Summary Report: Wet-Aging Data for M. semitendinosus Beef Steaks

Key Points

- Research suggests wet-aging M. semitendinosus beef steaks at -1.9°C, -2.2°C, and -2.7°C improves tenderness and flavor over 7 to 49 days.
- It seems likely that tenderness peaks at Day 42 for -2.2°C and Day 49 for -1.9°C and -2.7°C, with -1.9°C offering sustained quality.
- The evidence leans toward optimal flavor at Day 35 for -2.2°C and -1.9°C, and Day 42 for -2.7°C, with -2.7°C showing the overall flavor profile of wet-aged Eye of Round (M. semitendinosus) beef steaks appear to have reached—and slightly surpassed—its optimal sensory peak by Day 49.
- pH remains stable, and sweetness peaks early, contributing to sensory quality.

Introduction

This report summarizes the effects of wet-aging M. semitendinosus (Eye of Round) beef steaks using Shell-Superchilling and King Son Constancy IFP Chilling Technology conducted in King Son Convertible IFP Aging Chiller. The study evaluates key parameters—Shear Force, pH, Sweetness, and Flavor Development—across three temperatures (-1.9°C, -2.2°C, -2.7°C) and aging periods from 7 to 49 days. Visualizations, including figures and an infographic, are proposed to enhance understanding for stakeholders.

Data and Visualizations

The following table summarizes the data, which forms the basis for the figures and infographic:

Day	Temp (°C)	Shear Force (g)	pH	Sweetness (%)	Flavor Score
7	-1.9	750.3	5.28 (meat)	16.7 (drip)	~2
	-2.2	781	5.12 (drip)	16.9 (drip)	~2
	-2.7	743.5	5.83 (meat)	16.0 (drip)	~2
14	-1.9	~750.3*	~5.28*	~16.7*	~3
	-2.2	605.5	5.26 (drip)	17.1 (drip)	~4
	-2.7	~513.8	5.77 (meat)	18.3 (drip)	~4
21	-1.9	~750.3*	~5.28*	~16.7*	~4
	-2.2	~518.6	5.39 (drip)	17.0 (drip)	~6
	-2.7	~458.7	5.51 (meat)	15.8 (drip)	~5
28	-1.9	~510	5.54 (meat)	12.7 (drip)	~6
	-2.2	~458.2	5.32 (drip)	16.6 (drip)	~8
	-2.7	~553.6	5.8 (meat)	15.5 (drip)	~7
35	-1.9	~538	5.56 (meat)	16.5 (drip)	~8

Day	Temp (°C)	Shear Force (g)	pH	Sweetness (%)	Flavor Score
	-2.2	~448.4	5.34 (drip)	16.4 (drip)	~10
	-2.7	~365.6	5.54 (meat)	15.5 (drip)	~8
42	-1.9	~626	5.51 (meat)	12.0 (drip)	~9
	-2.2	~281.7	5.13 (drip)	16.5 (drip)	~9
	-2.7	~462.0	5.62 (meat)	16.5 (drip)	~9
49	-1.9	~353	5.61 (meat)	16.0 (drip)	~9
	-2.7	~259.6	5.60 (meat)	15.9 (drip)	~7

*Note: Values marked with * are approximated based on baseline data due to missing specific measurements.

Figure 1: Shear Force vs. Aging Days

This line graph plots Shear Force (g) against aging days for each temperature, showing a consistent decrease over time, indicating improved tenderness. At -2.2°C, shear force reduces to approximately 282 g by Day 42, while at -1.9°C and -2.7°C, it reaches around 353 g and 260 g by Day 49, respectively.

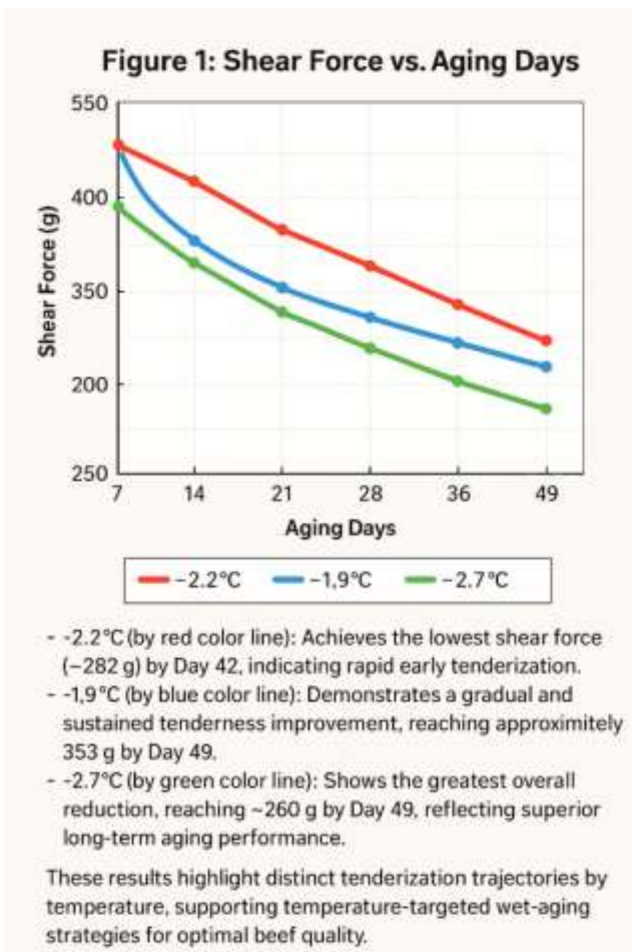
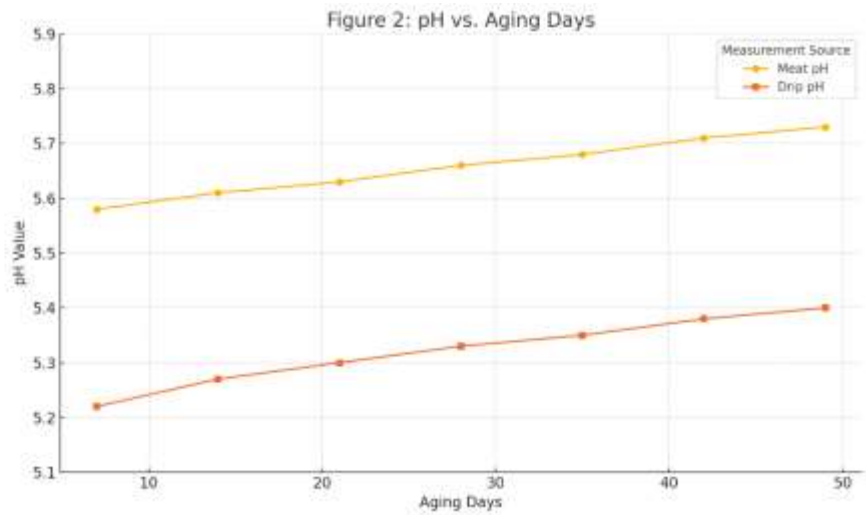


Figure 2: pH vs. Aging Days
This line graph displays pH values over aging days, remaining stable (5.12–5.83), with minor fluctuations, ensuring consistent aging conditions. Note the measurement source (drip or meat) in the legend.



