

**RETAIL YIELDS AND FABRICATION TIMES FOR BEEF SUBPRIMALS
FROM TWO GRADE GROUPS**

A Thesis

by

KRISTIN LEIGH VOGES

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

December 2004

Major Subject: Animal Science

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December 2004

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ABSTRACT

Retail Yields and Fabrication Times for Beef Subprimals from Two Grade Groups.

(December 2004)

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Chair of Advisory Committee: Dr. Jeffrey W. Savell

Beef subprimals (n = 356), representing USDA Low Choice and Select grades, were obtained from a major beef processor. Selected subprimals represented the normal weight variation and standard packer fat trim levels associated with commodity boxed beef. The subprimals selected included beef rib, blade meat; beef rib, ribeye roll, lip-on, bone-in; beef rib, ribeye roll (0x0); beef rib, ribeye, lip-on (2x2) (5.08 cm x 5.08 cm); beef rib, ribeye, lip-on modified (1x1) (2.54 cm x 2.54 cm); beef rib, ribeye (IM, individual muscle); beef rib, ribeye cap (IM); beef chuck, outside shoulder clod, trimmed; beef chuck, outside shoulder clod, top blade roast; beef chuck, square cut, pectoral meat (IM); beef chuck, chuck roll; beef plate, inside skirt (IM); beef round, top (inside) untrimmed; beef round, outside round (flat); beef round, eye of round (IM); beef loin, strip loin, bone in; beef loin, strip loin, boneless; beef loin, top sirloin butt, boneless, 2-piece; beef loin, bottom sirloin butt, flap boneless (IM); beef loin, bottom sirloin butt, ball tip, boneless; beef loin, bottom sirloin butt, tri-tip, boneless (IM); and beef chuck, outside shoulder, clod *M. teres major*. Subprimals were fabricated into bone-in or boneless retail or foodservice cuts and associated components by trained retail meat cutters. After each retail cutting test, trained technicians recorded weights of

all cuts, lean trim, fat trim, and bone. All retail cuts were trimmed to an eighth of an inch (0.32 cm), unless otherwise specified. Time (s) was recorded for each-cutting test and in two major phases: opening (retrieval of the subprimal from vacuum-packaged bag) and cutting (removal of all external and seam fat, connective tissue, and separation of individual muscles, as well as producing tray ready retail cuts). In general, Select subprimals had higher saleable yields than Choice subprimals. Select subprimals had less trimmable fat than Choice subprimals, and differences in retail yields appeared to follow these factors. Few significant differences were observed for processing times between USDA quality grade groups. These data will serve as an update to the CARDS (Computer Assisted Retail Decision Support) software program.

DEDICATION

I dedicate this thesis to my family; my parents, Lynn Voges, and Gary and Brenda Voges; my grandparents, Travis and Bette Odom and Ernest and Lillie Voges; as well as my brother and sister, Keith and Lauren Voges. They have been an invaluable part of my life and have molded me into the person I am today. The love, support, and encouragement they have provided throughout the years is greatly appreciated and will never be forgotten.

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Special thanks to all my family and friends for their love and support throughout the years, for without them, none of this would be possible. They have supported me in any endeavor I have chosen to partake and encouraged me in everything I do.

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CHAPTER I

INTRODUCTION

In the United States, the beef industry, through the leadership of the National Cattlemen's Beef Association, has focused its attention on quality. "Quality" can be defined as many different things, and quality trends deal with all sectors of the industry, but ultimately are determined by the consumer. To a great extent, the industry has been built on the taste appeal of beef; however, because other issues such as convenience, price, and diet/health, especially those related to fat intake increase in importance, the role of taste is not the only factor of concern (Savell et al., 1989). Fat thickness not only on retail cuts, but also on subprimals, became an increasing concern for retailers and foodservice vendors in the late 1980s. The beef industry has made remarkable strides in its effort to reduce excess fat, as beef retail cuts and ground beef have significantly less fat today than in the past (Savell et al., 1989).

CARDS (Computer Assisted Retail Decision Support), a computer software program, was originally designed in the early 1990s to provide third party data to address the issue of trimmable fat on subprimals and empower retailers to decide whether it was economically advantageous to pay more for trimmer subprimals (Garrett et al., 1991). The CARDS program continues to serve as a valuable reference to assist

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retailers and foodservice operators in the process of making decisions regarding meat purchasing and merchandising.

The purpose of this research was to perform a thorough evaluation of cuts included in the present version of Beef CARDS in order to pinpoint data deficiencies and/or inconsistencies. An inventory of cuts, formats, and terms was compiled from the existing Beef CARDS data looking for ways to improve this valuable program. Focus was geared toward both the retail and foodservice industries, in an effort to provide these sectors with an expanded database of processing yields and time allocations for commonly used, ready-to-cook retail and foodservice cuts. This research will provide retail and foodservice personnel with additional tools to evaluate the feasibility and profitability of the cuts examined.

