuum-packed lamb transported to distant markets: A review

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Contents lists available at SciVerse ScienceDirect

Food Microbiology

journal homepage: www.elsevier.com/locate/fm



Microbial growth, communities and sensory characteristics of vacuum and modified atmosphere packaged lamb shoulders

Andreas Kiermeier ^a, Mark Tamplin ^{b,*}, Damian May ^a, Geoff Holds ^a, Michelle Williams ^b, Alison Dann ^b

Shelf life

Up to 160 days for beef
Up to 90 days for lamb.

Available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci



Why does Australian beef have a long shelf life?

Good quality meat (pH reduction in muscle during chilling)

Good hygiene (low bacterial counts)

Good quality packaging materials (low oxygen permeability)

Low oxygen in sealed packs

Low temperature during storage and transport



Temperature control during storage and transport are essential for good quality





Duration summary		Product	Bacterial numbers (TVC)		
Start Date/Time:	#####	Beef	(cfu)	(log cfu)	
End Date/Time:	#####	Initial	100	2.00	
Recording Interval (min):	25.0	Increase	×1,000,000	6.00	
Total storage duration	119.7 days	Final	100,000,000	8.00	
	2872.8 hrs				
				Expected Shelf-life, if temperature held constant	Estimated Shelf-life Remaining, actual temperature trace provided
			Temperature		
Temperature Summary		Average	0.15 °C	128 days	2 days
Average Temp:	0.15 °C	Preferred	-0.50 °C	174 days	3 days
Min Temp:	-1.44 °C	Expected (remaining storage)	0.50 °C		2 days
Max Temp:	5.09 °C				

[illegible]