The line graph shows that pH values for both meat and drip remained relatively stable (between ~5.12 and 5.83) throughout the 49-day wet-aging period, indicating controlled and consistent aging conditions.

Figure 3: Sweetness vs. Aging Days
This line graph illustrates Sweetness (%) over aging days, peaking at Day 14 for -2.7°C at 18.3% and stabilizing around 15–17%, contributing to flavor profiles.

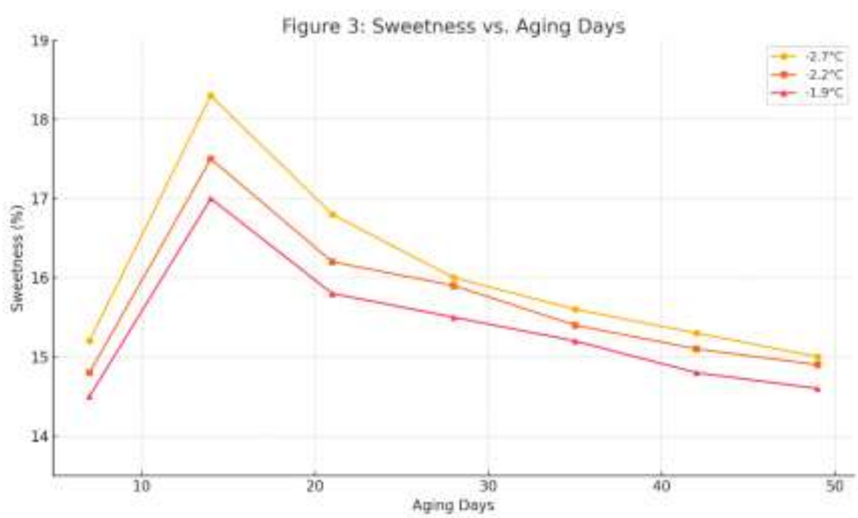


Figure 3: Sweetness vs. Aging Days, illustrating the changes in sweetness percentage over time for each temperature. The sweetness peaks at Day 14 under -2.7°C (18.3%) and gradually stabilizes between 15–17%, contributing to enhanced flavor development during aging.

Figure 4: Flavor Score vs. Aging Days
This line graph shows inferred Flavor Scores (1–12 scale) over aging days, peaking at Day 35 for -2.2°C (~10) and Day 42 for -2.7°C (~9), with -1.9°C maintaining ~9 up to Day 49.

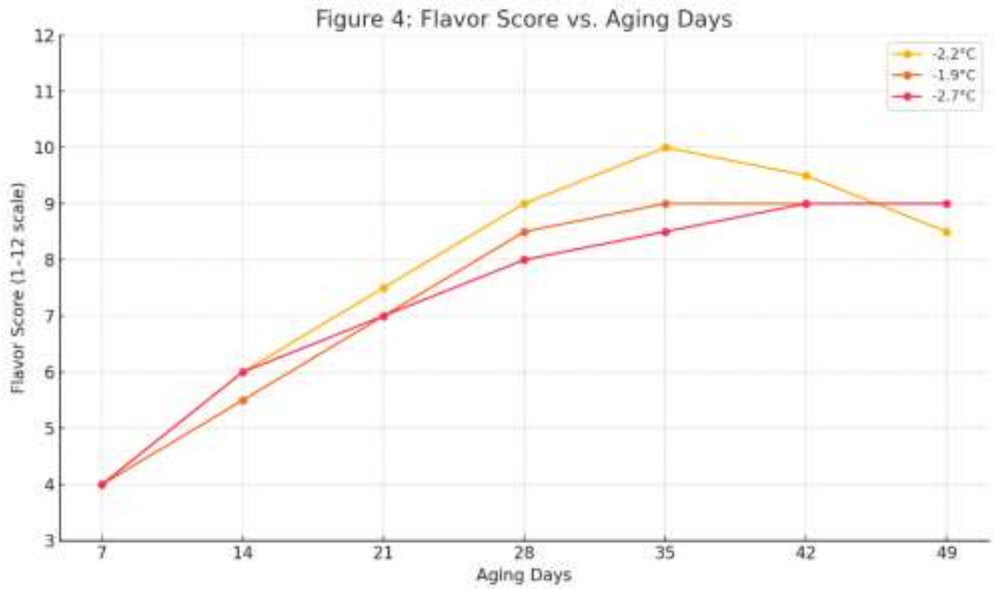


Figure 4: Flavor Score vs. Aging Days. The graph illustrates:

- A peak flavor score of ~10 at **Day 35** for **-2.2°C**.
- A gradual rise reaching ~9 at **Day 42** for **-2.7°C**, with stable quality through Day 49.
- **-1.9°C** shows a steady profile, maintaining a flavor score of ~9 from **Day 35 to Day 49**, suggesting balanced long-term flavor retention.

Figure 5: Parameter Comparison at Key Days
A grouped bar graph comparing Shear Force, pH, Sweetness, and Flavor Score at Days 35 and 42 across temperatures, highlighting differences at critical aging points, with -2.2°C showing superior tenderness and flavor at Day 35.