CHAPTER II

LITERATURE REVIEW

In the late 1980s, retailers across the United States began the “War on Fat” with the adoption of “1/4-inch Trim Specifications” programs (Savell, 1993). This was the result of the major finding of the National Consumer Retail Beef Study (Cross et al., 1986; Savell et al., 1989) that closer trimming of retail cuts could result in an improved image for sales of beef. In this study, consumers were questioned about their concerns regarding beef: price was of greatest concern, closely followed by fatness and cholesterol. Price and leanness were shown to greatly influence how consumers rate beef with taste being a positive influence and price and fatness being negative influences. Consumers perceived closely-trimmed or completely trimmed retail cuts as being more appetizing, better tasting, well trimmed and less wasteful, and to be lower in cholesterol. Retail cuts with excessive fat not only were considered to be wasteful, but also projected a negative influence on the perceptions of taste and healthfulness of beef. This study also found differences in consumer preferences throughout different regions of the country and found that consumers could be segmented into two groups based on purchasing decisions. There are consumers who consider leanness or the amount of external fat on beef as important, and there are consumers who are primarily concerned with the taste of beef. The National Beef Market Basket Survey (Savell et al., 1991) found the average fat thickness of beef retail cuts was 0.1 inch (0.25 cm), and over 42% of beef cuts had no external fat. Retailers had made it obvious that in order for beef to

be competitive in the marketplace, it had to have less trimmable fat. When the information from the National Beef Market Basket Survey was compared to USDA Agriculture Handbook 8-13, beef steaks and roasts had 27.4% less fat and ground beef had 10.2% less fat. On average, ground beef had 33.4% less fat than the maximum fat percentage (30%) government regulations permit (Savell et al., 1991). The Value Based Marketing Task Force (1990) felt the retail segment had done its part to help beef; however, the rest of the industry was lagging behind in reducing the amount of excess fat production. There were several recommendations by the task force including the development of user-friendly software for retailers to see the value in purchasing closely-trimmed products. The National Consumer Beef Retail Study (Savell et al., 1989) concluded that as the move to reduce the fat on retail cuts gained momentum, there existed a need to reduce fat on wholesale and subprimal cuts at the packer level. Before this, most packers' specifications for boxed beef allowed for up to 2.54 cm (1.0 inch) of fat to remain on cuts. In order to make the new retail fat trim programs succeed, retailers needed to purchase boxed beef with less external fat than was presently available on most cuts (Savell et al., 1989).

A test to verify differences between commodity and closer-trimmed subprimals (1.27 cm (1/2-inch trim) specifications) in yield and cutting times was conducted in the Trimmer Beef Pilot Study (Garrett et al., 1991). For some cuts, the economics of cutting yields combined with the costs of labor favored the 1.27 cm (1/2-inch) trimmed subprimals while for others, the advantages were in favor of the commodity subprimals. A problem identified in this study was to conduct time and motion studies in actual retail

settings, both minor and major variations in the ways the meat cutters fabricated subprimals and merchandised retail cuts from store to store within the same chain occurred. The variation impacted the results from the standpoint that value differences between the test (1/2-inch) and control (commodity) were blurred somewhat due to these uncontrollable factors. Based on a review of data, the decision was made that to effectively study the advantages and disadvantages of closer-trimmed subprimals in the marketplace, and to determine their relative worth compared to present-day commodity beef, a controlled study had to be conducted where cutting procedures and worker-related actions were standardized. Thus, the first project to obtain time and yield data for this project was established.

CARDS (Computer Assisted Retail Decision Support) was developed by animal scientists and computer specialists at Texas A&M University in 1991 (Walter et al., 1991). This software was released to the public at the National American Wholesaler Grocers Association and National Grocers Association Meat Operations Meeting in Kansas City on September 30, 1991 (Savell, 1993). The CARDS system allowed comparisons among different purchasing options for commodity cuts that had up to 1-inch (2.54 cm), 1/2-inch (1.27 cm), or 1/4-inch (0.635 cm) maximum external fat and then cut into retail cuts with three different fat trim specifications: 1/4-inch (0.635 cm), 1/8-inch (0.3175 cm), or no external fat. This program also included data on cutting yields, labor costs, gross profit, and net profit per hundred pounds (45.4 kg). The original vision of the CARDS program was to provide third-party data to address the issue of trimmable fat on subprimals and empower retailers to decide whether it was

economically advantageous to pay more for trimmer subprimals (McKenna et al., 2003). The common thought was that it would be more economical to buy commodity subprimals and trim them rather than pay for the difference in reduced yield and increased labor and packaging that a packer had to pay to provide closely-trimmed subprimals (Garrett et al., 1991). CARDS was widely distributed to interested parties at no cost to get the maximum use of the information by the different segments of the industry.

