Assessment of cold storage effects on meat quality attributes in American ground lamb

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This study evaluated how different cold storage methods (fresh, frozen, and Suspended Fresh®) impacted the quality of American ground lamb. Results indicated that Suspended Fresh® had comparable or improved moisture retention, lipid oxidation, and color stability compared to Fresh and Frozen storage. These findings provide compelling support for Suspended Fresh® as a strategy to extend shelf-life without diminishing quality.

Summary

The seasonal nature of lambing in America presents ongoing difficulties in maintaining a consistent, year-round supply of fresh lamb, particularly during peak demand periods. Although freezing extends product availability, it may compromise meat quality and shelf-life stability. This study evaluated the impact of different cold storage methods (fresh, frozen, and Suspended Fresh® for 36 days) on ground lamb quality. Initial findings showed that Suspended Fresh® reduced cook loss, lowered lipid oxidation levels, and increased color stability over a five-day retail display compared to fresh and frozen ground lamb. Therefore, the results support the feasibility of Suspended Fresh® technology as a practical alternative solution to address supply chain limitations in the sheep industry.

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Introduction

Ensuring a steady, year-round availability of fresh lamb remains a significant hurdle for the American lamb industry due to the concentration of lambing in the early months of the year (Redden et al., 2018). This seasonal production often results in an imbalance between supply and demand, especially during high-consumption periods like Easter and Passover (USDA-ERS, 2012). To compensate for these shortfalls, processors commonly freeze lamb products to prolong shelf-life and availability. Despite this practical solution, many consumers view frozen lamb less favorably, citing concerns over quality degradation such as discoloration, off-flavors, and inferior texture due to oxidative damage over time.

To address these quality-related issues, the industry is exploring new preservation methods. One such approach is Suspended Fresh®, a proprietary technology that stores meat slightly above its freezing point (approximately 28 degree Fahrenheit), preserving its "fresh" classification while avoiding the quality losses typically associated with freezing. Studies have shown that this method may minimize moisture loss and support better color stability (Small et al., 2012; Kiermeier, 2013; Choe et al., 2016). However, little is known about how this technology performs when applied to ground lamb under typical U.S. production and retail conditions. As such, this study was designed to evaluate the impact of different cold storage methods on key meat quality traits in ground lamb patties.

Procedures

Vacuum-packaged ground lamb (1.0 lbs.; $n = 60$) were sourced from a U.S. lamb processing facility and equally divided into three categories: fresh (F), frozen (FZ), and Suspended Fresh® (SF). Frozen ground lamb was immediately frozen and held at minus 4 degrees Fahrenheit until the completion of SF storage period. Frozen chops were given 24 hours to thaw before evaluation. Half-pound patties were made from each package using a commercially available patty maker. One patty from each package was assigned to pH, another patty for cook loss, a third patty was assigned to color stability analysis and lipid oxidation analysis. For lipid oxidation, an approximately 50 g sample was collected and frozen at minus 112 degrees Fahrenheit until analysis.

The pH of the patties was determined by weighing ~10 g of finely chopped sample into a blender.

Next, 100 mL of de-ionized water was added to the blender and blended for 30 seconds (well mixed, but not emulsified). The mixture was then filtered through cheese cloth before pH readings were recorded.

Patties assigned to cook loss were weighed and cooked on an electric grill preheated to 350 degrees Fahrenheit and the internal temperature of the patties were monitored with a thermapen, placed in the center of each patty. Once the internal temperature of 160 degrees Fahrenheit was reached, patties were removed from the electric grill and allowed to cool to room temperature. Cooked patties were reweighed to calculate for the percentage of cook loss.

Patties 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 five 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 pH ($P < 0.0001$), purge loss ($P = 0.04$), and MDA levels ($P < 0.0001$) as shown in Table 1. Suspended Fresh® patties maintained an intermediate pH value compared to F and FZ patties. Suspended Fresh® patties were comparable to purge loss with F patties, but had a higher purge loss percentage than FZ patties. Frozen and Suspended Fresh® patties were similar in MDA levels (lipid oxidation identifier), but SF patties had noticeably lower MDA levels compared to F patties.

The L^* (lightness) values showed distinct differences over time between storage methods (Figure 1). Fresh patties exhibited higher L^* values throughout the 5 day retail display, indicating a lighter surface appearance. The lowest L^* values were constantly observed in FZ patties, while SF patties maintained intermediate lightness values.

The a^* (redness) values showed a steady decline from day 0 to day 5 of the retail display (Figure 2). However, the rate of the decline is what differed between storage methods. Fresh patties demonstrated the quickest decline in surface redness appearance, while FZ declined more gradually. Suspended Fresh® patties followed a similar trend as F and FZ patties, but maintained a slightly more stable trajectory.