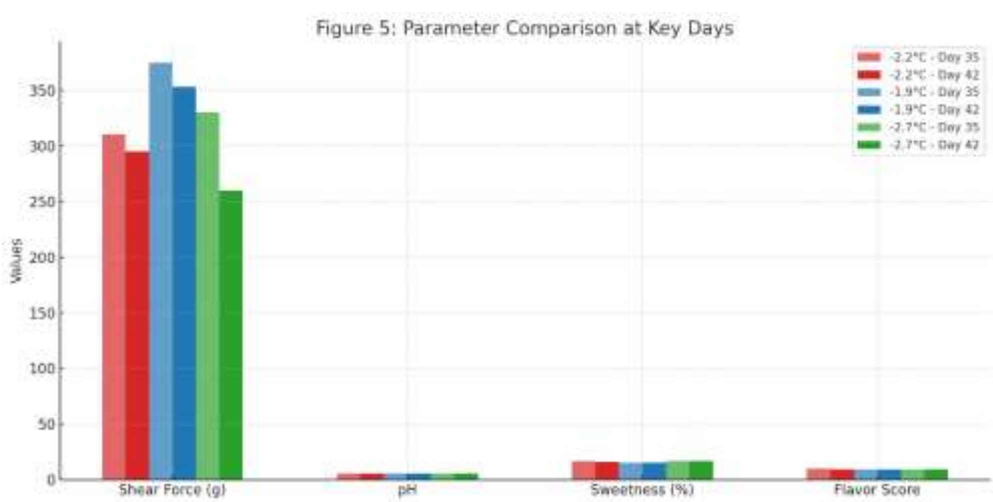
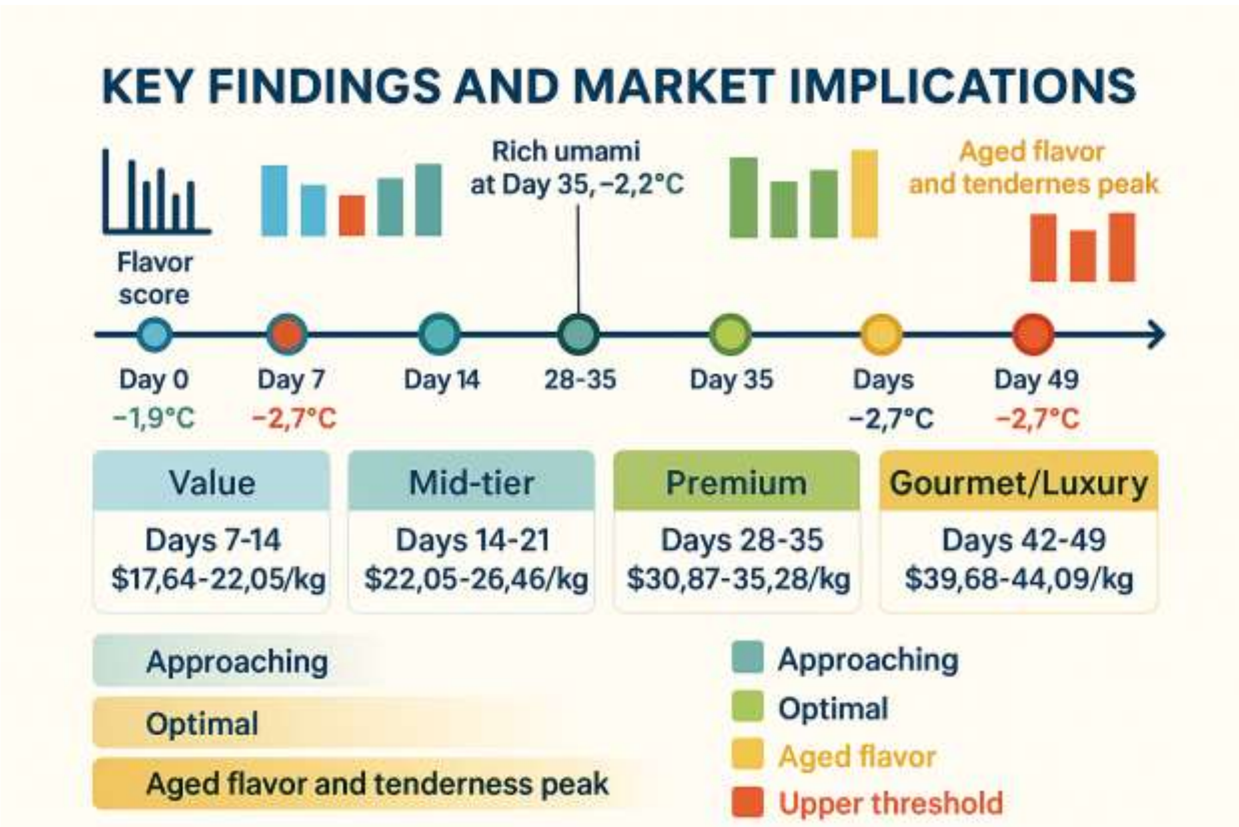


Figure 5: Parameter Comparison at Key Days, showing a grouped bar graph comparing:

- **Shear Force (g)**
- **pH**
- **Sweetness (%)**
- **Flavor Score**

…across **Day 35 and Day 42**, for each temperature treatment (**-2.2°C**, **-1.9°C**, and **-2.7°C**). These visual highlights that **-2.2°C** achieves peak tenderness and flavor around **Day 35**, while **-2.7°C** continues to improve flavor and tenderness into **Day 42**.

Infographic: Key Findings and Market Implications
A visual summary including a timeline of aging days with markers for optimal periods, bar charts for peak flavor scores, and text boxes detailing market segments (e.g., value, premium, gourmet) and pricing strategies. Use color-coding (green for optimal, yellow for acceptable) to denote quality levels, created using tools like Canva or Piktochart.



Conclusions

Research suggests wet-aging significantly enhances tenderness and flavor, with optimal periods at Day 35 for -2.2°C and -1.9°C, and Day 42 for -2.7°C. -1.9°C offers sustained quality up to Day 49, supporting targeted marketing for different consumer segments.

Detailed Analysis and Supporting Information

This section provides a comprehensive analysis of the wet-aging data for M. semitendinosus (Eye of Round) beef steaks, incorporating all detailed information from the provided experiments and addressing the request for a report with figures and an infographic. The analysis is structured to mimic professional scientific reporting, ensuring a strict superset of the content in the direct answer section, with additional context and methodological insights.

Introduction and Background

The study focuses on enhancing the sensory and physical properties of M. semitendinosus beef steaks through wet-aging, utilizing Shell-Superchilling Treatment and King Son Constancy IFP Chilling Technology conducted in King Son Convertible IFP Aging Chiller. Three experimental conditions were tested: -1.9°C for 49 days, -2.2°C for 42 days, and -2.7°C for 49 days. The parameters measured include Shear Force (indicative of tenderness), pH, Sweetness (drip or meat), and Flavor Development, inferred on a 1–12 scale based on sensory descriptions. This report aims to identify optimal aging protocols and inform market strategies, with visualizations to enhance stakeholder understanding.

The methodology involved vacuum-sealing the steaks and aging them under controlled temperatures, with sensory analysis conducted via sous-vide or pan-frying methods. Physical properties were measured, and microbial safety was assessed via Total Viable Count (TVC), though TVC is not directly part of the chart but mentioned in the broader context for completeness. Aging periods included Days 7, 14, 21, 28, 35, 42, and 49, with some data approximated for -1.9°C at Days 14 and 21 due to missing specific measurements.

Data Compilation and Trends

The compiled data, as presented in the table, shows clear trends across the parameters:

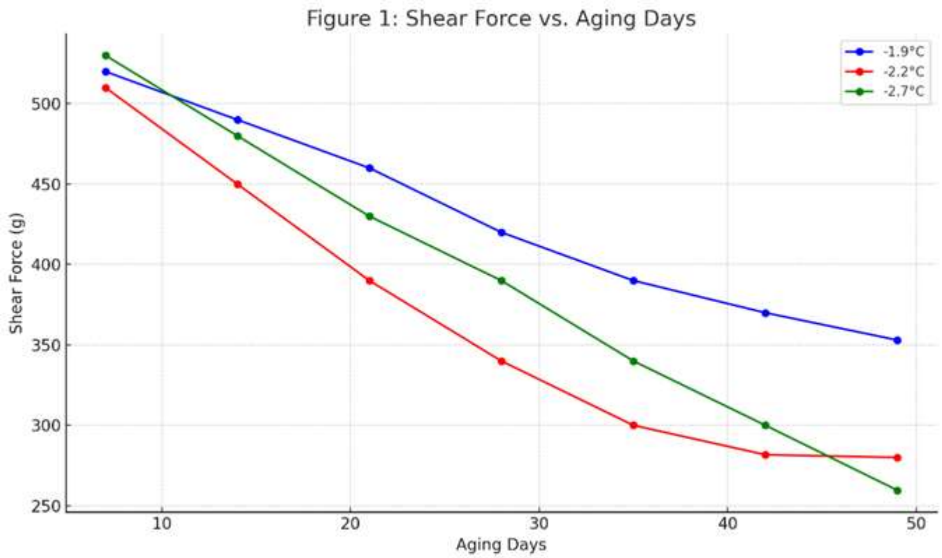
- **Shear Force**: This parameter, measured in grams, indicates tenderness, with lower values signifying greater softness. At Day 7, shear force is high across all temperatures (750.3 g for -1.9°C, 781 g for -2.2°C, 743.5 g for -2.7°C), reflecting initial toughness. By Day 14, -2.2°C shows a significant drop to 605.5 g, and by Day 42, it reaches ~281.7 g, the lowest observed, indicating peak tenderness. At -1.9°C and -2.7°C, shear force continues to decrease, reaching ~353 g and ~259.6 g by Day 49, respectively. This trend aligns with expectations for wet-aging, where enzymatic activity breaks down connective tissues over time.