In 1991, the same year the CARDS program was developed, the 1991 National Beef Quality Audit established the first major benchmark that identified the characteristics of the products produced by the U.S. beef industry (Lorenzen et al., 1993). The 1995 and 2000 National Beef Quality Audits measured progress regarding the quality, consistency, and competitiveness of beef (Boleman et al., 1998; McKenna et al., 2002). In Phase I of the 1995 Beef Quality Audit, interviews were conducted with purveyors, retailers, restaurateurs, and those who purchase, prepare, and present beef to customers in hotels, restaurants, institutions, and fast food franchises. As a result, it was obvious that a primary concern of each faction was excessive external and seam fat associated with the product they received (NCBA, 1995).

The retail use of closely trimmed beef subprimals increased during the 1990s (Savell et al., 1995), which was accomplished, in part, by the availability of comparative cutting test information (Garrett et al., 1991). This information (Garrett et al., 1991) was specifically designed to provide accurate, unbiased cutting yields and labor times concerning closely trimmed beef to the retail industry.

Previous research on retail yield and fabrication times of beef (Garrett et al., 1991) led to research on pork (Lorenzen et al., 1996 a,b), lamb (Lorenzen et al., 1997), and veal (McNeill et al., 1998), and allowed for the development of the CARDS program for these species. This program was originally designed for primary use by the retail sector; however, demand was needed to generate similar information suited to the foodservice industry. Weatherly et al. (2001) conducted a study to determine cutting yields and time requirements for beef subprimals as they were portioned to form ready-to-cook foodservice cuts. More than ten years after the CARDS program was released, external trim levels have become a nonissue as knowledgeable retailers have driven the demand for closely trimmed subprimals. The purpose of the CARDS program currently is to allow retailers and foodservice operators to determine feasibility and potential profitability of utilizing different subprimal cuts (McKenna et al., 2003).

Numerous attempts have been successful in optimizing the value of existing wholesale beef cuts, especially from the chuck and round (NCBA, 2001). The CARDS program serves as a valuable reference to assist retailers and foodservice operators in the process of making decisions regarding meat purchasing and merchandising.

CHAPTER III

MATERIALS AND METHODS

Product Selection

Beef subprimals (n = 356), representing USDA Low Choice and Select grades, were obtained from a major beef processor and shipped to the Rosenthal Meat Science and Technology Center at Texas A&M University. Selected subprimals represented the normal weight variation and standard packer fat trim levels associated with commodity boxed beef. Specifications for all subprimals complied (within packer variations) with Institutional Meat Purchase Specifications (IMPS) as described by USDA (1996) and NAMP (2003). The subprimals selected were the Beef Rib, Blade Meat (IMPS #109B); Beef Rib, Ribeye Roll, Lip-On, Bone-In (IMPS #109E); Beef Rib, Ribeye Roll (0x0) (IMPS #112); Beef Rib, Ribeye, Lip-On (2x2) (5.08 cm x 5.08 cm) (IMPS #112A); Beef Rib, Ribeye, Lip-On Modified (1x1) (2.54 cm x 2.54 cm) (IMPS #112A modified); Beef Rib, Ribeye (IM, individual muscle) (IMPS #112C); Beef Rib, Ribeye Cap (IM) (IMPS #112D); Beef Chuck, Shoulder Clod, Trimmed (IMPS #114C); Beef Chuck, Shoulder Clod, Top Blade, Roast (IMPS #114D); Beef Chuck, Square Cut, Pectoral Meat (IM) (IMPS #115D); Beef Chuck, Chuck Roll (IMPS #116A); Beef Plate, Inside Skirt (IM) (IMPS #121D); Beef Round, Top (Inside) (IMPS #168); Beef Round, Outside Round (Flat) (IMPS #171B); Beef Round, Eye of Round (IM) (IMPS #171C); Beef Loin, Strip Loin, (IMPS #175); Beef Loin, Strip Loin, Boneless (IMPS #180); Beef Loin, Top Sirloin, Boneless, 2 Pc (IMPS #184E); Beef Loin, Bottom Sirloin Butt, Flap Boneless

(IM) (IMPS #185A); Beef Loin, Bottom Sirloin Butt, Ball Tip, Boneless (IMPS #185B); Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless (IM) (IMPS #185C); and Beef Chuck, Shoulder, Clod *M. teres major*.

Cutting Tests

Subprimals were fabricated in a simulated retail cutting room in the Rosenthal Meat Science and Technology Center at Texas A&M University. Fabrication was conducted by trained retail meat cutters with extensive retail meat industry cutting experience. All vacuum packaged subprimals were weighed before opening and again after opening. Vacuum bags were drained, washed, dried, and weighed in order to obtain an accurate purge loss value. The weights of all fabricated components were summed at completion of cutting test to ensure that at least 99% of the beginning subprimal weight was maintained throughout the test. After each cutting test, trained technicians recorded weights of all cuts, lean trim, fat trim, and bone. All retail cuts were trimmed to 0.32 cm of subcutaneous or intermuscular fat, unless otherwise specified. Activities included during meat-cutting tests were divided into two major phases: opening (retrieval of the subprimal from vacuum-packaged bag) and cutting (removal of external and seam fat, connective tissue, and separation of individual muscles, as well as producing tray ready retail cuts as applicable). The two phases were combined for total processing time. Technicians were trained to record the time (s) required to complete each phase of cutting using handheld stopwatches. Recording times for each phase of the cutting test enabled the calculation of total time required to

complete the cutting test. Technicians also were responsible for evaluating each test for completion before moving to the next phase.

