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

Kiersten M. Gundersen[1], Taylor M. Dieball[2], Greta E. Huber[2], 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 loin lamb chops. The results from this study highlighted that Suspended Fresh® was able to preserve moisture retention without sacrificing palatability.

Summary

The seasonal nature of lamb production in the U.S. has made it difficult for the industry to consistently supply fresh lamb throughout the year, particularly during peak demand times. Although freezing is commonly used to stabilize supply, this preservation method may compromise product quality and reduce consumer appeal. This study evaluated the impact of different cold storage methods (frozen and Suspended Fresh® for 76 days) on lamb loin chop consumer preference and quality. Initial findings showed that Suspended Fresh® trended toward higher consumer acceptance and noticeable improvement in drip loss. These results demonstrate that Suspended Fresh® can preserve moisture retention without compromising consumer acceptance.

Introduction

Maintaining a consistent supply of fresh lamb year-round remains a persistent challenge for the U.S. lamb industry, largely due to the seasonal timing of lambing, which primarily occurs in the early part of the year (Redden et al., 2018). This seasonal production pattern often leads to mismatches between supply and consumer demand, particularly during major holidays such as Easter and Passover (USDA-ERS, 2012). To manage these supply gaps, processors frequently resort to freezing lamb to extend product availability. However, despite its logistical benefits, frozen lamb is often less preferred by consumers, who associate it with diminished quality attributes like discoloration and reduced palatability. Over time, frozen meat can also develop undesirable flavors and lose its fresh appearance due to oxidative changes.

In response to these quality concerns, the industry has begun to investigate alternative preservation strategies. One such innovation is Suspended Fresh®, a patented and proprietary technology that preserves meat just above freezing temperatures (around 28 degrees Fahrenheit), allowing the product to remain classified as fresh without undergoing the detrimental effects of freezing. Previous research suggests that this method may help with moisture retention and enhance sensory characteristics (Small et al., 2012; Choe et al., 2016). Nonetheless, limited research has evaluated the effectiveness of Suspended Fresh® for lamb loin chops under conditions reflective of U.S. production and retail systems. Therefore, the present study aimed to assess how various cold storage techniques influence critical quality attributes in lamb loin chops.

Procedures

Full lamb loins (N = 30) were sourced from a Northeast processing facility and split longitudinally (IMPS #232A, NAMP, 2010) and randomly assigned a treatment: frozen (FZ) or Suspended Fresh® (SF). Frozen loins were immediately frozen and held at minus 4 degrees Fahrenheit until the completion of the SF storage period (76 days). All split loins were fabricated into ~1.0 in. chops (IMPS #1232A lamb loin chops, NAMP, 2010). Chops from each loin were assigned to sensory evaluation, moisture loss, tenderness evaluation, or lipid oxidation evaluation.

Seventy-four untrained panelists were served six, 0.50 in cubed and cooked samples, and asked to evaluate each sample for juiciness-like, tenderness-like, flavor-like, and overall-like, on a 0 to 100 hedonic scale, with 0 being extremely dislike and 100 being like extremely.

Purge loss was evaluated by weighing each split loin still encased

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

in vacuum packaging, then removing the packaging and weighing the loin, before calculating purge loss percentage. 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 Warner-Bratzler shear force (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.

Approximately 1.0 g samples were taken from each chop 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

No differences ($P > 0.05$) were observed for any palatability trait as shown in Table 1. However, numerical trends showcased that panelists tended to rate SF chops more favorably in juiciness, tenderness, and overall liking.

Differences were seen in drip loss ($P < 0.0001$; Table 2) with SF chops having noticeably lower drip loss percentage (0.63% ± 0.30) compared to FZ chops (3.61% ± 0.30). No differences were observed for purge loss ($P = 0.66$), cook loss ($P = 0.34$), WBSF ($P = 0.99$) and MDA levels ($P = 0.98$) between FZ and SF chops.

Drip loss is a key indicator of the moisture retention of lamb retail cuts, which can affect saleable weight. Excessive drip loss can lead to unattractive packaging and reduced yield, eroding consumer confidence and lowering retail profitability (Hybu Cig Cymru, 2021). Adoption of Suspended Fresh® cold storage technologies could potential help processors and retailers maneuver around challenges of supply seasonality without sacrificing consumer satisfaction.

Table 1. LSMEANS of lamb palatability ratings[1] for lamb loin chops from consumer sensory panels

	Palatability Traits			
Treatment	Juiciness	Tenderness	Flavor	Overall liking
Frozen	66.24	67.86	65.99	66.03
Suspended Fresh®	70.65	72.57	64.51	68.08
SEM[2]	2.13	1.99	1.66	1.73
P Value	0.15	0.09	0.53	0.41

[1]Sensory scores: 0 = extremely dry/tough/dislike; 50 = neither dry nor juicy, neither tough nor tender, neither like nor dislike; 100 = extremely juicy/tender/like extremely.
[2]SEM (largest) of the least-square means

Table 2. LSMEANS of lamb loin chops for moisture loss, tenderness, and lipid oxidation

	Variables[1]				
Treatment	Purge loss, %	Drip loss, %	Cook loss, %	WBSF, kg	MDA levels
Frozen	1.64	3.61[a]	13.44	2.15	13.13
Suspended Fresh®	1.70	0.63[b]	14.18	2.15	13.11
SEM[2]	0.09	0.30	0.55	0.08	0.91
P Value	0.66	< 0.0001	0.34	0.99	0.98

[1]Variables: Purge loss = [(initial weight – final weight) / initial weight] x 100; Drip loss = [(initial weight – final weight) / initial weight] x 100; Cook loss = [(initial weight – final weight) / initial weight] x 100; WBSF = Warner-Bratzler shear force; MDA Levels = mg of malondialdehyde/kg of meat
[2]SEM (largest) of the least-square means.
[a-b]Least-square means within the same column without common superscript differ ($P < 0.05$).

Acknowledgements

This project was supported by a coordinated agreement between North Dakota State University and the American Lamb Board. A special thank you to iQFoods and the Suspended Fresh® team for collaboration on this research.

Literature Cited

Choe, J. H., A. Stuart, and Y. H. B. Kim. 2016. Effect of different aging temperatures prior to freezing on meat quality attributes of frozen/thawed lamb loins. J. Meat Sci. 116:158–164.

Hybu Cig Cymru – Meat Promotion Wales. 2021. Factors affecting lamb meat quality (Booklet). From: https://meatpromotion.wales/wp-content/uploads/2024/05/4157_HCC_Factors_Affecting_Lamb_Meat_Quality_booklet_July21_EN_V5_WEB_FIN_1-compressed.pdf

Redden, R., E. Sanko, R. Ehrhardt, and C. Hiemke. 2018. Seasonality of the US lamb industry. Industry White Paper. American Lamb Board, pp. 1–17.

Small, A. H., I. Jenson, A. Kiermeier, and J. Sumner. 2012. Vacuum-packed beef primals with extremely long shelf life have unusual microbiological counts. J. Food Protect. 75:1524–1527.

USDA-ERS. 2012. Lamb/mutton production expected to show strength leading up to the Spring religious holidays. From: https://www.ers.usda.gov/data-products/charts-of-note/chart-detail?chartId=75628. United States Department of Agriculture-Economic Research Service.