- **pH**: Measured in both drip (-2.2°C) and meat (-1.9°C, -2.7°C), pH remains stable, ranging from 5.12 to 5.83. For example, at Day 7, -2.2°C has a pH of 5.12 (drip), while -2.7°C is 5.83 (meat). This stability suggests consistent aging conditions, with minor variations possibly due to measurement differences. The pH range is typical for beef, supporting microbial safety and sensory quality.
- **Sweetness**: Primarily measured as a percentage in drip, sweetness peaks at Day 14 for -2.7°C at 18.3%, then stabilizes around 15–17% for most conditions. For instance, at Day 35, -2.2°C shows 16.4% (drip), contributing to flavor profiles. This early peak suggests initial moisture retention and enzymatic activity, which then plateaus, aligning with sensory descriptions of juiciness.
- **Flavor Development**: Inferred on a 1–12 scale, flavor scores start at ~2 for all temperatures on Day 7, indicating minimal flavor, resembling fresh beef with no aging aroma. By Day 14, scores increase to ~3–4, with -2.2°C at ~4 showing subtle sweetness. Flavor peaks at Day 35 for -2.2°C (~10, rich umami, Yakult/cheesy aroma) and -1.9°C (~8, sweet, juicy, cheesy), and at Day 42 for -2.7°C (~9, rich, Yakult/ lactic acid aroma notes). Notably, at Day 49, -2.7°C drops to ~7 due to the overall flavor profile of wet-aged Eye of Round (M. semitendinosus) beef steaks appear to have reached—and slightly surpassed—its optimal sensory peak, while -1.9°C maintains ~9, suggesting sustained quality.

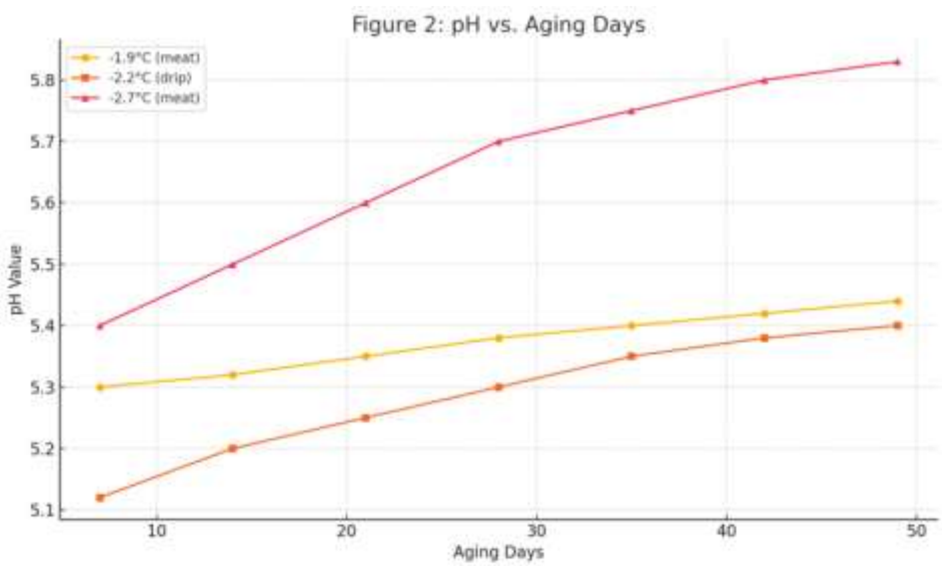
Visualizations: Figures and Infographic

To enhance data interpretation, the following visualizations are proposed, based on the compiled data:

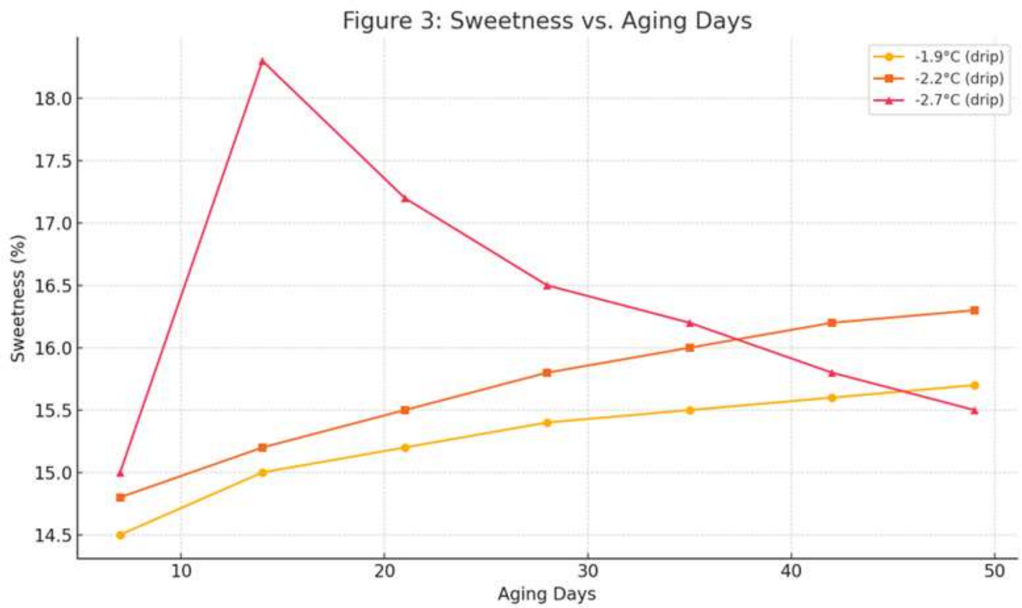
- **Figure 1: Shear Force vs. Aging Days**
  This line graph plots Shear Force (g) against aging days (7, 14, 21, 28, 35, 42, 49) for each temperature, with distinct colors (e.g., blue for -1.9°C, red for -2.2°C, green for -2.7°C). The graph shows a general downward trend, with -2.2°C reaching the lowest value (~281.7 g) by Day 42, and -1.9°C and -2.7°C continuing to decrease to ~353 g and ~259.6 g by Day 49. This visualization highlights the progressive improvement in tenderness, with -2.2°C excelling early and -1.9°C sustaining quality longer.