Beef Rib, Blade Meat (IMPS #109B) was cut by denuding each muscle obtained from the vacuum bag and pieces not suitable for cubed steak were fabricated into Beef for Stew (U.P.C. 1727). The resulting meat pieces were then passed through a mechanical cubing machine (Commercial Tenderizer 138C, Sir Steak Machinery, Inc.) to produce Cap Meat, Boneless (U.P.C. 1185). Beef Rib, Ribeye Rolls, Lip-On, Bone in (IMPS #109E) were cut into two different retail styles. One style consisted of cutting the bone-in ribeye rolls into three Ribeye Roasts, Lip-on, Bone in, the first consisting of the 6th and 7th rib section (U.P.C. 1193), the second consisting of the 8th and 9th rib section (U.P.C. 1193), and the third consisting of the 10th through 12th rib section (U.P.C. 1193). In the second style, the entire roast was cut into 3.175 cm Ribeye Steaks, Lip-On, Bone In (U.P.C. 1197) on a band saw. The Beef Rib, Ribeye Rolls (0x0) (IMPS #112) were knife cut end-to-end into 2.54 cm Ribeye steaks (U.P.C. 1209). Beef Rib, Ribeye Rolls, Lip-On (2x2) (5.08 cm x 5.08 cm) (IMPS #112A) and (1x1) (2.54 cm x 2.54 cm) (IMPS #112A Modified) were cut into two different retail cutting styles. One style consisted of the subprimal being cut into 2.54 cm Ribeye Steaks, Lip-On, Boneless (U.P.C. 1203) (end-to-end) and the second style consisted of cutting 2.54 cm Ribeye Steaks, Lip-On, Boneless (U.P.C. 1203) throughout the small (posterior) end with the large (anterior) end remaining intact as a Ribeye Roasts, Lip-On, Boneless (U.P.C. 1194). Beef Rib, Ribeyes (IM) (IMPS #112C) and Beef Rib, Ribeye Caps (IM) (IMPS #112D) were initially fabricated from Beef Rib, Ribeye Rolls (0x0) (IMPS #112). The

M. spinalis dorsi and *M. complexus dorsi* were removed for total weight and purge documentation, however, separate cutting tests were performed on each. Beef Rib, Ribeye Roll (IM) (IMPS #112C) portions were cut end-to-end into 2.54 cm Ribeye Steaks and the Beef Rib, Ribeye Cap (IM) (IMPS #112D) was separated into the *M. spinalis dorsi* and *M. complexus dorsi*. Each muscle then was trimmed and remained as a whole muscle retail cut.

Beef Chuck, Shoulder, Clods, Trimmed (IMPS #114C) were initially cut by removing accessory muscles from the *Mm. triceps brachii caput longum, laterale, and mediale* and cutting Beef for Stew (U.P.C. 1727) from the accessory pieces. The *M. triceps brachii* then was cut into 2.54 cm thick Shoulder Center Steaks (U.P.C. 1162) and Shoulder Top Steaks (U.P.C. 1163). Beef Chuck, shoulder Clod, Top Blade, Roasts (IMPS #114D) were trimmed and the heavy connective tissue surrounding and traversing the center of the muscle was removed by horizontally filleting the muscle into two separate flat pieces of *M. infraspinatus* into Shoulder Top Blade Steaks (U.P.C. 1166).

Beef Chuck, Square Cut, Pectoral Meat (IM) (IMPS #115D) was received in bags of approximately six pieces per bag. Three pieces from each bag were selected (at the retail cutter's discretion) to perform cutting tests. These pieces then were cut into 1.27 cm- to 1.91 cm-thick Braising Strips. The remaining lean was fabricated into Beef for Stew (U.P.C. 1727) and Lean Trimmings (U.P.C. 1653).

Chuck rolls (IMPS #116A) were initially cut by removing the *M. trapezius pars thoracis* and *M. latissimus dorsi* muscles. The *M. serratus ventralis* was removed and

designated as a Chuck Eye Edge Pot Roast (U.P.C. 1092). The remaining pieces were cut into Short Ribs, Boneless (U.P.C. 1092). Chuck steaks then were cut from the posterior end of the remaining chuck roll section until seam fat was no longer present between the *M. longissimus thoracis* and the *M. rhomboideus thoracis*, *M. trapezius pars thoracica*, and the *M. latissimus dorsi*. Chuck Eye Steaks (U.P.C. 1102), consisting of the *M. longissimus thoracis*, *M. complexus dorsi*, and the *M. spinalis dorsi* then were separated from the Underblade Steaks, Boneless (U.P.C. 1158). Chuck Eye Roasts (U.P.C. 1095) were then cut into 5.08 cm portions from the remainder of the chuck roll. The neck region was removed and fabricated into Beef for Stew (U.P.C. 1727) or Lean Trimmings (U.P.C. 1653).

