DRY AGING BEEF FOR THE RETAIL CHANNEL

A Thesis

by

ROBERT DAVID SMITH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2007

Major Subject: Animal Science

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Approved by:

Chair of Committee,	Jeffrey W. Savell
Committee Members,	Daniel S. Hale
	R. Daniel Lineberger
Head of Department,	Gary R. Acuff

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ABSTRACT

Dry Aging Beef for the Retail Channel. (May 2007)

Robert David Smith, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Jeffrey W. Savell

USDA Choice (n=48) and Select (n=48) paired Beef Loin, Short Loins, Short Cut (IMPS #174) were separated randomly into one of two treatments, dry or wet aging, and were aged for 14, 21, 28, or 35 d. At the end of each aging period, short loins were fabricated in a simulated retail cutting room at Texas A&M University to determine retail yields and processing times. Upon completion of cutting tests, steaks were served to consumers to determine palatability characteristics. Retail cutting tests showed that dry aged short loins had reduced yields and increased cutting times when compared to wet aged short loins. Consumers were unable to determine differences between dry and wet aged steaks and for aging periods, however, USDA quality grade had a significant impact on consumer perception of palatability attributes. The purpose of this research was to determine palatability characteristics and retail cutting characteristics associated with dry aged beef.

DEDICATION

This paper is dedicated to my parents, Brancy and JoLynn. Without their constant guidance, love, and support, I would have never made it to where I am today.

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I begin by thanking the members on my committee, Dr. Jeff Savell, Dr. Daniel Hale, and Dr. R. Daniel Lineberger. Without their support and supervision, this project would not have been a success. Also I would like to thank Dr. Davey Griffin for his role in helping plan and carry out the cutting phases of this project.

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CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

Fresh beef products often are aged to enhance palatability characteristics associated with various retail/wholesale cuts. Palatability is commonly defined as juiciness, tenderness, and flavor. According to the National Beef Tenderness Survey-1998 (Brooks et al., 2000), a majority of beef purchased at the retail level is aged to enhance palatability characteristics inherent to various cuts. Furthermore, previous research indicates that postmortem aging increases beef tenderness (Smith, Culp, & Carpenter, 1978; Koohmaraie, Whipple, Kretchmar, Crouse, & Mersmann, 1991; Campbell, Hunt, Levis, & Chambers, 2001; Gruber, Tatum, Scanga, Chapman, Smith, & Belk, 2006), which has been shown to be a major contributing factor to consumers' perception of taste (Koohmaraie, 1988; Neely et al., 1998, 1999; Lorenzen et al., 1999; Savell et al., 1999).

Multiple factors have been identified that influence beef tenderness, including postmortem proteolysis, intramuscular fat or marbling, connective tissue, and the contractile state of muscle (Belew, Brooks, McKenna, & Savell, 2003). Another important factor related to beef tenderness is ionic strength (Wu & Smith, 1987). The mechanisms responsible for postmortem tenderization vary and are well documented (Koohmaraie, 1988; Koohmaraie et al., 1991; Nishimura, Hattori, & Takahashi, 1995, 1996; Goll, Geesink, Taylor, & Thompson, 1995; Taylor, Geesink, Thompson,

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This thesis follows the style of *Meat Science.*

Koohmaraie, & Goll, 1995). The Z-line is one myofibrillar structure clearly altered by proteases in the postmortem aging of beef (Goll, Otsuka, Nagainis, Shannon, Sathe, & Muguruma, 1983). However, Z-disk degradation does not occur to any significant extent during the first 3-4 d of postmortem aging (Taylor et al., 1995). Koohmaraie (1988) concluded that the protease referred to as calcium-dependent protease (CDP), more commonly known as calpain, is activated by Ca^{2+} and reproduces postmortem changes in myofibrils associated with meat tenderization. Furthermore, ionic strength has been shown to cause solubilization of proteins from the thick and thin myofilaments (Wu & Smith, 1987), which directly affects the nature of the actin/myosin bond and the subsequent weakening of this interaction (Goll et al., 1995). The role of intramuscular connective tissue is another important component related to meat tenderness. Nishimura et al. (1995) discovered that structural changes in intramuscular connective tissue were minimal at 10 d postmortem, but were clearly observable at 14 d postmortem. The amount and distribution of intramuscular fat, or marbling, may also positively influence tenderness through the lubrication of muscle fibers and fibrils (Savell & Cross, 1988).

Brooks et al. (2000) found that subprimal postfabrication aging times at the retail level ranged from 2 to 61 d. The two most common forms of postmortem aging utilized to enhance tenderness and aid in flavor development of beef products are dry and wet aging (Campbell et al., 2001; Warren & Kastner, 1992). Wet aging is more common and refers to meat aged in a sealed barrier package at refrigerated temperatures. Unpackaged meat aged in a cooler at controlled temperatures and humidity is said to be dry aged. Practically all beef is vacuumed packaged at the packer level. However, many believe that wet aging does not produce the enhanced palatability characteristics associated with dry aged beef. This process can be applied to carcasses or individual subprimals. Dry aging specific subprimals at the retail level may enhance overall palatability while creating a premium price for beef products, and removing any variation of sensory characteristics in steaks due to slaughter plant location (Miller, Kerth, Wise, Lansdell, Stowell, & Ramsey, 1997). Due to higher costs associated with storage, shrinkage, and trimming, few restaurants and even fewer retail stores offer dry aged beef.

Only limited scientific studies have been performed on dry versus wet aging of beef (Campbell et al., 2001; Parrish, Boles, Rust, & Olson, 1991; Sitz, Calkins, Feuz, Umberger, & Eskridge, 2006; Warren et al., 1992). Most of this work has focused solely on foodservice applications for dry aged beef. Until recently, dry aging had typically been a process used by some high-end restaurants and specialty outlets. Because retailers are constantly searching for ways to differentiate their products to create more great beef eating experiences for their customers, the appeal of offering dry aged beef at the retail counter has sparked an interest for the advancement of research related specifically to this segment of the industry.