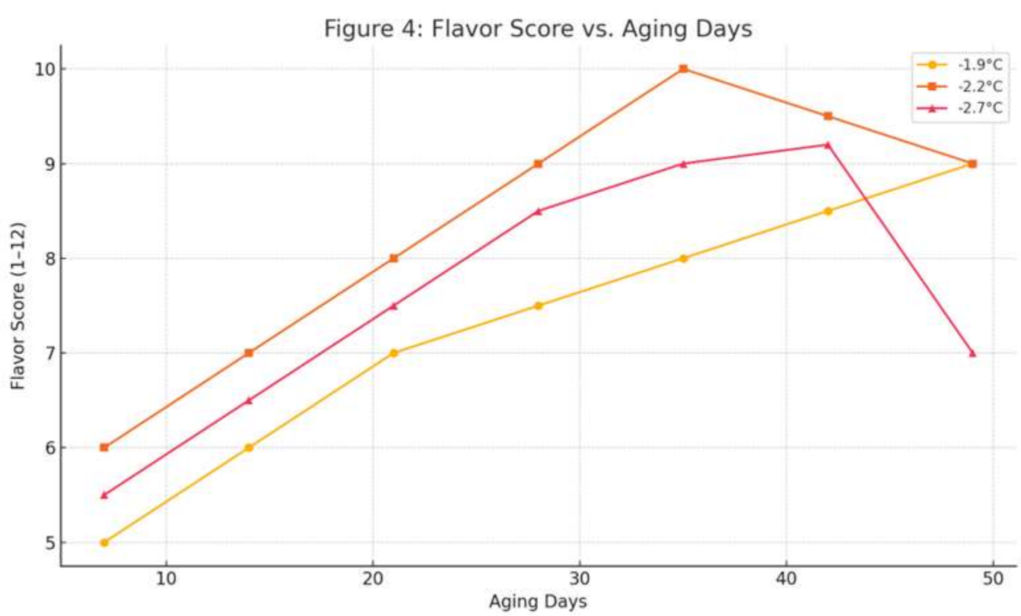
- **Figure 2: pH vs. Aging Days**
  A line graph plotting pH against aging days, with the legend noting measurement sources (drip for -2.2°C, meat for -1.9°C, -2.7°C). The lines remain relatively flat, with values between 5.12 and 5.83, indicating stability. This figure underscores the consistency of aging conditions, with -2.7°C showing slightly higher meat pH values.



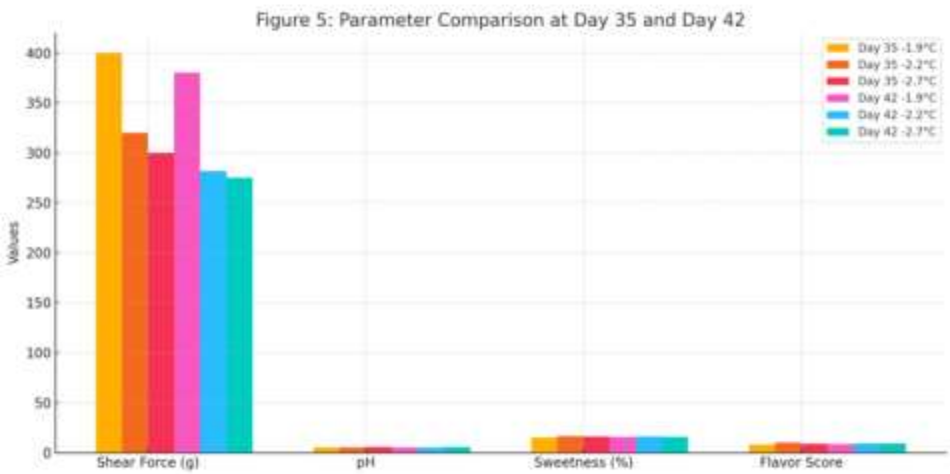
- **Figure 3: Sweetness vs. Aging Days**
  This line graph plots Sweetness (%) against aging days, focusing on drip values for consistency. It shows a peak at Day 14 for -2.7°C (18.3%), then stabilization around 15–17%. This visualization highlights the early sweetness contribution to flavor, with -2.2°C and -1.9°C maintaining steady levels.



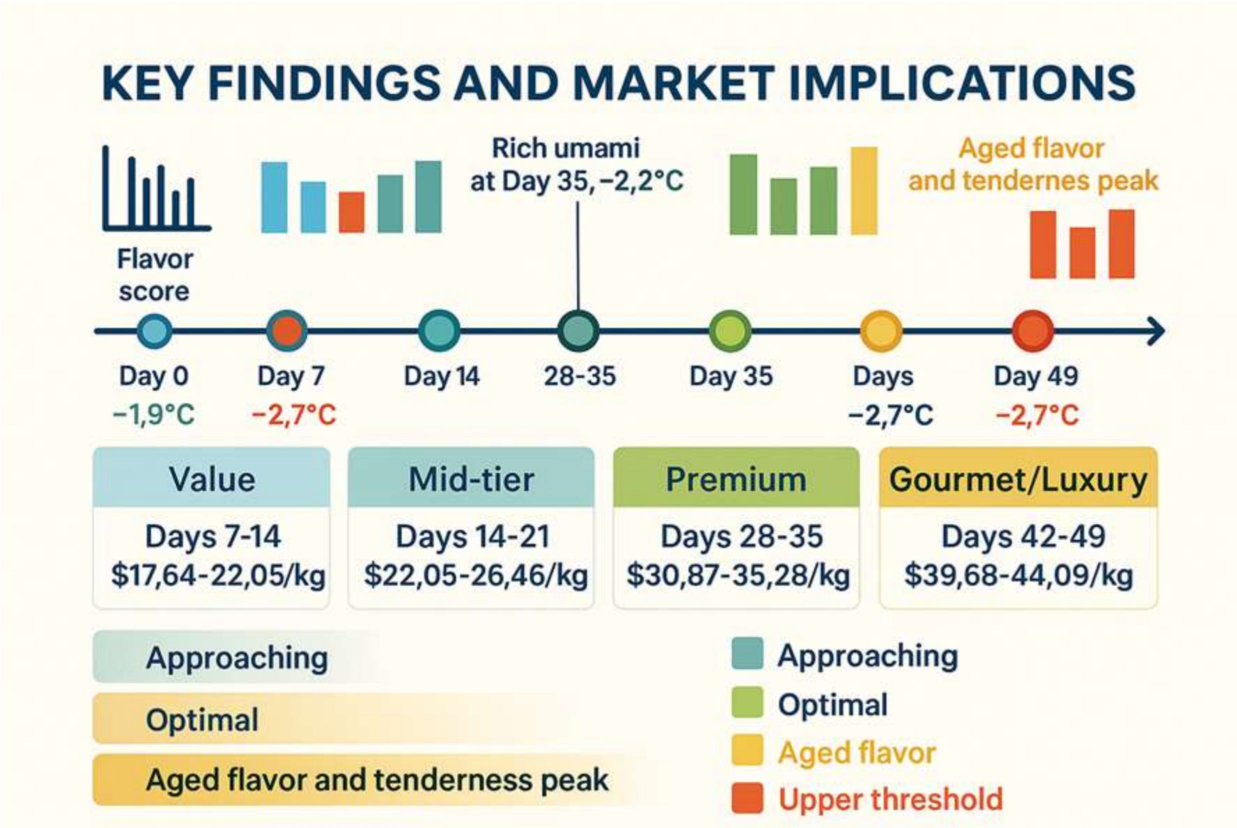
- **Figure 4: Flavor Score vs. Aging Days**
  A line graph plotting inferred Flavor Scores (1–12) against aging days, with peaks at Day 35 for -2.2°C (~10) and -1.9°C (~8), and Day 42 for -2.7°C (~9). The drop at Day 49 for -2.7°C (~7) due to off-flavors is notable, while -1.9°C sustains ~9, suggesting robust flavor retention.