Journey from Australia to HCMC



Hour 0 – Meat processor

Hour 15 – arrive airport

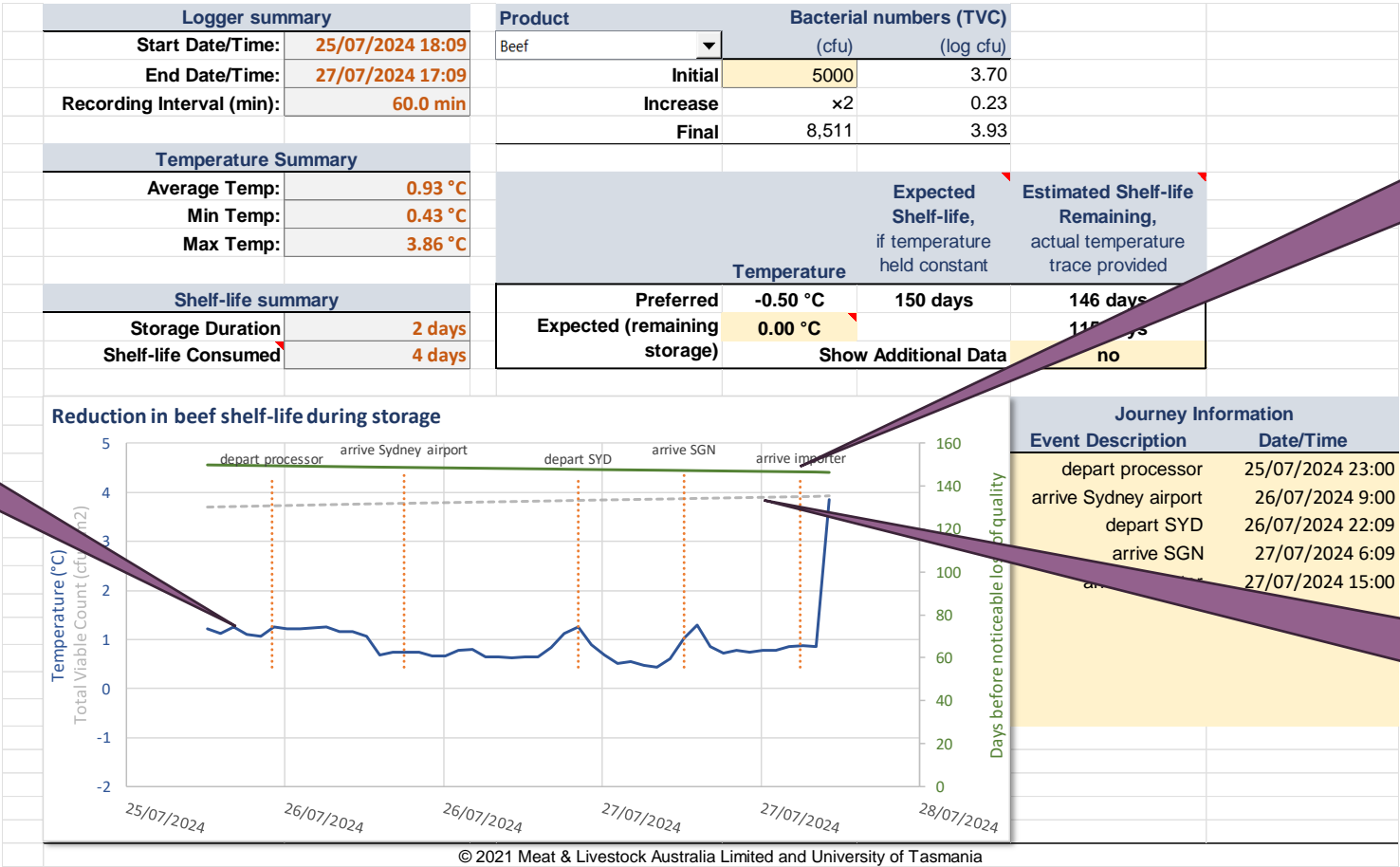
Hour 28 – depart SYD

Hour 36 – arrive SGN

Hour 45 – arrive at importer

Effect of temperature on shelf life

Temperature

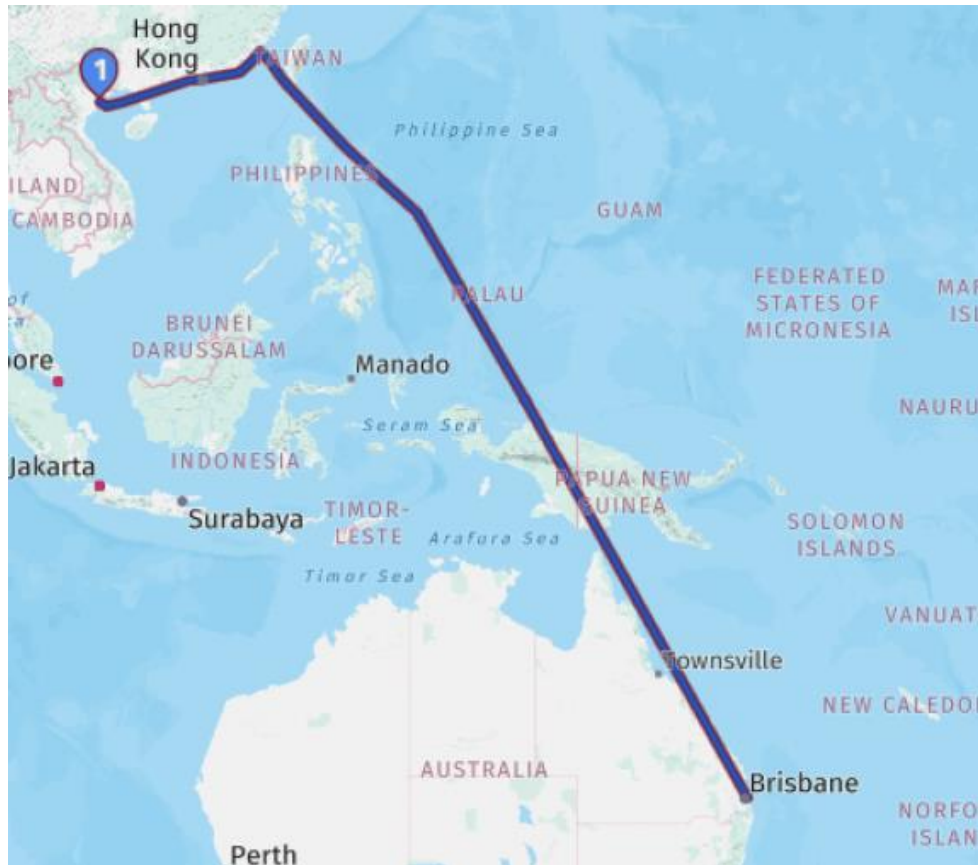


Remaining shelf life

Predicted bacterial count

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Journey from Australia to Hai Phong