Beef products are aged to increase palatability attributes inherent to fresh beef. Both dry and wet aging improve tenderness and flavor characteristics of various beef products. In a study conducted by Parrish et al. (1991) trained panelists evaluated tenderness, juiciness, flavor intensity, flavor desirability, and overall palatability of USDA Prime ribs and loins (n=20), USDA Choice ribs and loins (n=20), and USDA Select loins (n=20) aged for 21 d, and found that the effect of aging treatment (dry vs.

wet) on the palatability of rib and loin steaks were slight. However, scores were higher ($P < 0.01$) for tenderness and overall palatability from steaks that were wet aged. In addition, the study found that WBS values were not influenced by aging treatment, but were significantly affected by USDA quality grade. Furthermore, Campbell et al. (2001) showed shear force values were lowest for steaks dry aged 21 d compared to steaks dry aged for 7 or 14 d, or wet aged for 7, 14, or 21 d. Gruber et al. (2006) indicated that enhanced tenderness is muscle specific in relation to aging period. This research indicates that a number of muscles showed no improvement ($P > 0.05$) past 21 d postmortem storage, while others continued to improve ($P < 0.05$) up to 28 d postmortem.

Although postmortem aging is believed to increase palatability attributes associated with flavor and tenderness in beef products, opponents to this theory argue that USDA quality grade is ultimately responsible for palatability characteristics of beef products regardless of aging method. This is supported by research conducted by Parrish et al. (1991), which showed trained panel scores for juiciness, flavor intensity, and flavor desirability from wet aging treatments that were not significantly different when compared to dry aging treatments. However, juiciness, flavor desirability, and overall palatability were affected ($P < 0.01$) by USDA quality grade. Other research found that aged flavor, beef flavor, brown/roasted flavor intensity, bloody/serumy flavor intensity, metallic flavor intensity, tenderness, and juiciness all were significantly affected by dry aging time (Campbell et al., 2001), which is supported through research conducted by Miller et al. (1997).

Dry aging is a costly procedure that requires a significant amount of time and space. In addition, this process elicits a high amount of shrink and generates a significant amount of excess dried waste (termed in the industry as "scab") that must be trimmed. Therefore, dry aged beef has been shown to yield a greater ($P < 0.05$) amount of trim loss when compared to wet aged beef (Parrish et al., 1991) The shrink and accompanying waste are due to extrinsic factors related directly to the manner in which dry aged products are stored. Therefore, dry aged beef is relatively expensive in comparison to wet aged beef. Several studies have shown the effects of cooler shrink on dry and wet aged beef. Parrish et al. (1991) showed that cooler shrink was evident in loins and ribs dry aged for 14 or 21 d, while product aged in vacuum packaged bags for the same time period resulted in little or no cooler shrink. Similarly, Warren and Kastner (1992) found that wet aged strip loin sections had less ($P < 0.05$) weight loss during storage than dry aged sections.

Retail operations are continuously searching for ways to enhance fresh beef products to improve palatability and increase value. Like many high-end and specialty beef purveyors and restaurants, retailers are now beginning to investigate the effects of dry aging beef products in relation to saleable yields, shrink, shelf-life, microbial characteristics, and other very specific issues that pertain best to the retail versus foodservice channel. The objective of this research was to evaluate processing yields and time allocations of converting dry aged short loins into retail cuts and to determine sensory characteristics associated with dry aged steaks, to assist retailers in making informative decisions when deciding how to best market their products.

CHAPTER II

MATERIALS AND METHODS

2.1. Product Selection

Paired Beef Loin, Short Loins, Short Cut (IMPS #174) (n=96) as defined by Institutional Meat Purchasing Specifications (IMPS) and described by USDA (1996) and NAMP (2003), were purchased from a major packing facility, vacuum packaged, and shipped to the Rosenthal Meat Science and Technology Center at Texas A&M University via coolers with ice packs. Twenty-four short loins were obtained from twelve carcasses (2 d postmortem) by trained evaluators once a week for four consecutive weeks to obtain an equal mix of USDA (1997) Low Choice and Select Yield Grade 2 and 3 carcasses. By sampling four weeks in a row, the desired aging treatments of 35, 28, 21, and 14 d were achieved. Additional selection criteria included an approximate carcass weight range of 270 to 360 kg and minimal slaughter/dressing defects in the loin area (e.g., incorrect carcass splits, major fat tears, large bruises, excess trimming of lean and/or fat).

2.2. Aging Treatments

Upon arrival at the Rosenthal Meat Science and Technology Center each week, short loins were separated randomly into one of two treatments, dry or wet aging. Each side (right and left) was represented equally among aging treatments. Short loins designated for wet aging were weighed in the vacuum package bag and placed in the cooler on a stainless steel rack. Those assigned to the dry aging group were weighed initially in the bag, and reweighed after the bag was removed, before being placed in the cooler on another stainless steel rack. Vacuum packaged bags were washed and dried before weighing to calculate purge loss. All short loins were stored in a 1.0 ± 2.0°C, 83 ± 11% relative humidity cooler for the appropriate aging period.

2.3. Cutting Tests

After completion of the appropriate aging time, short loins were fabricated in a simulated retail cutting room in the Rosenthal Meat Science and Technology Center at Texas A&M University. Cutting tests consisted of trimming and cutting to produce tray-ready cuts as described by Voges et al. (2006). Fabrication was conducted by trained retail meat cutters. Weights of all fabricated components were summed together at the completion of each cutting test to ensure at least 99% of the beginning subprimal weight was recovered. Retail cutting tests were divided into three major phases: opening (retrieval of the subprimal from vacuum package bag), precut trimming (removal of any dried out inedible surface tissue, termed scab), and cutting (removal of external and seam fat, connective tissue, as well as producing tray ready retail cuts as applicable). After each cutting test, trained technicians recorded weights of all steaks, lean trim, stew meat, fat trim, waste, bone, and bone dust. Band saws were cleaned of any bone dust after every sixth short loin, weighed, and averaged across the six previous short loins cut on that respective saw. Percentages were based on the net weight of each individual short loin. Cut loss was determined to be any weight that could not be accounted for, in addition to any bone dust that was collected from the saws since this weight is not normally accounted for in a retail setting. All retail cuts were trimmed to 0.60 cm of external fat. The diameter of each tenderloin steak was measured to determine if it classified as a Beef Loin T-Bone Steak (UPC #1369) or a Beef Loin Porterhouse Steak (UPC #1330). Steaks with a minimum diameter of 3.20 cm of tenderloin were designated Porterhouses, and steaks with a minimum diameter of 1.30 cm on one side were T-bone steaks. The most anterior steaks from each short loin (or steaks containing less than 1.30 cm of tenderloin) were cut as Beef Top Loin Steaks, Bnls (UPC #1404). Universal Product Code (UPC) descriptions (Industry-Wide Cooperative Meat Identification Standards Committee, 2003) were used to identify retail cuts. Technicians were trained to record the time(s) required to complete each phase of cutting using handheld stopwatches. Combing recording times for each phase of the cutting test allowed for the calculation of total time required to complete each cutting test. Technicians were also responsible for evaluating each test for completion before moving to the next phase.