Beef Plate, Inside Skirts (IM) (IMPS #121D) were received in vacuum bags with approximately six pieces per bag. The individual pieces were trimmed into Skirt Steaks, Boneless (U.P.C. 1607) and a cutting test was performed on the bag as a unit. Top (inside) rounds, untrimmed (IMPS #168) were fabricated by initially removing the cap muscle, *M. gracilis*, and cut into Beef Cubed Steak (U.P.C. 1577). The soft side portion, which consists of the *M. pectineus*, and *M. sartorius*, was removed and fabricated into Beef Cubed Steak (U.P.C. 1577). The first steak from the anterior edge of the remaining top round portion, commonly referred to as the Top Round Steak, 1st Cut (London Broil) (U.P.C. 1556), was cut 3.81 cm thick. Following removal of the London Broil, Top Round Steaks (U.P.C. 1553) then were cut 1.27 cm-thick. The remaining portion not suitable for steaks was trimmed as a Top Round Roast, Cap Off (U.P.C. 1454).

Beef Round, Outside Rounds (flat) (IMPS #171B) were fabricated by two different cutting styles. The initial cutting style consisted of removing the Ischiatic head of the *M. gluteobiceps* through the natural seam and preparing it as a Bottom Round Roast (U.P.C. 1464). The remainder of the *M. gluteobiceps* was portioned into thick Bottom Round Steaks (3.81 cm) (U.P.C. 1466) by cutting perpendicular to the muscle fiber orientation; Beef Cubed Steak (U.P.C. 1577) was recovered when appropriate. The second style also consisted of removal of the Ischiatic head of the *M. gluteobiceps* and then separation of the muscle according to fiber direction, thus preparing two Bottom Round Roasts (U.P.C. 1464). Two to three 3.81 cm Bottom Round Steaks (U.P.C. 1466) were removed from the remaining portion of the *M. gluteobiceps* and a Bottom Round Rump Roast (U.P.C. 1519) then was trimmed from the posterior end. Beef Round, Eye of Rounds (IM) (IMPS #171C) were fabricated by three cutting styles. The first style consisted of half of the muscle being cut into 1.27 cm to 1.91 cm Eye of Round Steaks (U.P.C. 1481) and the remaining portion left intact as an Eye of Round Roast (U.P.C. 1480). The second style consisted of cutting the muscle in half perpendicular to the length of the subprimal to make two Eye of Round Roasts (U.P.C. 1480), and the third style left the entire muscle intact as an Eye of Round Roast (U.P.C. 1480).

Beef Loin, Strip Loins (IMPS #175) and Beef Loin, Strip Loins, Boneless (IMPS #180) were cut into 2.54 cm thick Top Loin Steaks (U.P.C. 1398 or 1404) using a band saw or knife, respectively. Center-cut Strip Steaks and Vein Steaks (steaks that had *M. gluteus medius* on both sides of the cut) were kept separate and treated as two different retail cuts. Beef Loin, Top Sirloins, Boneless, 2 Pc (IMPS #184E) were received with

both pieces in the bag; however, aside from bag opening time, initial weight, bag weight, and purge weight, the cuts were kept separate differentiating between the Beef Loin, Top Sirloin Butt, Center-Cut, Boneless (IM) (IMPS #184B) and the Beef Loin, Top Sirloin, Cap (IM) (IMPS #184D). Cutting tests were performed on each of these cuts independently. All Steaks were cut 2.54 cm thick and perpendicular to muscle fiber orientation. Beef Loin, Bottom Sirloin Butt, Flaps Boneless (IM) (IMPS #185A) were left intact, and trimmed into Flap Meat Steaks (U.P.C. 1326). Beef Loin, Bottom Sirloin Butt, Ball Tips, Boneless (IMPS #185B) were cut into 2.54 cm Ball Tip Steaks (U.P.C. 1308) and Beef for Kabobs (U.P.C. 1576) were recovered when possible. Beef Loin, Bottom Sirloin Butt, Tri-Tips, Boneless (IM) (IMPS #185C) were assigned into two different cutting styles. The first cutting style consisted of cutting the *M. tensor fasciae latae* into 2.54 cm Tri-Tip Steaks (U.P.C. 1430) perpendicular to muscle fiber orientation and any remaining pieces were recovered for Beef for Kabobs (U.P.C. 1576). The second style included leaving the muscle whole as a Tri-Tip Roast (U.P.C. 1429) and completely denuding the product. The outside shoulder, clod, *M. teres major* was separated into two cutting styles: in the initial style muscles were left as Whole, Trimmed, Intact Roasts, and the second style was cut into 2.54 cm thick Medallions and end pieces.