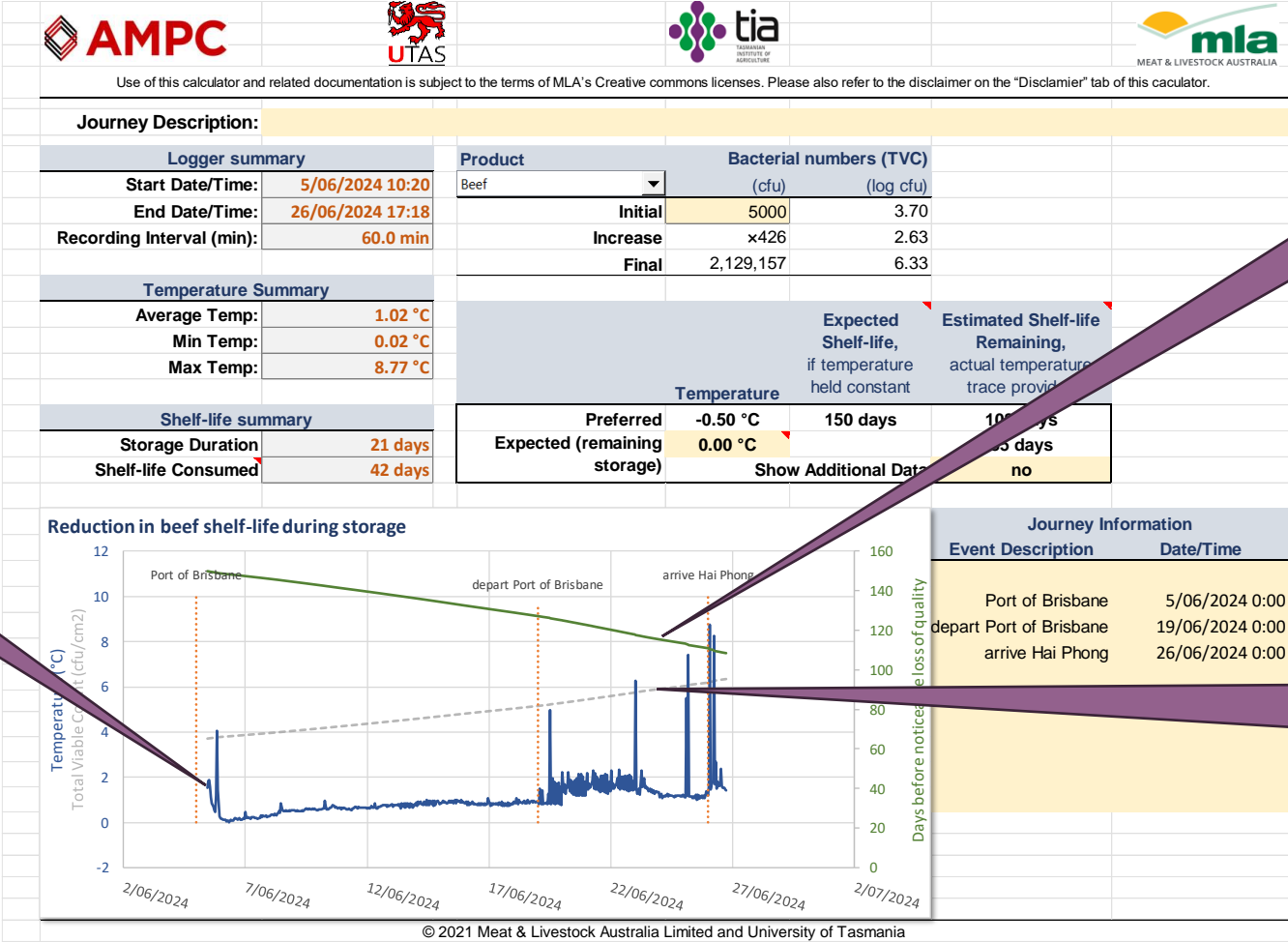
Day 0 – Meat processor

Day 2 – arrive Port of Brisbane

Day 16 – depart Port of Brisbane

Day 31 – Hai Phong

Effect of temperature on shelf life

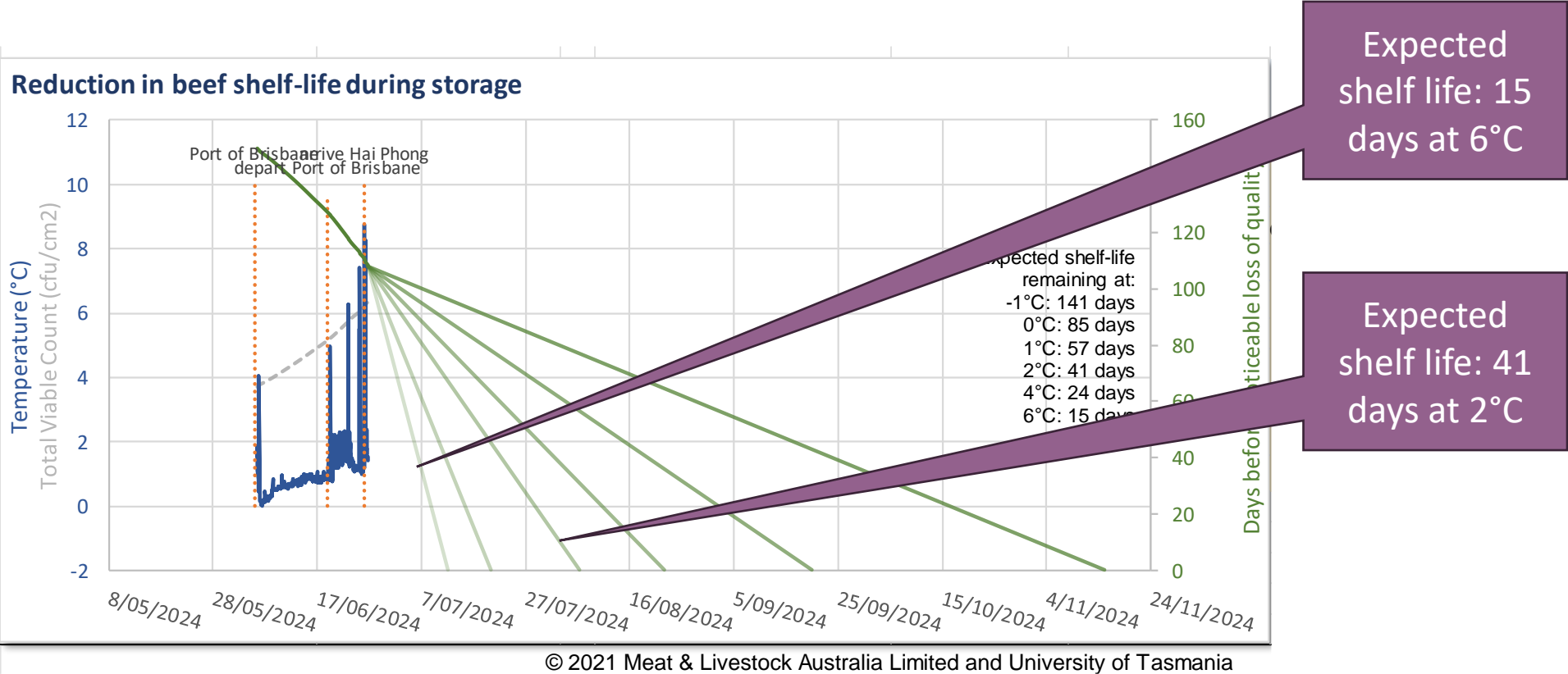


Remaining shelf life

Temperature

Predicted bacterial count

Predicting the effect of future storage temperature



To achieve the best shelf life

Keep the temperature as low as possible (-1°C)

Short time at a higher temperature is OK

Don't let the temperature go up and down too many times

Don't have too much stock

Rotate stock – First expire, first out (FEFO)

Monitor temperature



Frozen meat

What is the shelf life of frozen meat?