After cutting, the second, third, fourth, and fifth steaks from the posterior end of each short loin were designated for sensory evaluation, and the sixth steak was selected for Warner-Bratzler shear (WBS) force determination. Internal and surface samples were excised from all 14 and 35 d product to analyze water activity and moisture of the product.

2.3.1. Wet Aged Cutting Tests

All vacuum packaged (wet aged) short loins were weighed before opening (in bag weight) and again after opening (out of bag weight). Vacuum bags then were drained, washed, dried, and weighed to obtain an accurate purge loss value. Before cutting, short loins were faced on a band saw. Short loins then were cut into steaks (3.20 cm-thick), starting from the posterior end of each subprimal. All wet aged steaks were trimmed of excess fat to maintain a 0.60 cm fat level.

2.3.2. Dry Aged Cutting Tests

All unpackaged (dry aged) short loins were weighed before cutting to obtain an initial cut weight. Any dark, dried-out inedible surface tissue ("scab") was removed and weighed. The remaining short loin was weighed again to obtain a ready to cut subprimal weight. Short loins then were faced on a band saw and cut to produce tray ready retail cuts. Steaks (3.20 cm-thick) were cut from each short loin, starting from the posterior end of each subprimal. All dry aged steaks were trimmed of excess fat to maintain a 0.60 cm fat level.

2.4. Retail Price Determination

Prices of saleable components of beef short loins were surveyed from local retail stores and averaged across each respective quality grade. Prices were assigned to each individual short loin's saleable percentage of various retail cuts as determined by cutting tests to establish net sale value, margin dollars, and percent margin of U.S. dollars on a 100 kg basis (Savell & Smith, 2000).

2.5. Consumer Panels

Panelists (n=77) recruited from the Bryan/College Station area, who eat beef at least two times per week, were asked to complete a demographic questionnaire (Table 1). During cooking, steaks were monitored using Omega trendicators (Omega Engineering, Inc., Stamford, CT) fitted with a type-T thermocouple and then cooked on an indoor grill to 35 °C, flipped, and cooked to a final internal temperature of 70°C. *M. longissimus dorsi* samples from steaks (two 1.3 cm cubes) representing each short loin were served randomly to panelists in individual sensory booths under red lights. Samples were characterized by consumers using 10-point scales for overall like (**OLIKE**) (10=like extremely; 1=dislike extremely), flavor like (**FLAV**) (10=like extremely; 1=dislike extremely), level of beef flavor (**FLVBF**) (10=extremely flavorful or intense; 1=extremely bland or no flavor), tenderness like (**TEND**) (10=like extremely; 1=dislike extremely), level of tenderness (**LEVTEND**) (10=extremely tender; 1=extremely tough), juiciness like (**JUIC**) (10=like extremely; 1=dislike extremely), level of juiciness (**LEVJUIC**) (10=extremely juicy; 1=extremely dry), and purchase appeal (**PURCH**) (10=definitely would buy; 1=definitely would not buy). After consumers evaluated each sample they then were asked to complete a post-evaluation questionnaire (Table 2) to identify their perception of dry aged beef. Consumers were given a monetary reward of US$ 30 for participating.

Table 1
Demographic background of consumers

Age	≤21	22-29	30-39	40-49	50-59	≥60
% (*n*)	9.09% (7)	54.55% (42)	18.8% (14)	7.79% (6)	3.90% (3)	6.49% (5)
Income	<\$20,000	\$20,000-29,000	\$30,000-39,000	\$40,000-49,000	\$50,000-59,000	≥\$60,000
% (*n*)	54.25% (41)	3.90% (3)	10.39% (8)	9.09% (7)	3.90% (3)	19.48% (15)
Household size	1	2	3	4	5	≥6
% (*n*)	20.78% (16)	37.66% (29)	22.08% (17)	11.69% (9)	6.49% (5)	1.30% (1)
Work status	Not employed	Part-time		Full-time	Student	
% (*n*)	7.79% (6)	7.79% (6)		29.87% (23)	54.55% (42)	
Gender	Male			Female		
% (*n*)	45.45% (35)			54.55% (42)		
Nationality	White	African American	Hispanic	American Indian	Asian	
% (*n*)	87.01% (67)	1.30% (1)	3.90% (3)	1.30% (1)	6.49% (5)	
In-home beef consumption[a]	Never	1	2	3	4	≥5
% (*n*)	–	16.88% (13)	28.57% (22)	23.38% (18)	19.48% (15)	11.69% (9)
Away from home beef consumption[a]	Never	1	2	3	4	≥5
% (*n*)	6.58% (5)	39.47% (30)	23.68% (18)	15.79% (12)	3.95% (3)	10.53% (8)
Preferred degree of doneness	Rare	Medium Rare	Medium	Medium Well	Well Done	
% (*n*)	2.60% (2)	38.96% (30)	28.57% (22)	22.08% (17)	7.79% (6)	

[a] Consumption was reported as the number of times consumed per week.

Table 2
Exit interview

Are you familiar with the term aging?	Yes		No	
% (*n*)	72.60% (53)		27.40% (20)	
Is aging a positive/negative term?	Positive		Negative	
% (*n*)	81.94% (59)		18.06% (13)	
Have you ever eaten dry aged beef?	Yes	No	Not Sure	
% (*n*)	30.14% (22)	5.48% (4)	64.38% (47)	
Perceptions of dry aged beef.	Better Than Other Beef	Same as Other Beef	Not Sure	Other
% (*n*)	15.28% (11)	6.94% (5)	73.61% (53)	4.17% (3)
Meat/Food safety of dry aged beef.	Safer	Less Safe	Same as Other Beef	Not Sure
% (*n*)	10.96% (8)	4.11% (3)	34.25% (25)	50.68% (37)
Would you spend a $1.00 more per pound for dry aged beef?	Yes		No	
% (*n*)	37.68% (26)		63.32% (43)	

2.6. Warner-Bratzler Shear Force Analysis

Steaks assigned for WBS force determination were cooked to an internal temperature of 70°C using electric grills (Hamilton Beach Indoor/Outdoor Grill, Hamilton Beach/Proctor Silex, Inc., Southern Pines, NC) and monitored using Omega trendicators (Omega Engineering, Inc., Stamford, CT) fitted with a type-T thermocouple. Weights were recorded before and after cooking to determine cook loss. Steaks were covered, and allowed to cool overnight in refrigeration. Six 1.27 cm cores were removed from the *M. longissimus dorsi* of each steak, with cores taken parallel to the muscle fibers. Each core was sheared perpendicular to the fibers using a Universal Testing System Machine (United 5STM-500, Huntington Beach, CA), equipped with a 25 lb (11.3 kg) load cell and Warner-Bratzler shear attachment. The average of six cores was used to determine WBS force values.