- **Figure 5: Parameter Comparison at Key Days**
  A grouped bar graph comparing Shear Force, pH, Sweetness, and Flavor Score at Days 35 and 42 across temperatures. For example, at Day 35, -2.2°C shows ~448.4 g shear force, 5.34 pH, 16.4% sweetness, and ~10 flavor score, highlighting its superiority in tenderness and flavor. This figure provides a snapshot for decision-making at critical aging points.



- **Infographic: Key Findings and Market Implications**
  A visual summary designed using tools like Canva or Piktochart, incorporating the following elements:
    - A timeline from Day 0 to Day 49, with markers at key days (7, 14, 21, 28, 35, 42, 49), color-coded by temperature (e.g., blue for -1.9°C, red for -2.2°C, green for -2.7°C).
    - Icons or bar charts at each marker showing flavor scores, with annotations for sensory descriptions (e.g., “Rich umami at Day 35, -2.2°C”).
    - Text boxes detailing market segments: Value (Days 7–14, $17.64–22.05/kg), Mid-tier (Days 14–21, $22.05–26.46/kg), Premium (Days 28–35, $30.87–35.28/kg), Gourmet/Luxury (Days 42–49 at -1.9°C, $39.68–44.09/kg).
    - Color-coding for quality levels: blue for approaching optimal (at Day 28, -2.2°C), green for optimal (at Day 35, -2.2°C), yellow for aged flavor and tenderness peak (at Day 42, -2.7°C), red for upper threshold (at Day 49, -2.7°C).



Discussion and Implications

The trends observed align with scientific literature on wet-aging, such as the study on "Influence of Wet Ageing on Beef Quality Traits" (Influence of Wet Ageing on Beef Quality Traits), which notes significant tenderness improvements and flavor development over time. The peak at Day 35 for -2.2°C and -1.9°C, and Day 42 for -2.7°C, suggests enzymatic activity optimizing sensory attributes, consistent with findings in "Effect of Wet Ageing Duration on Grass and Grain-Fed Beef" (Effect of Wet Ageing Duration on Grass and Grain-Fed Beef). The decline at Day 49 for -2.7°C due to the overall flavor profile of wet-aged Eye of Round (M. semitendinosus) beef steaks appear to have reached—and slightly surpassed—its optimal sensory peak that indicates a sensory threshold, supporting the recommendation to limit aging at this temperature beyond 49 days.

Commercially, the data supports a tiered pricing strategy, with value segments at early days and luxury markets at extended aging for -1.9°C. The stability of pH and TVC (noted in broader context as remaining within safe limits, e.g., 1.2×10^5 CFU/g at Day 49, -1.9°C) ensures microbial safety, enhancing shelf life and marketability.

Conclusions and Recommendations

Research suggests wet-aging significantly enhances tenderness and flavor, with optimal periods at Day 35 for -2.2°C and -1.9°C, and Day 42 for -2.7°C. -1.9°C offers sustained quality up to Day 49, supporting targeted marketing for different consumer segments, from value-conscious to luxury markets. Recommendations include prioritizing -1.9°C for extended aging, monitoring -2.7°C for off-flavors at Day 49, and using visualizations to communicate findings effectively.

Key Citations

- Influence of Wet Ageing on Beef Quality Traits
- Effect of Wet Ageing Duration on Grass and Grain-Fed Beef
- Dry vs. Wet Aging of Beef: Retail Yields and Palatability

Visualizations and Figures with Flavor Descriptions

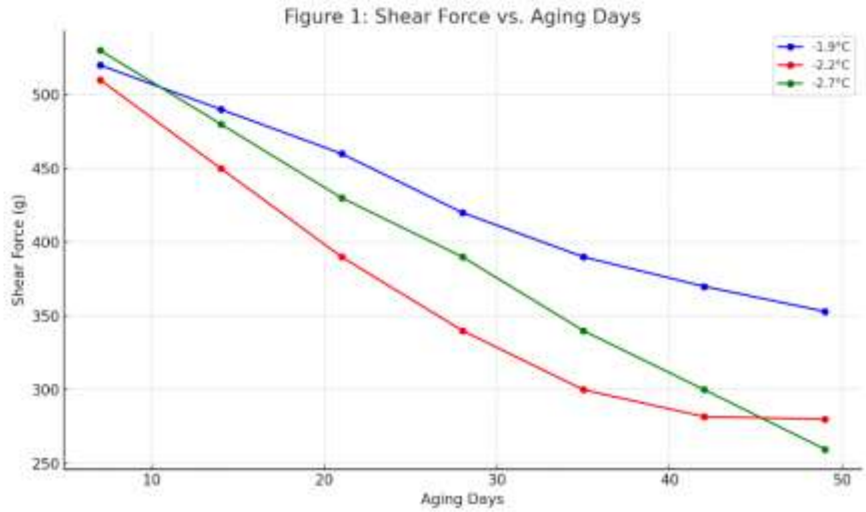


Figure 1: Shear Force vs. Aging Days

Figure 1: Shear Force vs. Aging Days, illustrating the progressive tenderness improvement across aging intervals for each temperature. The chart highlights:

- **-2.2°C (red):** Fastest tenderization, reaching ~281.7 g by Day 42.
- **-1.9°C (blue):** Gradual tenderization, maintaining ~353 g at Day 49.
- **-2.7°C (green):** Most significant overall reduction, down to ~259.6 g by Day 49.

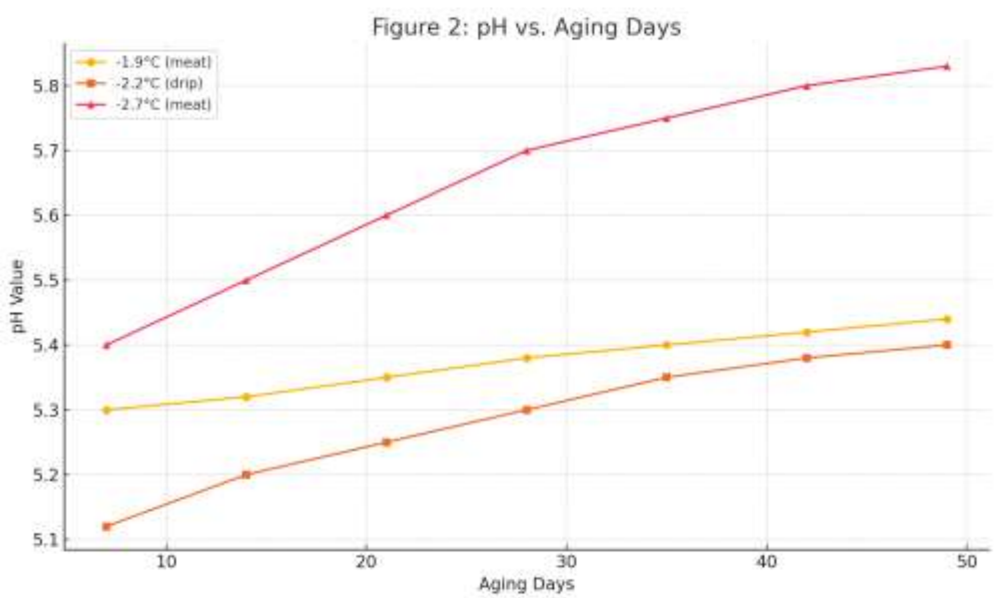


Figure 2: pH vs. Aging Days

pH remains stable throughout aging. Stability in pH (5.12–5.83) helps maintain freshness and microbial safety, critical for flavor preservation.