Shelf life assessment – beef (striploin, manufacturing) and lamb (short loin, manufacturing)

- Commercial shipping Australia – Grimsby (United Kingdom)
- Store -12°C, -18° C and -24°C for 38 months from processing
- Physical – drip, colour, texture
- Chemical – fat degradation
- Microbiological – Aerobic colony counts
- Sensory – cooked product – appearance, odour, flavour, juiciness, tenderness

International Journal of Refrigeration 171 (2025) 51–65



Contents lists available at ScienceDirect

International Journal of Refrigeration

journal homepage: www.elsevier.com/locate/ijrefrig



INSTITUT INTERNATIONAL DU FROID
INTERNATIONAL INSTITUTE OF REFRIGERATION

The practical storage life of Australian frozen boxed beef and lamb

Christian James^{a,1,6}, Stephen J. James^a, Graham Purnell^a, Luke Talbot^a,
Essam Hebishy^{b,2}, Sophie Bowers^b, Bukola A. Onarinde^b, Long Huynh^{c,3}, Ian Jenson^{c,4,5,*}

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James, C. et al. (2022) The shelf-life of Australian frozen red meat MLA Final Report V.MFS.0428

James, C et al., (2025) International Journal of Refrigeration 171:51-65

What is the shelf life of frozen meat?

- All meat had a shelf life of at least 28 months
- -12, -18 and -24°C were equally effective
- Product held in vacuum bags (Beef and lamb loin and beef trim) without significant sensory degradation for a period of over 36 months.
- Frozen boxed lamb wrapped in plastic did not produce unacceptable sensory scores until more than 28 months of frozen storage.

James, C. et al. (2022) The shelf-life of Australian frozen red meat MLA Final
Report V.MFS.0428

James, C et al., (2025) International Journal of Refrigeration 171:51-65

James, C et al., (2025) International Journal of Refrigeration 171:51-65

Australian Meat Processor Corporation

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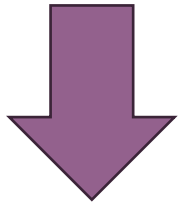
Freezing of chilled meat



Chilled – frozen beef and lamb



Chilled
beef and
lamb
stored for
5 weeks



Frozen for
up to 12
months
-12, -18°C

Analysis:

Eating quality (instrumental methods)

Display life

Chemistry: lipid and protein degradation

https://www.ampc.com.au/getmedia/345cd1ed-e513-4355-9cab-8cdc9061e37b/AMPC_IdentifyingStorageThresholdsInFrozenAndChilledRedMeat_FinalReport.pdf?ext=.pdf

Chilled – frozen beef and lamb

- Effects of storage temperature were negligible
- Consumers may not be aware of the difference
- Product can be held without a reduction in tenderness, development of rancidity
- Colour stability was reduced – will not remain as red for as long on retail display once thawed

Shelf life of retail meat

Retail packaging

		Appearance	Shelf life	Cost	Consumer	Drip leakage
Overwrap		Bright red	3-5 days	VND	Familiar, fresh look	high
Modified Atmosphere		Bright red	7-14 days	VND VND	Bright red, premium feel	moderate
Vacuum skin pack		Darker	30-40 days	VND VND VND	Premium feel packaging,	low

Retail packaging – what happens after the vacuum pack?