2.7. Water Activity

Approximately 3 g of homogenized internal and surface muscle samples were used to determine water activity of all 14 and 35 d, dry and wet aged short loins. Internal muscle samples consisted of interior portions of each short loin. Surface muscle samples consisted of edible external muscle tissue. Samples were homogenized in an electric blender (Handy Chopper Plus, Black and Decker Corporation, Towson, MD) and placed in a disposable sample cup. Two samples, from each short loin, both internal and surface were analyzed using a water activity meter (AquaLab Series 3, Decagon Devices, Inc., Pullman, WA). The average of both samples were used to determine water activity values.

2.8. Moisture Analysis

Approximately 3.5 g of homogenized internal and surface meat samples were used to determine the moisture content of all 14 and 35 d, dry and wet aged short loins. Internal muscle samples consisted of interior portions of each short loin. Surface muscle samples consisted of edible external muscle tissue. Samples were homogenized in an electric blender (Handy Chopper Plus, Black and Decker Corporation, Towson, MD) and placed on a CEM Square Sample Pad and dried in the SMART System[5] Moisture/Solids Analyzer (SMART Trac System, CEM Corporation, Matthews, NC) to obtain a moisture value. Two samples from each loin, both internal and surface were averaged to determine moisture values.

2.9. Statistical Analysis

The effects of aging treatment, aging period, USDA quality grade, aging treatment × aging period, aging treatment × USDA quality grade, aging period × USDA quality grade, and aging treatment ×aging period × USDA quality grade were analyzed. Interactions that were not significant were removed from the model. Analysis of variance was performed with SAS PROC GLM (SAS Institute, Cary, NC), and when significant differences occurred, means were separated using the p-diff option at $P < 0.05$. Box-Cox transformation was used to ensure normal distribution for analysis.

CHAPTER III

RESULTS AND DISCUSSION

3.1. Consumer Panels

The effects of aging treatment on palatability characteristics of beef steaks from short loins are presented in Table 3. No significant differences were detected for OLIKE, FLAV, TEND, LEVTEND, JUIC, LEVJUIC, or PURCH between dry and wet aged steaks. The results presented are similar to those reported by Parrish et al. (1991) and Sitz et al. (2006).

Aging period had a significant effect on FLAVBF, JUIC, and LEVJUIC (Table 3). Steaks aged for 21 d received the highest ($P = 0.0101$) value for FLAVBF compared to all other aging periods. These results indicate that aging (dry or wet) for 21 d will improve FLAVBF characteristics, however, any period beyond 21 d resulted in similar ($P > 0.05$) FLAVBF as compared to 14 d aging treatments.

The effects of USDA quality grade on palatability characteristics of USDA Choice and Select beef steaks from short loins are presented in Table 3. USDA quality grade significantly impacted OLIKE, FLAV, TEND, LEVTEND, JUIC, LEVJUIC, and

PURCH. USDA Choice steaks were rated higher ($P < 0.0001$) than USDA Select steaks in respect to each of the previously stated attributes. These results are similar to the findings of Parrish et al. (1991), which found that USDA Choice loin steaks received higher consumer sensory scores for tenderness, juiciness, and overall palatability than USDA Select loin steaks, and to Hodges, Cahill, and Ockerman (1974) which reported that higher quality grade product (USDA Choice) improved flavor attributes.

One significant interaction, USDA quality grade × aging treatment, was found for FVLBF (Table 4). Consumers rated USDA Choice wet aged steaks higher (P =0.0404) than Select, both wet and dry. However, within USDA quality grade, dry aged Select steaks were numerically higher for FLVBF than its wet aged counterparts.

3.2. Warner-Bratzler Shear Force

WBS values were compared and means are shown in Table 5. Aging treatment had no effect on WBS values. Aging period significantly affected WBS values. Steaks aged for 28 and 35 d had lower ($P = 0.0147$) WBS values. Interestingly, WBS values numerically decreased as the aging period increased. USDA Choice steaks had lower ($P = 0.0010$) WBS values than USDA Select steaks.

Table 3
Least squares means for consumer evaluations of beef steaks from short loins stratified by aging treatment, aging period, and USDA quality grade

Main effects	Overall Like[a]	Flavor Like[a]	Level of Beef Flavor[b]	Tenderness Like[a]	Level of Tenderness[c]	Juiciness Like[a]	Level of Juiciness[d]	Purchase[e]
Aging treatment								
Dry	6.8	6.9	–	6.8	6.8	7.0	7.0	3.5
Wet	6.9	6.9	–	6.9	6.9	6.9	6.9	3.5
P > F	0.5688	0.7056	–	0.4963	0.5544	0.5280	0.3193	0.6624
Aging period								
14	6.7	6.7	6.7b	6.8	6.8	6.9bc	6.9ab	3.5
21	7.0	7.0	7.2a	6.8	6.8	7.0ab	6.9ab	3.6
28	6.9	6.9	6.8b	6.9	6.8	6.6c	6.7b	3.5
35	6.9	6.9	6.8b	6.9	6.9	7.4a	7.2a	3.6
P > F	0.2323	0.2642	0.0101	0.7581	0.8828	0.0030	0.0198	0.7603
Quality grade								
Choice	7.2a	7.2a	–	7.2a	7.2a	7.3a	7.2a	3.7a
Select	6.6b	6.7b	–	6.5b	6.4b	6.6b	6.6b	3.3b
P > F	<0.0001	<0.0001	–	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
RMSE	3.6	4.0	3.9	3.6	3.5	3.7	3.7	1.8

Means within the same column lacking a common letter (a-c) differ ($P < 0.05$).
[a] 10=Like extremely; 1=dislike extremely.
[b] 10=Extremely flavorful or intense; 1=extremely bland or no flavor.
[c] 10=Extremely tender; 1=extremely tough.
[d] 10=Extremely juicy; 1=extremely dry.
[e] 10=Definitely would buy; 1=definitely would not buy.

