# Assessment of cold storage effects on meat quality attributes in U.S. retail ready sirloin lamb chops

Kiersten M. Gundersen[1], Wanda L. Keller[1], Mara R. Hirchert[1], Virginia Montgomery[1], Erin S. Beyer[2], Kasey R. Maddock-Carlin[1] and Travis W. Hoffman[1]

*This study evaluated how different cold storage methods (fresh, frozen, and Suspended Fresh®) impacted the quality of U.S. retail-ready sirloin lamb chops. Results showed that Suspended Fresh® storage for 75 or 90 days improved tenderness and reduced moisture loss, while maintaining color and limiting fat breakdown similar to frozen storage. These findings suggest that Suspended Fresh® may be a practical tool to help the lamb industry extend product availability and maintain quality without relying solely on freezing.*

## Summary

Due to challenges caused by seasonal lambing patterns, the U.S. lamb industry's ability to meet year-round consumer demand for fresh product, especially during high-demand periods, has been strenuous. While freezing helps extend supply, it can negatively affect product quality and consumer acceptance. This study evaluated the impact of different cold storage methods (fresh, frozen, and Suspended Fresh® for 60, 75, and 90 days) on lamb sirloin chop quality. Key findings showed that Suspended Fresh® for 75 and 90 days reduced moisture loss and improved tenderness compared to fresh and frozen chops. While frozen chops retained visual redness better during retail display, Suspended Fresh® maintained lighter color and similar oxidative stability, helping preserve a fresh appearance. Additionally, lipid oxidation (a marker for shelf-life and fat degradation) was highest in fresh chops but controlled in both frozen and Suspended Fresh® chops. Overall, these results suggest that Suspended Fresh® technology offers a promising alternative to freezing, allowing processors to extend product availability while maintaining quality traits that mater to consumers.

## Introduction

The U.S. lamb industry continues to struggle with keeping a steady supply of fresh lamb available throughout the year. This is mainly due to the seasonal nature of lambing, with most lambs born in the early months of the year (Redden et al., 2018). As a result, supply does not always match up with demand, especially during peak buying times like Easter and Passover (USDA-ERS, 2012).

To help bridge this supply gap, processors often freeze lamb to stretch availability. While this helps with inventory, many consumers still prefer fresh meat and are hesitant to buy frozen lamb. The consumers' concerns usually center around changes in meat quality, such as color and eating experience. Even when frozen, lamb can still develop off-flavors and lose its fresh appearance over time due to oxidation.

To address these concerns, the industry has been exploring better preservation methods and one of the promising technologies under investigation is Suspended Fresh®, a patented, proprietary, trademarked process that stores product just above the meat freezing point (around 28 degrees Fahrenheit) to keep the classification of fresh, without actually freezing it. This method has been shown to help reduce moisture loss, maintain color stability, and improve eating quality (Small et al., 2012; Kiermeier, 2013; Choe et al., 2016). However, how well this technology works for lamb sirloin chops has not been thoroughly studied, especially under conditions typical of U.S. lamb production and retail markets. Therefore, the objectives of this study were to compare how different cold storage methods affect key meat quality traits in lamb sirloin chops.

## Procedures

Retail ready paired sirloin lamb chops ($n$ = 100) were sourced from a U.S. lamb processing facility and equally divided into five categories: fresh (F), frozen (FZ), and Suspended Fresh® (SF) for 60, 75, and 90 days. Frozen chops were immediately

[1]Animal Sciences, North Dakota State University, Fargo, ND
[2]Animal Sciences, Kansas State University, Manhattan, KS

frozen and held at minus 4 degrees Fahrenheit until the completion of all SF storage periods. Frozen chops were given 24 hours to thaw before evaluation.

One sirloin chop from each pair was assigned to a 6 day retail display study and lipid oxidation. Approximately 50 g sample was collected from the chop and frozen until further analysis. The other sirloin chop was used to evaluate for moisture (drip and cook loss) and tenderness (Warner-Bratzler shear force [WBSF]).