Vacuum pack



Overwrap - air



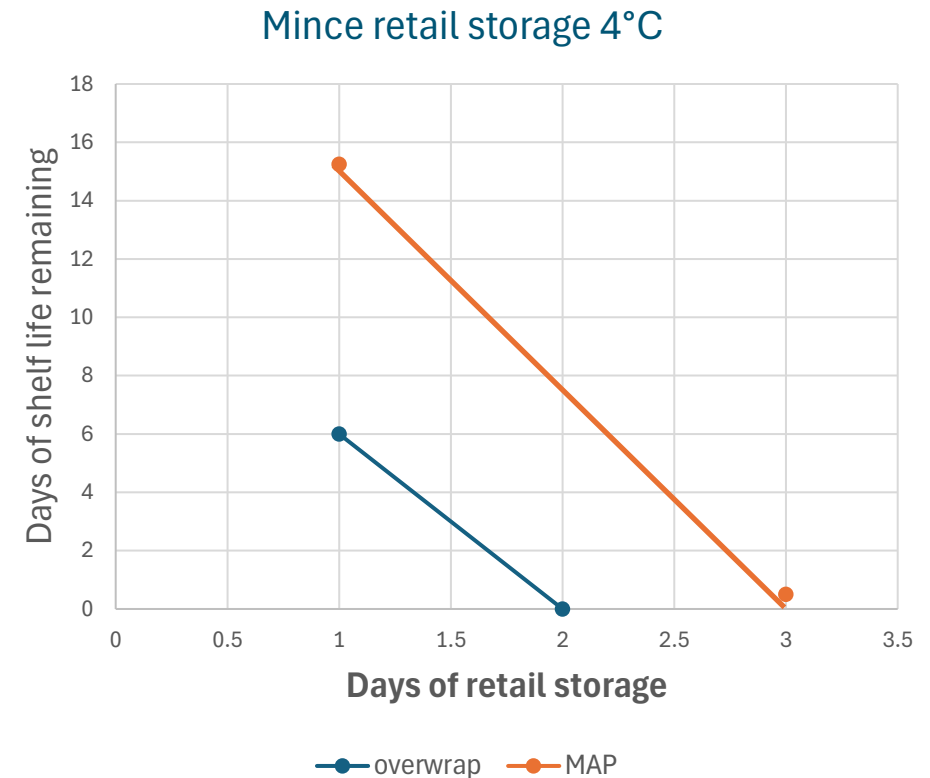
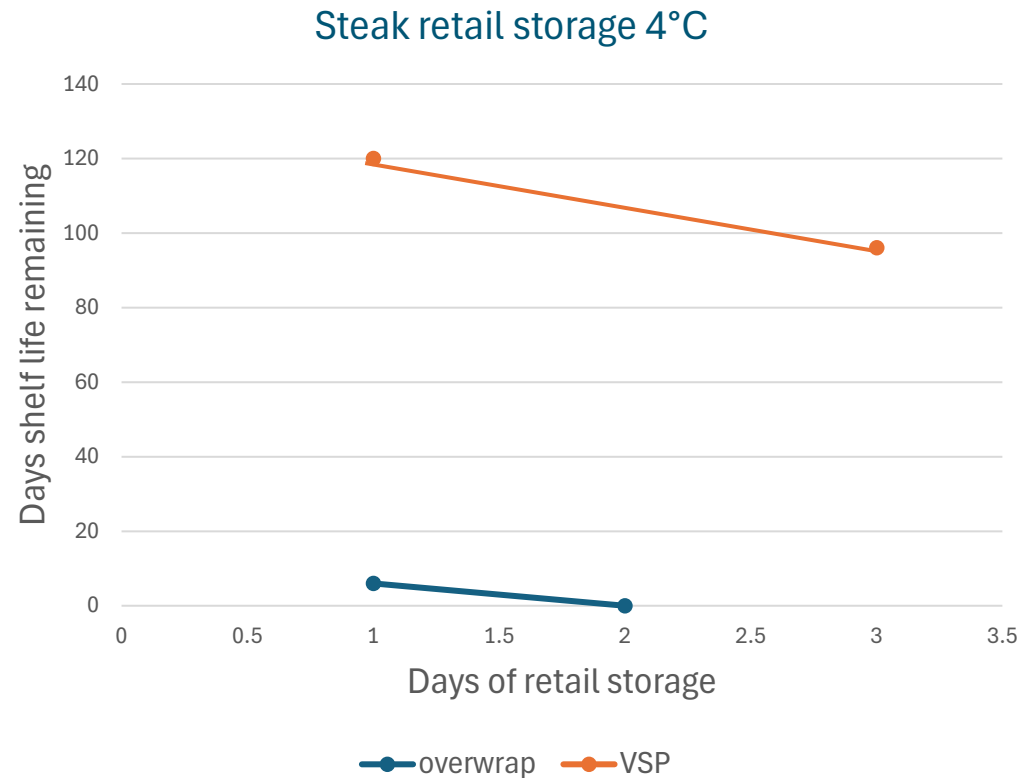
Modified atmosphere
(MAP) – 20%CO₂ in
O₂