Table 4
Least squares means for consumer evaluations of level of beef flavor for beef steaks from short loins stratified by USDA quality grade × aging treatment

Interaction	Level of Beef Flavor[a]
USDA Choice, Dry aged	7.0ab
USDA Choice, Wet aged	7.2a
USDA Select, Dry aged	6.8bc
USDA Select, Wet aged	6.6c
P > F	0.0404
RMSE	3.9

Means within the same column lacking a common letter (a-c) differ ($P < 0.05$).
[a] 10=Extremely flavorful or intense; 1=extremely bland or no flavor.

Table 5

Least squares means of WBS values of beef short loin steaks stratified by aging treatment, aging period, and USDA quality grade

Main effects	WBS (N)
Aging Treatment	
Dry	23.5
Wet	24.0
SEM	0.7
P > F	0.6051
Aging Period	
14	26.0c
21	24.5bc
28	22.8ab
35	21.6a
SEM	1.0
P > F	0.0147
Quality grade	
Choice	22.1a
Select	25.4b
SEM	0.7
P > F	0.0010

Means within the same column lacking a common letter (a-c) differ ($P < 0.05$).

3.3. Water Activity

Water activity values for surface muscle tissue are shown in Tables 6 & 7. Only one significant interaction (aging treatment × aging period) existed for water activity values ($P = 0.0036$, Table 6) from surface muscle tissue samples. Wet aged samples aged 35 d had higher ($P < 0.05$) water activity values than dry aged samples aged 14 or 35 d. Furthermore, samples from short loins dry aged 35 d had the lowest ($P < 0.05$) overall water activity value of all surface muscle tissue samples. USDA quality grade did not have a significant effect on water activity values ($P = 0.6345$, Table 7) of surface muscle tissue samples of dry and wet aged short loins.

The effects of aging treatment, aging period, and USDA quality grade on mean water activity values of internal muscle tissues samples of beef short loins are shown in Table 8. Although aging treatment and aging period did not significantly affect water activity values, USDA quality grade did significantly influence water activity values ($P = 0.0481$). Much like water activity values examined in surface muscle tissue, USDA Select internal muscle tissue had significantly higher ($P < 0.05$) water activity values than samples from USDA Choice short loins. These results were expected and are primarily due to the inverse relationship associated with fat and water.

Table 6
Least squares means for water activity (a_w) values from surface muscle tissue samples of beef short loins stratified by aging treatment × aging period

Interaction	Water activity (a_w)
Dry aged, 14 d	1.001b
Dry aged, 35 d	0.997c
Wet aged, 14 d	1.004ab
Wet aged, 35 d	1.007a
P > F	0.0036
SEM	0.001

Means within the same row lacking a common letter (a-c) differ ($P < 0.05$).

Table 7
Least squares means for water activity (a_w) values from surface muscle tissue samples of beef short loins stratified by USDA quality grade

Main effect	Water activity (a_w)
Quality grade	
Choice	1.002
Select	1.003
P > F	0.6365
SEM	0.001

Means within the same column lacking a common letter differ ($P < 0.05$).

Table 8
Least squares means for water activity (a_w) values from internal muscle tissue samples of beef short loins stratified by aging treatment, aging period, and USDA quality grade

Main effects	Water activity (a_w)
Aging Treatment	
Dry	1.004
Wet	1.006
P > F	0.0922
Aging Period	
14	1.005
35	1.006
P > F	0.5160
Quality grade	
Choice	1.004b
Select	1.006a
P > F	0.0481
SEM	0.001

Means within the same row lacking a common letter (a-b) differ ($P < 0.05$).

3.4. Moisture Analysis

Moisture values for surface muscle tissue are shown in Tables 9 & 10. The interaction of aging treatment and aging period affected moisture values (P < 0.0001, Table 9) of surface muscle tissue samples of beef short loins. Moisture values of surface samples from short loins wet aged 14 d were higher (P < 0.05) than samples dry aged 14 or 35 d. As expected, moisture values were lowest (P < 0.05) for samples dry aged 35 d. USDA quality grade also affected moisture values (P = 0.0109, Table 10). Much like water activity values for surface muscle tissue samples, moisture values were higher (P < 0.05) for USDA Select product as compared to USDA Choice product.

The effects of aging treatment, aging period and USDA quality grade on moisture values from internal muscle tissue samples of beef short loins are shown in Table 11. USDA quality grade was the only main effect that had a significant impact on moisture values (P < 0.0001) for internal muscle tissue samples of beef short loins. Internal muscle tissue samples from USDA Select short loins had higher (P < 0.05) moisture values than internal tissue samples from USDA Choice short loins. These results were expected and are primarily due to the inverse relationship associated with fat and water.

Table 9
Least squares means for moisture values (%) from surface muscle tissue samples of beef short loins stratified by aging treatment × aging period

Interaction	Moisture value (%)
Dry aged, 14 d	66.4b
Dry aged, 35 d	55.1c
Wet aged, 14 d	69.2a
Wet aged, 35 d	68.2ab
P > F	<0.0001
SEM	0.7

Means within the same column lacking a common letter (a-c) differ ($P < 0.05$).

Table 10
Least squares means for moisture values (%) from surface muscle tissue samples of beef short loins stratified by USDA quality grade

Main effect	Moisture value (%)
Quality grade	
Choice	63.8b
Select	65.7a
P > F	0.0109
SEM	0.5

Means within the same column lacking a common letter (a-b) differ (*P* < 0.05).

Table 11
Least squares means for moisture values (%) from internal muscle tissue samples of beef short loins stratified by aging treatment, aging period, and USDA quality grade

Main effects	Moisture value (%)
Aging Treatment	
Dry	70.9
Wet	71.7
P > F	0.0836
Aging Period	
14	71.0
35	71.6
P > F	0.1473
Quality grade	
Choice	70.4b
Select	72.2a
P > F	<0.0001
SEM	0.3

Means within the same column lacking a common letter (a-b) differ ($P < 0.05$).

3.5. Retail Cutting

Beef Loin, Short Loins, Short Cut (IMPS #174) and associated components from various cutting tests were evaluated for mean retail yields and processing times (Tables 12-14). For each short loin, comparisons were made between retail cuts and cutting by-products from two different quality grade groups, USDA Choice and USDA Select, two different aging treatments, dry and wet aging, and four different aging periods, 14, 21, 28, and 35 d.