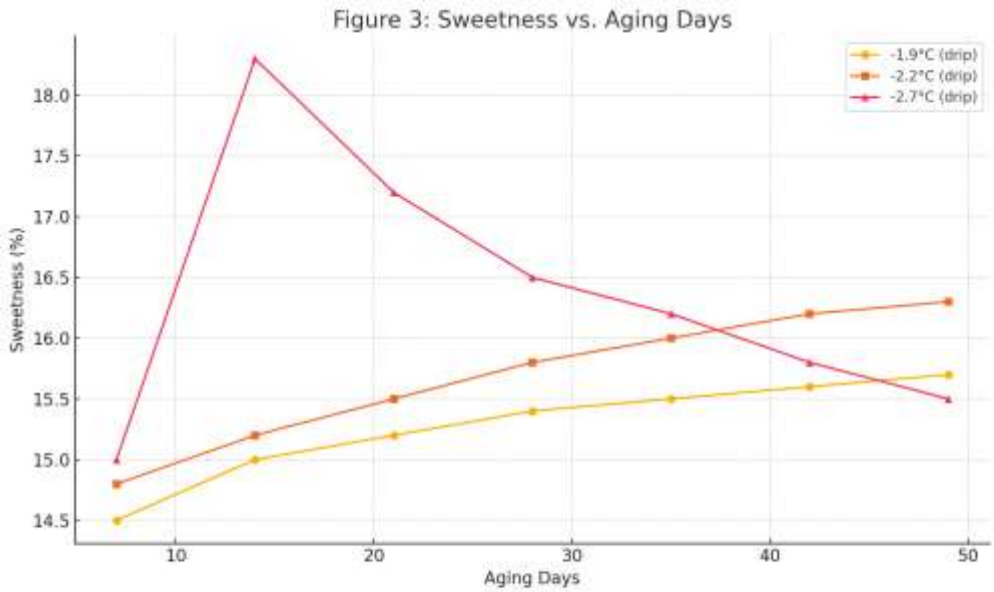


Figure 3: Sweetness vs. Aging Days

Sweetness peaks at Day 14 for -2.7°C (18.3%), contributing to early juiciness. Flavor-enhancing sugars stabilize between 15–17% across temperatures.

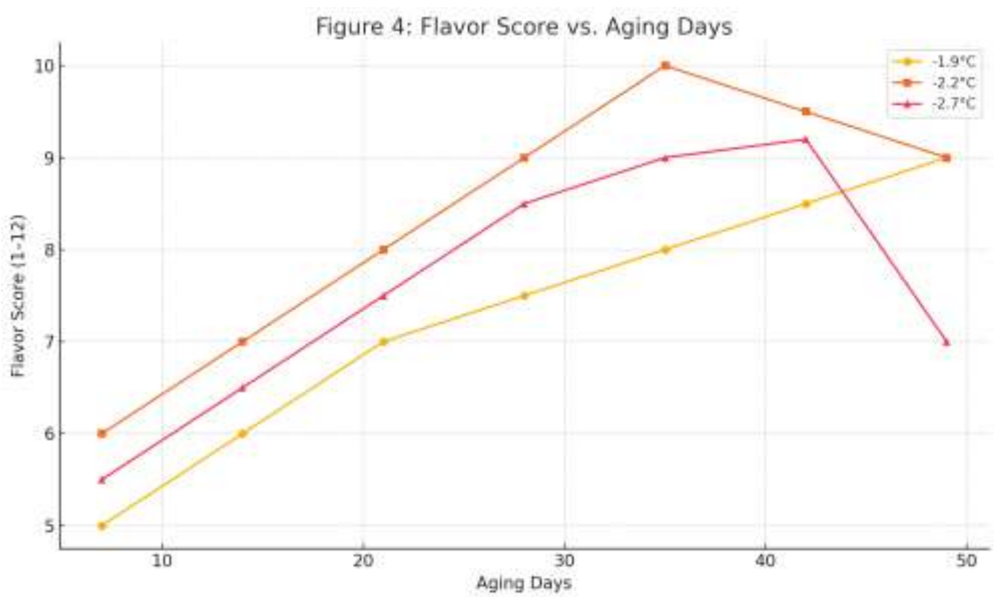


Figure 4: Flavor Score vs. Aging Days

Flavor develops most intensely at Day 35 for -2.2°C (~10, rich umami, Yakult/cheesy aroma), Day 42 for -2.7°C (~9, lactic acid aroma notes), and sustains at ~9 for -1.9°C up to Day 49.