Collectively, this study supports the implementation of Suspended Fresh® technology as a practical solution to maintain and(or) improve meat quality without sacrificing consumer confidence.

Acknowledgments

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Literature Cited

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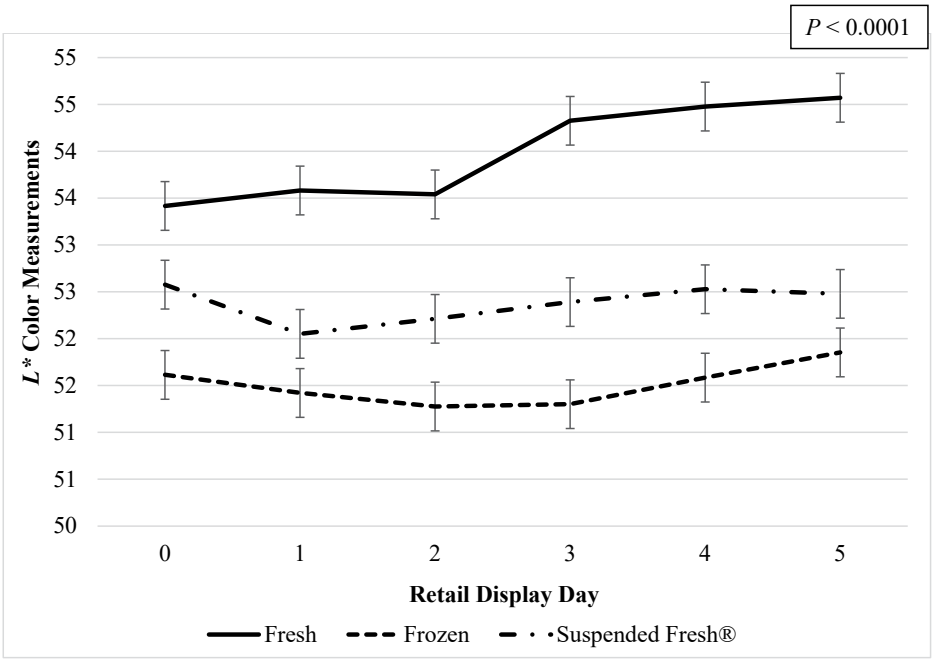
Table 1. LSMEANS of ground lamb for pH, moisture loss (purge and cook loss), and lipid oxidation

	Variables[1]			
Treatment	pH	Purge loss, %	Cook loss, %	MDA levels
Fresh	5.13[c]	2.46[ab]	30.05	13.34[a]
Frozen	5.40[a]	2.38[b]	30.45	11.05[b]
Suspended Fresh®	5.27[b]	2.70[a]	28.57	10.70[b]
SEM[2]	0.20	0.09	0.61	0.24
P Value	< 0.0001	0.04	0.08	< 0.0001

[1]Variables: Purge 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

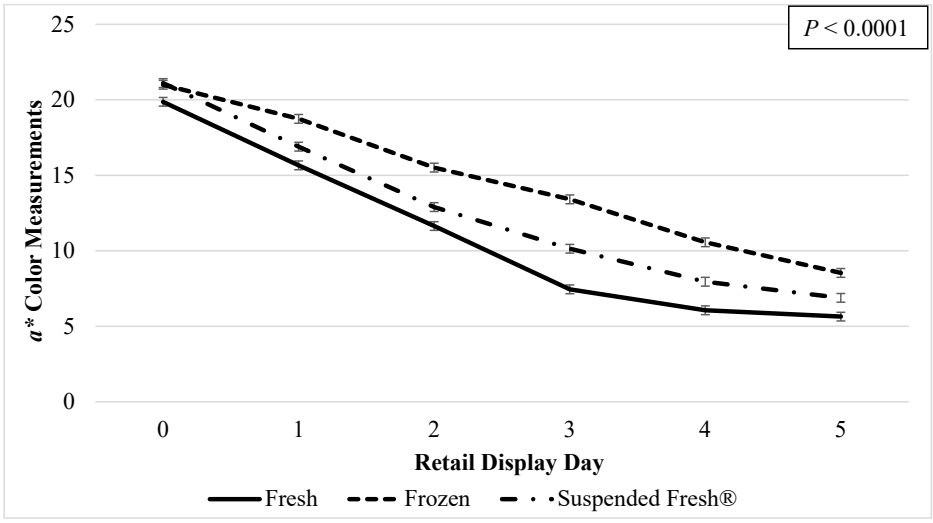
[2]SEM (largest) of the least-square means.

[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 ground lamb assigned fresh, frozen or Suspended Fresh® treatment**



*a**: -60 = green; 60 = red

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

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