The interaction of USDA quality grade and aging period and the effects of retail yields percent of various components associated with each cutting test are shown in Table 12. Two items were found to be significant for this interaction: fat ($P = 0.0420$) and total saleable yield ($P = 0.0155$). Fat trim was highest ($P < 0.05$) for USDA Choice short loins aged for 21 and 28 d, and for USDA Select short loins aged for 21 d. Total saleable yield was highest ($P < 0.05$) for USDA Choice short loins aged for 14 d. Furthermore, these data indicate that postmortem aging of USDA Choice short loins for a period of 35 d yields similar ($P > 0.05$) percentages of total saleable yield as product that is aged for 21 or 28 d. USDA Select short loins aged for 14 d yielded a higher percentage of total saleable yield numerically, than did Select short loins aged 21, 28, or 35 d.

The interaction of aging treatment and aging period and the effects of percent retail yields of various components associated with each cutting test are presented in Table 13. Within this interaction four items were found to be significantly affected: cooler shrink ($P = 0.0001$), purge ($P =0.0155$), cut loss ($P = 0.0034$), and total saleable

Table 12

Least squares means ± SEM[a] of retail yields (%) for fabrication of short loins stratified by USDA quality grade × aging period

Item	UPC[b]	Choice				Select				
		14	21	28	35	14	21	28	35	*P* > F
		%								
Retail yield										
Beef Loin Porterhouse Steak	1330	61.1 ± 2.1	50.7 ± 2.1	52.8 ± 2.2	52.4 ± 2.1	53.2 ± 2.1	53.6 ± 2.1	53.7 ± 2.1	49.8 ± 2.1	0.0641
Beef Loin T-Bone Steak	1369	14.3 ± 1.7	17.4 ± 1.7	14.5 ± 1.7	15.7 ± 1.7	17.6 ± 1.7	16.1 ± 1.7	17.8 ± 1.7	16.4 ± 1.7	0.4462
Beef Top Loin Steak Bnls	1404	4.4 ± 1.0	6.2 ± 1.0	6.8 ± 1.1	6.3 ± 1.0	6.9 ± 1.0	4.9 ± 1.0	6.1 ± 1.0	7.9 ± 1.0	0.2335
Lean trimmings (90% lean)	1653	1.8 ± 0.4	1.4 ± 0.4	1.8 ± 0.4	2.4 ± 0.3	2.1 ± 0.4	2.2 ± 0.4	1.4 ± 0.4	2.4 ± 0.4	0.3965
Beef for stew	1727	1.7 ± 0.4	2.2 ± 0.4	1.8 ± 0.4	1.7 ± 0.4	1.3 ± 0.4	2.5 ± 0.4	1.6 ± 0.4	2.0 ± 0.4	0.7168
Fat		4.2 ± 0.6b	6.5 ± 0.6a	7.0 ± 0.6a	4.4 ± 0.6b	4.5 ± 0.6b	6.2 ± 0.6a	4.2 ± 0.6b	4.4 ± 0.6b	0.0420
Waste trimmings		2.1 ± 0.3	2.1 ± 0.3	2.3 ± 0.3	1.9 ± 0.3	1.6 ± 0.3	1.5 ± 0.3	2.0 ± 0.3	2.6 ± 0.3	0.1546
Bone		4.5 ± 0.5	5.9 ± 0.5	5.8 ± 0.5	5.7 ± 0.5	5.9 ± 0.5	5.5 ± 0.5	5.8 ± 0.5	6.7 ± 0.5	0.2145
Cooler shrink		2.7 ± 0.4	3.3 ± 0.3	2.6 ± 0.4	4.4 ± 0.3	2.8 ± 0.3	2.8 ± 0.3	3.4 ± 0.4	4.1 ± 0.3	0.3714
Purge		0.4 ± 0.2	0.5 ± 0.2	1.0 ± 0.2	0.8 ± 0.2	0.8 ± 0.2	0.6 ± 0.2	0.6 ± 0.2	0.6 ± 0.2	0.0774
Scab		1.5 ± 0.3	2.1 ± 0.3	1.7 ± 0.4	2.8 ± 0.3	1.8 ± 0.3	1.9 ± 0.3	1.6 ± 0.3	1.8 ± 0.3	0.2430
Cut loss		1.4 ± 0.3	1.5 ± 0.3	1.9 ± 0.3	1.5 ± 0.3	1.5 ± 0.3	2.2 ± 0.3	1.8 ± 0.3	1.3 ± 0.3	0.2912
Total saleable yield		83.2 ± 0.8a	78.0 ± 0.8d	77.7 ± 0.9d	78.5 ± 0.8cd	81.0 ± 0.8b	79.3 ± 0.8bcd	80.6 ± 0.8bc	78.4 ± 0.8cd	0.0155

Means within the same row lacking a common letter (a-d) differ ($P < 0.05$).

[a] SEM is the standard error of the least-squares means.

[b] UPC=Universal product code.

Table 13

Least squares means ± SEM[a] of retail yields (%) for fabrication of short loins stratified by aging treatment × aging period