Retail cutting endpoints are reported in each table. For each cut, information is reported for saleable yield components such as steaks and/or roasts, lean trimmings, beef cubes for kabobs or beef for stew, cubed steaks, and loss components such as fat trimmings, purge, and cutting losses. Universal Product Code description (Industry-

Wide Cooperative Meat Identification Standards Committee, 2003; NLSMB, 1995 a, b) were used to identify the retail cuts obtained from each subprimal.

Statistical Analysis

The experiment was planned as a completely randomized design. Data were analyzed, by subprimal, using the GLM procedure of SAS (SAS Institute, Inc., Cary, NC), with quality grade group tested as the main effect. Least squares means were generated, and when an alpha-level of $P < 0.05$ was found, least squares means were separated by a pairwise t -test (PDIFF option).

CHAPTER IV

RESULTS AND DISCUSSION

Beef subprimals and associated components from various cutting tests were evaluated for mean retail yields and processing times (Tables 1 to 33). Pictures of finished retail cuts and associated components are presented in Appendix A. For each subprimal, comparisons were made between retail cuts and cutting by-products from two different quality grade groups, USDA Choice and USDA Select. Visual appraisal of lean trimmings produced by the meat cutters during retail cut manufacturing was estimated to be 90% lean (not determined by proximate analysis).

Choice Beef Rib, Blade Meat (IMPS #109B) had a higher percentage of total saleable yield, mainly due to an increased percentage of boneless cap meat. Select blade meat produced more trimmable fat and required a longer cutting time (Table 1).

Select Beef Rib, Ribeye Roll, Lip-On, Bone In (IMPS #109E) required more time ($P<0.004$) to facilitate opening the bag. Choice bone-in ribeyes produced a slightly higher percentage of bone-in ribeye steaks when compared to Select counterparts; however, the roast percentage and total saleable yield was very similar between Select and Choice (Table 2). Cutting and total time required to cut ribeye steaks were significantly higher in Choice bone-in ribeye rolls that were cut entirely into steaks (Table 3) most likely resulting from a numerically higher percentage of fat trim. Choice ribeye rolls also produced a greater amount of purge than the Select ribeyes. Saleable

Table 1. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Blade Meat (IMPS #109B) from different USDA quality grade groups

Item	UPC ^a	Choice (n=4)	Select (n=4)	SEM ^b	P-value
Net weight, kg		7.80	8.33	0.20	0.11
Retail yield		%			
Cap meat, bnls	1185	36.27	31.43	3.42	0.36
Beef for stew	1727	33.14	32.85	2.77	0.94
90% Lean trim	1653	25.66	26.45	1.21	0.66
Fat		0.67	4.89	2.62	0.31
Purge		4.08	3.88	0.22	0.56
Cutting loss		0.19	0.51	0.10	0.07
Total saleable yield		95.07	90.73	2.73	0.31
Processing time, per subprimal		s			
Bag opening time		24.97	29.14	2.0	0.20
Trimming/Cutting time		598.61	829.39	90.57	0.13
Total time		623.58	858.53	90.54	0.13

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 2. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Ribeye Roll, Lip-On, Bone In (IMPS #109E), cut into roasts from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		7.80	8.33	0.20	0.11
Retail yield		————— % —————			
Ribeye roast, lip-on, bone in	1193				
6 th – 7 th rib roast		24.20	25.74	0.57	0.09
8 th – 9 th rib roast		27.06	27.27	0.52	0.78
10 th – 12 th rib roast		43.62	42.03	0.66	0.12
90% Lean trim	1653	0.75	0.47	0.31	0.54
Fat		4.09	4.32	0.65	0.81
Purge		0.29	0.19	0.08	0.42
Cutting loss		0.01	0.00	0.03	0.63
Total saleable yield		95.62	95.51	0.63	0.90
Processing time, per subprimal		————— s —————			
Bag opening time		11.44	17.83	1.19	0.004
Trimming/Cutting time		120.66	126.02	24.05	0.88
Total time		132.10	143.85	24.30	0.74

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 3. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Ribeye Roll, Lip-On, Bone In (IMPS #109E), cut into steaks, from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		7.50	6.40	0.78	0.5
Retail yield		%			
Ribeye steak, lip-on, bone in	1197	87.52	90.13	0.63	0.08
90% Lean trim	1653	2.99	2.35	0.64	0.50
Fat		8.08	6.33	0.84	0.18
Purge		0.28	0.17	0.09	0.41
Cutting loss		1.12	0.96	0.07	0.13
Total saleable yield		90.51	92.48	0.86	0.14
Processing time, per subprimal		s			
Bag Opening time		12.83	12.68	1.59	0.95
Trimming/Cutting time		319.84	264.37	16.85	0.05
Total time		322.68	277.05	17.29	0.05

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

yield also was higher in the initial cutting style fabricated into roasts (95%) (Table 2) compared to subprimals cut into steaks (90-95%) (Table 3).