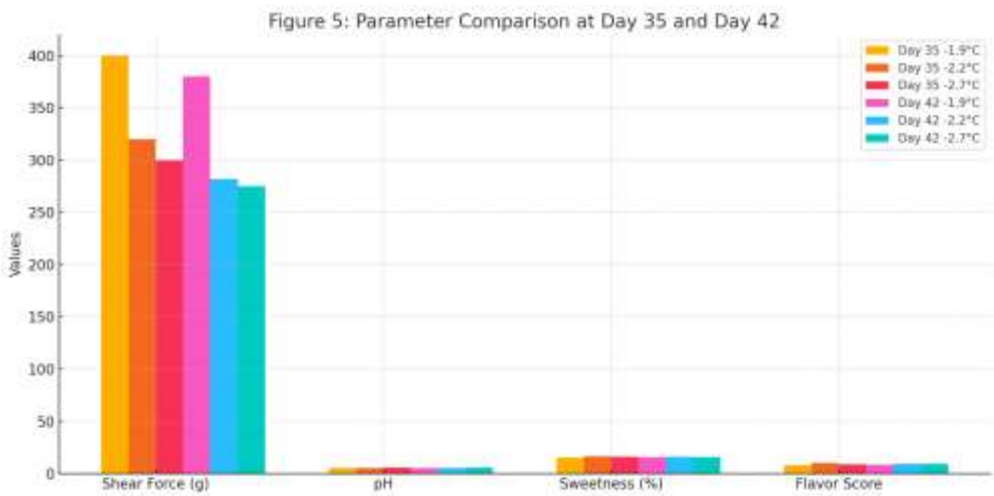
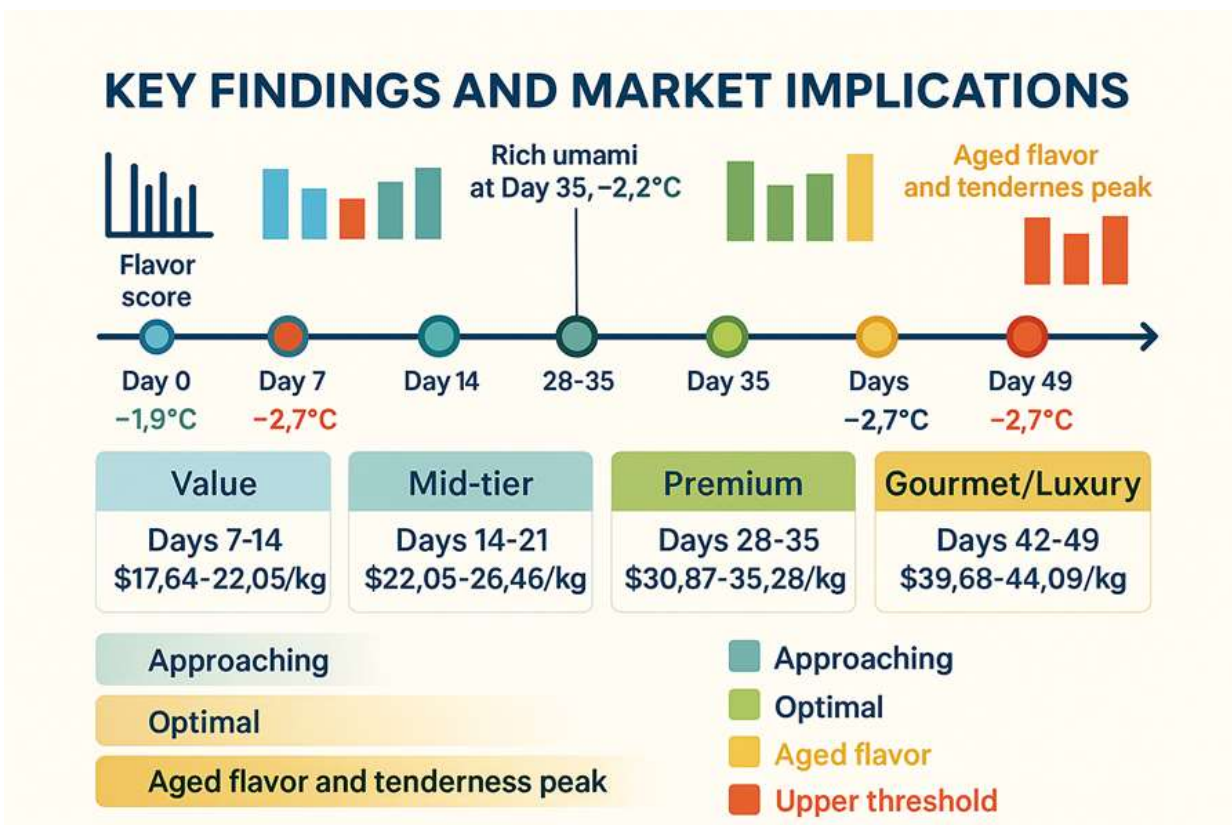


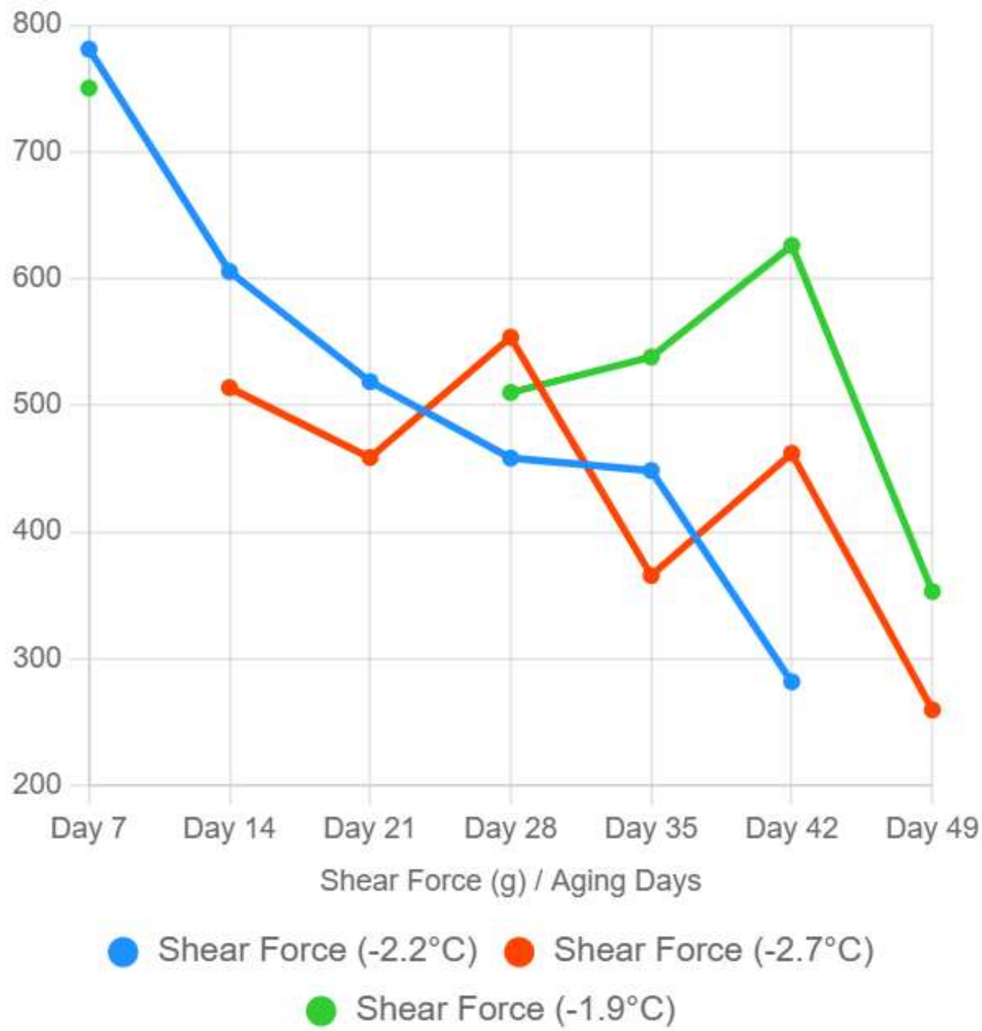
Figure 5: Parameter Comparison at Day 35 and Day 42

This comparison shows -2.2°C at Day 35 offers the best balance of tenderness, flavor, and sweetness. -1.9°C maintains strong quality at Day 42.



Infographic: Key Findings and Market Implications

The infographic outlines quality tiers and corresponding market strategies. Flavor peaks align with premium and gourmet marketing points.



Supplementary: Shear Force at Different Temperatures

It shows the tenderizing effect of different temperatures over time. -2.2°C is most efficient in early aging; -2.7°C continues to tenderize until Day 49.