Drip loss was evaluated by weighing an ~25 g sample and suspending the sample with a large paperclip in a wire closure bag that was stored for 24 hours at 39 degrees Fahrenheit. After 24 hours, samples were reweighed for final weight and drip loss percentage was calculated. Chops assigned to WBSF were weighed and cooked on an electric grill preheated to 350 degrees Fahrenheit and the internal temperature of the chops were monitored with a thermapen, placed in the center of each chop. Once the internal temperature of 160 degrees Fahrenheit was reached, chops were removed from the electric grill and allowed to cool to room temperature. Cooked chops were reweighed to calculate for the percentage of cook loss. Three cores were taken from each cooked chop and the core samples were used with a shear force machine to imitate the force used during the first bite, to analysis tenderness. The average of the three cores from each cooked chop were averaged and used for statistical analysis.

Chops assigned to retail display were placed on polystyrene trays and overwrapped with oxygen permeable polyvinylchloride film, and then placed into a retail refrigerated display case at 39 degrees Fahrenheit under continuous fluorescent lighting. Color measurements ($L^*$, $a^*$, and $b^*$) were recorded every 24 hours for six days.

The frozen ~50 g sample was partially thawed and ~1.0 g samples were taken from the 50 g samples allocated to lipid oxidation. Minced samples were mixed with a buffer to breakdown products from the fat. Utilizing a TBARS (thiobarbituric acid reactive substances) assay kit, the amount of fat indicating rancidity was measured. Results were reported in mg of malondialdehyde (MDA) per kg of meat. The higher the MDA levels were used to indicate increased fat breakdown had occurred.

Data were analyzed using PROC GLIMMIX procedure of SAS (SAS 9.4, SAS Institute Inc., Cary, NC). Treatment was established as the fixed effect. Means were separated using the PDIFF option and were considered significant when $P \leq 0.05$.

## Results and Discussion

Differences were observed in drip loss ($P = 0.002$), cook loss ($P = 0.05$), tenderness ($P < 0.0001$), and in lipid oxidation (MDA levels; $P < 0.0001$) as shown in Table 1. Sirloin chops stored using SF method for 75 and 90 days had less drip loss compared to F, FZ, and SF 60-day chops. Cook loss in SF 90-day chops was similar to F chops and lower than SF 75-day chops, indicating better moisture retention. All SF treated chops were more tender, based on WBSF results, than either F or FZ chops. However, tenderness was similar across all SF storage durations. Fresh chops had the highest levels of lipid oxidation, suggesting a shorter shelf-life. In contrast, there were no differences in oxidation levels between FZ and SF chops, indicating that both methods are effective at limiting fat breakdown.

There were differences ($P < 0.0001$) in how the color changed over time in the display case (Figures 1 and 2). Across the first four days of the simulated retail display, all SF chops appeared visually lighter (higher $L^*$ values) than F or FZ chops. The FZ chops demonstrated stability in redness ($a^*$ values) throughout the retail display, while SF 60-day chops showed the lowest redness throughout the display period.

In regard to meat quality, the results from this study indicate that Suspended Fresh® cold storage technologies offer a viable alternative to traditionally frozen storage for retail-ready sirloin lamb chops.