Vacuum skin pack
(VSP)

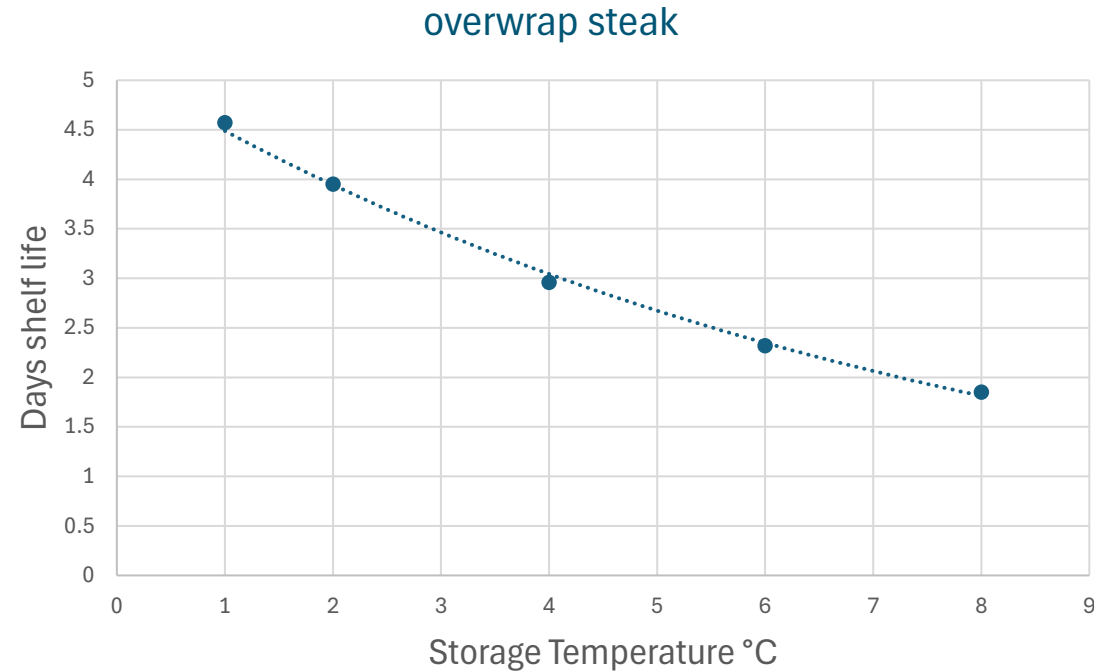
<https://www.mla.com.au/contentassets/f16b0d6882f14970962b8f5f0be36726/manuscript-for-shelf-life-model-development-of-ow-and-map.pdf>

Packaging method determined shelf life



<https://tools.mla.com.au/shelf-life-calculator/>

Temperature also determines retail shelf life



<https://tools.mla.com.au/shelf-life-calculator/>

For more information



Shelf life of Australian red meat



[shelf-life-of-australian-red-meat-2nd-edition.pdf](#)

Acknowledgements

Dr Alison Small, Dr Damian Frank (CSIRO)
Prof Mark Tamplin, Prof Tom Ross, Dr Mandeep
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Dr Andreas Kiermeier (SARDI)
Dr Yimin Zhang 张一敏 (SDAU)





In the journey from
processor to customer, keep
the product cold.