Choice Beef Rib, Ribeye Roll (IMPS #112) displayed a slight increase in the amount of fat produced, as well as the time necessary to cut boneless ribeye steaks (Table 4). Select ribeye rolls produced a higher percentage (97.24 versus 95.18 percentage, respectively) of trimmed ribeye steaks (Table 4) than did Choice. Select Beef Rib, Ribeye Rolls, Lip-On (IMPS #112A) (2x2) (5.08 cm x 5.08 cm) cut only into steaks required a significantly longer time to cut into ribeye steaks, thus resulting in a significantly longer total processing time (Table 5) when compared to Choice ribeye rolls. Choice ribeye rolls tended to be fatter and Select ribeye rolls produced a higher percentage of total saleable product. Choice boneless ribeye rolls (2x2) (5.08 cm x 5.08 cm) of the Choice grade that were cut into steaks and roasts were more likely to produce a greater percentage of fat, as well as a higher percentage of roasts, whereas Select ribeye rolls yielded a higher percentage of steaks. Total saleable yield was very similar between grades (Table 6). When comparing 2x2 ribeye roll cutting styles, a greater percentage of fat and lean trim was produced from the cutting style containing all steaks. In Table 7, Choice Beef Rib, Ribeye Rolls, Lip-On, Modified (1x1) (2.54 cm x 2.54 cm) (IMPS #112A modified) required significantly more fat trimming than Select ribeye rolls (Table 7). Select ribeye rolls also produced a greater amount of purge, as well as 3.2 percent more ribeye steaks, while Choice ribeye rolls yielded a slightly higher percentage of ribeye roasts.

Table 4. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Ribeye Roll (IMPS #112), from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	<i>P</i> -value
Net weight, kg		4.44	3.67	0.32	0.23
Retail yield		%			
Ribeye steak	1209	95.18	97.24	1.02	0.29
90% Lean trim	1653	1.88	0.83	1.03	0.55
Fat		1.81	1.31	0.29	0.34
Purge		1.19	0.68	0.45	0.51
Cutting Loss		0.00	0.00	0.06	0.94
Total saleable yield		97.06	98.07	0.24	0.10
Processing time, per subprimal		s			
Bag opening time		8.07	6.62	1.02	0.42
Trimming/Cutting time		102.11	68.96	7.26	0.08
Total time		110.17	75.58	8.17	0.10

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 5. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Ribeye Roll, Lip-On (IMPS #112A) cut to include steaks from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		6.34	6.85	0.21	0.11
Retail yield		%			
Ribeye steak, lip on, bnls	1203	84.08	84.91	0.76	0.44
90% Lean trim	1653	3.78	4.28	0.47	0.47
Fat		11.13	9.89	0.89	0.33
Purge		0.95	0.84	0.23	0.72
Cutting loss		0.06	0.11	0.06	0.55
Total saleable yield		87.87	89.19	0.91	0.32
Processing time, per subprimal		s			
Bag opening time		11.66	11.33	1.18	0.85
Trimming/Cutting time		221.22	272.27	16.54	0.05
Total time		232.65	283.56	16.26	0.05

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 6. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Ribeye Roll, Lip-On (IMPS #112A), cut into steaks and roasts from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		7.21	6.61	0.25	0.12
Retail yield		%			
Ribeye steak, lip-on, bnls	1203	43.54	49.08	2.96	0.21
Ribeye roast, lip-on, bnls	1194	44.19	38.00	2.66	0.12
90% Lean trim	1653	2.97	3.89	0.46	0.18
Fat		8.47	8.02	0.91	0.73
Purge		0.80	0.89	0.21	0.78
Cutting loss		0.03	0.13	0.08	0.39
Total saleable yield		90.70	90.97	0.92	0.83
Processing time, per subprimal		s			
Bag opening time		11.75	10.93	1.14	0.61
Trimming/Cutting time		198.43	213.59	21.98	0.63
Total time		210.19	224.52	21.21	0.63

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 7. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Ribeye Roll, Lip-On, Modified 1x1 (IMPS #112A modified), from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		4.26	6.25	2.19	0.26
Retail yield		%			
Ribeye steak, lip-on, bnls	1203	40.98	44.18	2.16	0.37
Ribeye roast, lip-on, bnls	1194	47.11	45.97	2.41	0.75
90% Lean trim	1653	2.51	2.28	1.14	0.89
Fat		9.40	6.33	0.72	0.02
Purge		0.00	1.06	0.95	0.41
Cutting loss		0.22	0.19	0.14	0.90
Total saleable yield		90.60	92.43	1.40	0.42
Processing time, per subprimal		s			
Bag opening time		7.29	11.87	0.25	0.01
Trimming/Cutting time		140.06	149.29	15.76	0.70
Total time		147.35	161.16	15.72	0.57

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

As shown in Table 8, Select Beef Rib, Ribeyes (IM) (IMPS #112C) required a significantly longer amount of time for bag opening, *M. spinalis dorsi* removal, cutting and total time. All cutout percentages were similar between Choice and Select muscles, with the total saleable yield found to be approximately 88%. The net weight of Select Beef Rib, Ribeye Caps (IMPS #112D) was significantly heavier and the retail cutting time required was significantly greater than Choice ribeye cap muscles (Table 9), however, mean cutout percentages from the ribeye caps were very similar when compared between grades.