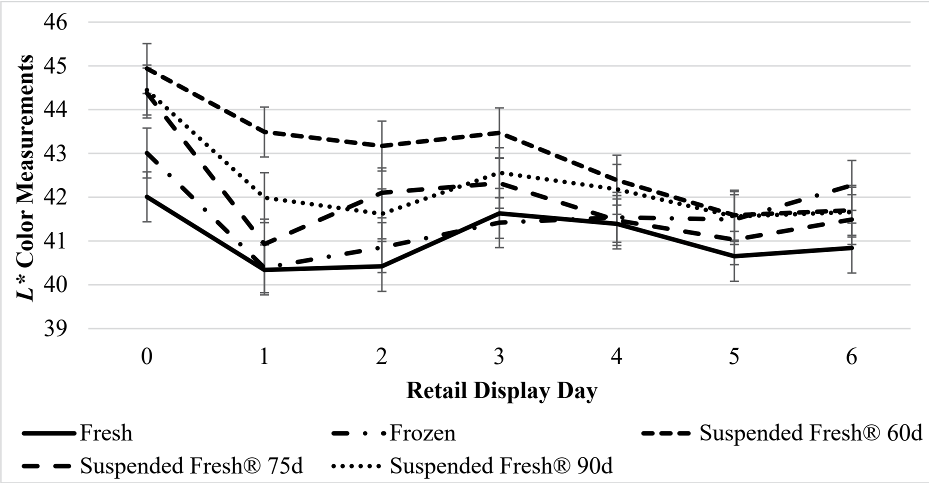
**Table 1. Least-square means of lamb sirloin chops for moisture loss (drip and cook loss) and Warner-Bratzler shear force (tenderness)**

| | Variables[1] | | | |
|---|---|---|---|---|
| Treatment | Drip loss, % | Cook loss, % | WBSF, kg | MDA levels |
| Fresh | 0.44[a] | 18.52[a] | 2.31[a] | 14.22[a] |
| Frozen | 0.42[a] | 19.07[ab] | 2.33[a] | 9.95[b] |
| Suspended Fresh® 60d | 0.38[a] | 19.25[ab] | 2.07[b] | 7.82[b] |
| Suspended Fresh® 75d | 0.34[b] | 20.51[b] | 2.04[b] | 8.28[b] |
| Suspended Fresh® 90d | 0.29[b] | 18.26[a] | 1.92[b] | 7.65[b] |
| SEM[2] | 0.28 | 0.55 | 0.07 | 0.89 |
| *P* Value | 0.0015 | 0.05 | < 0.0001 | < 0.0001 |

[1]Variables: Drip loss = [(initial weight – final weight) / initial weight] x 100; Cooking loss = [(raw weight – cooked weight) / raw weight] x 100; MDA Levels = mg of malondialdehyde/ kg of meat

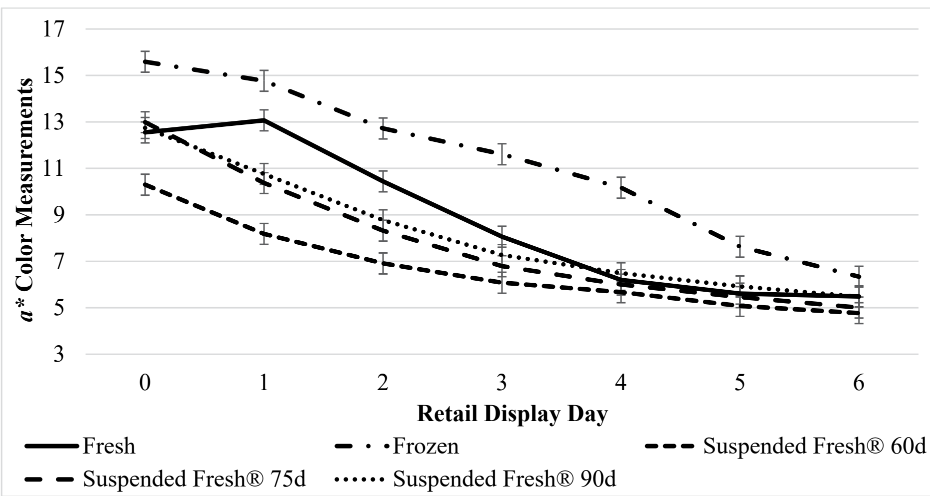
[2]SEM (largest) of the least-square means.

[a-c]Least-square means within the same column without common superscript differ ($P < 0.05$).




L*: 0 = black; 100 = white

**Figure 1. Instrumental *L** (lightness) values of lamb sirloin chops assigned fresh, frozen or Suspended Fresh® treatment**




a*: -60 = green; 60 = red

**Figure 2. Instrumental *a** (redness) values of lamb sirloin chops assigned fresh, frozen or Suspended Fresh® treatment**

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