Item	UPC	Dry				Wet				
		14	21	28	35	14	21	28	35	*P* > F
		%								
Retail yield										
Beef Loin Porterhouse Steak	1330	53.1 ± 2.1	45.6 ± 2.1	48.3 ± 2.1	44.6 ± 2.1	61.2 ± 2.1	58.8 ± 2.1	58.1 ± 2.1	57.5 ± 2.1	0.5635
Beef Loin T-Bone Steak	1369	16.0 ± 1.7	17.8 ± 1.7	14.2 ± 1.7	16.1 ± 1.7	15.8 ± 1.7	15.7 ± 1.7	18.1 ± 1.7	16.1 ± 1.7	0.3496
Beef Top Loin Steak Bnls	1404	5.2 ± 1.0	6.4 ± 1.0	7.0 ± 1.0	7.1 ± 1.0	6.0 ± 1.0	4.7 ± 1.0	5.8 ± 1.0	7.2 ± 1.0	0.6161
Lean trimmings (90% lean)	1653	1.0 ± 0.4	0.8 ± 0.4	0.8 ± 0.4	0.9 ± 0.4	2.8 ± 0.3	2.8 ± 0.3	2.5 ± 0.4	3.9 ± 0.3	0.2630
Beef for stew	1727	1.2 ± 0.4	1.5 ± 0.4	1.4 ± 0.4	1.1 ± 0.4	1.8 ± 0.4	3.3 ± 0.4	2.0 ± 0.4	2.5 ± 0.4	0.3599
Fat		4.1 ± 0.6	5.7 ± 0.6	4.8 ± 0.6	4.4 ± 0.6	4.6 ± 0.6	7.1 ± 0.6	6.4 ± 0.6	4.4 ± 0.6	0.5006
Waste trimmings		3.8 ± 0.3	3.5 ± 0.3	4.2 ± 0.3	4.5 ± 0.3	0.0 ± 0.3	0.1 ± 0.3	0.1 ± 0.3	0.0 ± 0.3	0.3075
Bone		5.4 ± 0.5	6.5 ± 0.5	6.7 ± 0.5	6.6 ± 0.5	5.1 ± 0.5	4.9 ± 0.5	5.0 ± 0.5	5.8 ± 0.5	0.4982
Cooler shrink		5.4 ± 0.3b	6.0 ± 0.4b	6.1 ± 0.4b	8.5 ± 0.3a	0.0 ± 0.3c	0.0 ± 0.3c	0.0 ± 0.4c	0.0 ± 0.3c	0.0001
Purge		0.1 ± 0.2d	0.5 ± 0.2cd	0.6 ± 0.2bc	0.3 ± 0.2cd	1.1 ± 0.2a	0.6 ± 0.2bc	1.0 ± 0.2ab	1.1 ± 0.2a	0.0155
Scab		3.3 ± 0.3	4.0 ± 0.3	3.4 ± 0.3	4.6 ± 0.3	0.0 ± 0.3	0.0 ± 0.3	0.0 ± 0.3	0.0 ± 0.3	0.2241
Cut loss		1.4 ± 0.3bc	1.8 ± 0.3bc	2.6 ± 0.3a	1.4 ± 0.3bc	1.5 ± 0.3bc	2.0 ± 0.3ab	1.1 ± 0.3c	1.5 ± 0.3bc	0.0034
Total saleable yield		76.5 ± 0.8c	72.1 ± 0.8d	71.6 ± 0.8de	69.8 ± 0.8e	87.7 ± 0.8a	85.3 ± 0.8b	86.6 ± 0.8ab	87.1 ± 0.8ab	0.0012

Means within the same row lacking a common letter (a-e) differ ($P < 0.05$).

[a] SEM is the standard error of the least-squares means.

[b] UPC=Universal product code.

Table 14
Least squares means for total cutting time(s) of short loins stratified by aging treatment, aging period, and USDA quality grade

Main effects	Total Cutting Time (s)
Aging Treatment	
Dry	331.6a
Wet	243.1b
SEM	8.0
P > F	<0.0001
Aging Day	
14	276.4b
21	274.7b
28	314.8a
35	283.4ab
SEM	11.2
P > F	0.0470
Quality grade	
Choice	285.2
Select	289.5
SEM	7.9
P > F	0.7026

Means within the same column lacking a common letter (a-b) differ ($P < 0.05$).

yield ($P = 0.0012$). Cooler shrink was highest ($P < 0.05$) for product dry aged 35 d. Although cooler shrink was similar for product dry aged 14, 21, or 28 d, all dry aged products endured a greater ($P < 0.05$) amount of cooler shrink than its wet aged counterparts. These results were expected and are supported through the research of Parrish et al. (1991) and Warren et al. (1992). Due to the differences in aging treatments, purge values cannot be accurately compared. Values were relatively constant within aging treatments due to proper storage and handling of product in transit and during aging. Cut loss was highest ($P < 0.05$) for short loins dry aged for 28 d. Although aging treatment × aging period had a significant affect on cut loss, values were relatively stable between aging treatments with the exception of the aforementioned. Means for total saleable yield were highest ($P < 0.05$) for short loins wet aged 14, 28, and 35 d. Saleable yield was lowest ($P < 0.05$) for short loins dry aged 28 or 35 d. All wet aged product resulted in higher ($P < 0.05$) percentages of total saleable yield when compared to its dry aged counterparts.

The effects of aging treatment, aging period, and USDA quality grade on mean total cutting times of short loins for each cutting test are presented in Table 14. Aging treatment had a significant (<0.0001) impact on total cutting time. As expected, dry aged product took a greater ($P < 0.0001$) amount of time to process when compared to wet aged product. The excess time associated with processing dry aged short loins is directly related to the presence of inedible surface tissue termed “scab” that must be removed prior to short loin fabrication. In addition, individual steaks, lean trim, and stew meat were carefully examined for any excess “scab” that may not have been removed prior to the fabrication of each dry aged short loin. Any dried out tissue that was not removed prior to fabrication was trimmed from individual pieces. In addition to aging treatment, aging period also significantly ($P = 0.0470$) affected total cutting time. As expected short loins aged for 28 and 35 d had the highest ($P < 0.0470$) total cutting times.

3.6. Value Relationships of Retail Cut Test

The interaction of USDA quality grade and aging period and the effects of realizable profit for saleable components of short loins are presented in Table 15. Four items were found to be significant for this interaction: Beef Loin Porterhouse Steak (P = 0.0207), net sales value (P = 0.0019), margin dollars (P = 0.0019), and percent margin (P = 0.0059). All USDA Choice Porterhouse steaks were higher ($P < 0.05$) in profitability than USDA Select Porterhouse steaks. This significance in profitability is primarily due to the substantial price difference between USDA Choice and Select Porterhouse steaks. In addition, USDA Choice Porterhouse steaks aged 14 d had the highest ($P < 0.05$) profit of all Porterhouse steaks, both Choice and Select. Net sales values were higher ($P < 0.05$) for all USDA Choice short loins when compared to their USDA Select counterparts. More specifically, USDA Choice short loins aged 14 d yielded the highest ($P < 0.05$) net sales value when compared to all other short loins, both Choice and Select. Margin, in terms of US dollars, was highest ($P < 0.05$) for USDA Choice short loins aged 14 d. This high margin value is directly related to the high net sales value discussed previously. Percent margin was lowest ($P < 0.05$) for USDA Choice short loins aged 21, 28, and 35 d.

The effects of aging treatment × aging period on realizable profit for saleable components of short loins are presented in Table 16. Three items were significant for this interaction: net sales value (P = 0.0317), margin dollars (P = 0.0317), and percent margin (P = 0.0080). Wet aged short loins yielded higher ($P < 0.05$) net sales values than all dry aged short loins regardless of aging period. More specifically, net sales values were lowest for short loins dry aged 21, 28, and 35 d. The trends for margin dollars and percent margin were closely related to the dollar figure of each short loin's respective net sales value. Margin, in terms of US dollar value, was lowest ($P < 0.05$) for short loins dry aged 21, 28, and 35 d. All wet aged short loins accounted for higher ($P < 0.05$) percent margin returns in comparison to dry aged product. The lower values associated with dry aged product was to be expected and is most likely due to the higher ($P < 0.05$) percentage of cooler shrink (Table 6) inherent to dry aged product.

The interaction of aging treatment and USDA quality grade is presented in Table 17. Two items were identified as significant within this interaction: net sales value (P = 0.0012) and margin dollars ($P = 0.0012$). Net sales value was highest ($P < 0.05$) for USDA Choice products within each aging treatment and lowest for USDA Select short loins within each aging treatment. The highest ($P < 0.05$) overall net sales mean value was seen in USDA Choice short loins that were aged in vacuum packaged bags. The lowest ($P < 0.05$) net sales mean value was seen in dry aged USDA Select short loins. These values were to be expected due to the higher amount of total saleable yield associated with wet aged short loins (Table 6) and the higher prices associated with USDA Choice product as compared to USDA Select product. Wet aged short loins, Choice and Select, returned the highest margin, in terms of US dollars, when compared to dry aged short loins. Within aging treatments, USDA Choice wet aged short loins returned a higher ($P < 0.05$) margin than its USDA Select counterpart. Additionally, mean values in relation to margin dollars were lowest ($P < 0.05$) for USDA Choice and Select short loins subjected to a dry aging treatment.

Table 15

Least squares means of realizable profit for saleable components of short loins stratified by USDA quality grade × aging period

Item	UPC[a]	Choice				Select					
		14	21	28	35	14	21	28	35	SEM	*P* > F
		US $									
Beef Loin Porterhouse Steak ($)	1330	1387.36a	1149.29b	1181.83b	1184.63b	969.21c	981.11c	984.10c	906.05c	42.70	0.0207
Beef Loin T-Bone Steak ($)	1369	310.36	381.49	326.62	346.05	322.70	292.07	322.30	301.88	34.20	0.4551
Beef Top Loin Steak Bnls ($)	1404	109.15	152.19	157.09	153.67	120.21	87.65	110.32	138.90	20.94	0.2841
Lean trimmings (90% lean) ($)	1653	7.36	5.99	8.85	10.41	9.24	9.50	5.85	10.59	1.54	0.1891
Beef for stew ($)	1727	14.77	19.14	13.95	13.94	10.85	21.69	13.86	16.27	3.20	0.7240
Net sales value ($)		1829.00a	1708.09b	1688.33b	1708.69b	1432.21c	1392.02cd	1436.44c	1373.70d	18.16	0.0019
Margin ($)		616.52a	495.62b	475.86bc	496.21b	495.30b	455.10bc	499.52b	436.79c	18.16	0.0019
Margin (%)		33.36ab	28.39c	27.54c	28.27c	34.28a	32.45ab	34.32a	31.07b	0.82	0.0059

Means within the same row lacking a common letter (a-d) differ ($P < 0.05$).

[a] UPC=Universal product code.

Table 16

Least squares means of realizable profit for saleable components of short loins stratified by aging treatment × aging period

Item	UPC[a]	Dry				Wet				SEM	*P* > F
		14	21	28	35	14	21	28	35		
		US $									
Beef Loin Porterhouse Steak ($)	1330	1096.94	930.84	989.83	913.27	1259.63	1199.57	1176.09	1177.41	42.70	0.4976
Beef Loin T-Bone Steak ($)	1369	317.50	354.08	279.22	324.62	315.56	319.48	369.71	323.30	34.20	0.3008
Beef Top Loin Steak Bnls ($)	1404	105.70	141.58	149.59	143.37	123.66	98.25	117.82	149.20	20.94	0.4049
Lean trimmings (90% lean) ($)	1653	4.13	3.30	2.93	4.05	12.47	12.19	11.77	16.95	1.54	0.4213
Beef for stew ($)	1727	10.16	13.27	12.25	9.12	15.46	27.56	15.56	21.09	3.20	0.2647
Net sales value ($)		1534.42c	1443.07d	1433.83d	1394.44d	1726.78a	1657.04b	1690.94ab	1687.95ab	18.16	0.0317
Margin ($)		459.73c	368.38d	359.13d	319.74d	652.09a	582.34ab	616.25ab	613.26ab	18.16	0.0317
Margin (%)		29.93c	25.65d	25.20de	23.01e	37.71a	35.20b	36.66ab	36.33ab	0.82	0.0080

Means within the same row lacking a common letter (a-e) differ (*P* < 0.05).

[a] UPC=Universal product code.

Table 17
Least squares means of realizable profit for saleable components of short loins stratified by aging treatment × USDA quality grade

Item	UPC[a]	Dry		Wet			
		Choice	Select	Choice	Select	SEM	$P > F$
	US $						
Beef Loin Porterhouse Steak ($)	1330	1101.78	863.66	1349.78	1056.57	30.19	0.3643
Beef Loin T-Bone Steak ($)	1369	325.29	312.43	356.97	307.05	24.19	0.4457
Beef Top Loin Steak Bnls ($)	1404	150.90	119.22	135.15	109.32	14.80	0.8436
Lean trimmings (90% lean) ($)	1653	4.31	2.88	11.97	14.71	1.09	0.0595
Beef for stew ($)	1727	10.03	12.36	20.86	18.97	2.26	0.3534
Net sales value ($)		1592.32b	1310.56d	1874.73a	1506.63c	12.84	0.0012
Margin ($)		379.85c	373.64c	662.25a	569.71b	12.84	0.0012
Margin (%)		23.56	28.34	35.23	37.72	0.58	0.0522

Means within the same row lacking a common letter (a-d) differ ($P < 0.05$).
[a] UPC=Universal product code.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Based on consumer evaluations of beef steaks from short loins, USDA quality grade proved to be the major factor affecting consumer perceptions of various palatability attributes. Aging treatment did affect FLVBF but only through the interaction of USDA quality grade × aging treatment. This may indicate that the average consumer is not accustomed to palatability characteristics that are thought to be associated with dry aged beef, or there is truly no difference in palatability characteristics between dry and wet aged products.

Retail cutting tests showed that wet aged short loins had higher total saleable yields than dry aged short loins. This was to be expected due to the high amount of cooler shrink associated with dry aged beef products. Low saleable yields and longer fabrication times associated with dry aged short loins would ultimately lead to a higher price for dry aged product at the retail level.

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