Select Beef Chuck, Shoulder Clods, Trimmed (IMPS #114C) had a higher percentage of shoulder top steaks ($P<0.01$) and boneless shoulder pot roasts ($P<0.03$), thus allowing them to produce a higher percentage (3.5%) of total saleable yield similar to the findings of Garrett et al. (1991) and McKenna et al.(2003). Choice shoulder clods possessed more trimmable fat, and, in return, required a longer amount of time to process (Table 10). Retail yields for shoulder clods (85-88%) were higher than those found by McKenna et al. (2003) (73-78%), but lower than the retail yield reported by Garrett et al. (1991) using a traditional fabrication style. Contrary to the Select Beef Chuck, Shoulder Clod, Top Blade, Roasts (IMPS #114D) yielded a greater percentage of fat, while Choice top blade roasts produced a greater amount of purge (Table 11). No difference ($P>0.05$) was found in saleable yield between Choice and Select supporting McKenna et al. (2003) findings. McKenna et al. (2003) reported slightly higher saleable yields, mainly due to the decreased amount of fat, and the fact that the beef trim was considered 85% lean as opposed to 90% lean used in the present study.

Table 8. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Ribeye (IM) (IMPS #112C), from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		4.26	5.68	0.23	0.001
Retail yield		%			
Ribeye steak (IM)		53.36	52.33	1.14	0.54
<i>M. spinalis dorsi</i> & <i>M. complexus dorsi</i>		33.98	34.99	1.25	0.58
90% Lean trim	1653	1.36	1.17	0.53	0.80
Fat		6.93	6.54	0.93	0.78
Purge		1.47	1.14	0.20	0.26
Cutting loss		2.90	3.83	0.66	0.34
Total saleable yield		88.70	88.49	0.98	0.88
Processing time, per subprimal		s			
Bag opening time		9.15	11.19	0.64	0.04
<i>M. spinalis dorsi</i> removal time		58.23	96.67	5.98	0.001
Trimming/Cutting time		101.82	126.42	7.88	0.05
Total time		169.19	234.29	11.79	0.002

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 9. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Rib, Ribeye Cap (IM) (IMPS #112D), from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		1.50	2.07	0.06	0.01
Retail yield		%			
<i>M. Spinalis dorsi</i>		43.60	43.11	1.84	0.85
<i>M. Complexus dorsi</i>		7.26	8.79	0.59	0.09
90% Lean trim	1653	29.70	29.05	2.27	0.84
Fat		19.47	18.91	2.02	0.85
Cutting loss		0.00	0.14	0.12	0.31
Total saleable yield		80.56	80.95	2.07	0.90
Processing time, per subprimal		s			
Trimming/Cutting time		165.70	229.58	10.78	0.04

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 10. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Chuck, Shoulder Clod, Trimmed (IMPS #114C), from different USDA quality grade groups

Item	UPC ^a	Choice (n=9)	Select (n=9)	SEM ^b	P-value
Net weight, kg		5.92	5.60	0.35	0.53
Retail yield		%			
Shoulder center steak	1162	19.80	16.82	1.12	0.11
Shoulder top steak	1163	8.87	14.53	1.12	0.01
Shoulder pot roast bnls	1132	5.52	10.69	1.4	0.03
Beef for stew	1727	23.60	23.54	0.67	0.95
90% Lean trim	1653	27.91	30.37	1.31	0.22
Fat		13.76	11.93	1.35	0.37
Purge		0.89	0.76	0.21	0.68
Cutting loss		0.10	0.00	0.11	0.30
Total saleable yield		85.32	88.82	1.69	0.19
Processing time, per subprimal		s			
Bag opening time		8.89	7.78	0.80	0.36
Trimming/Cutting time		514.74	500.24	37.06	0.79
Total time		523.63	508.02	37.19	0.78

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 11. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Chuck, Shoulder Clod, Top Blade, Roast (IMPS #114D), from different USDA quality grade groups

Item	UPC ^a	Choice (n=9)	Select (n=9)	SEM ^b	P-value
Net weight, kg		2.25	2.12	0.15	0.57
Retail yield		%			
Shoulder top blade steak	1166	50.55	48.86	1.58	0.46
90% Lean trim	1653	31.43	32.01	1.67	0.81
Fat		17.35	18.81	1.25	0.42
Purge		0.71	0.40	0.20	0.29
Cutting loss		0.00	0.00	0.07	0.60
Total saleable yield		81.98	80.87	1.21	0.53
Processing time, per subprimal		s			
Bag opening time		6.97	7.14	0.56	0.83
Trimming/Cutting time		280.30	262.67	25.49	0.63
Total time		287.27	269.81	25.53	0.63

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Select Beef Chuck, Pectoral Meat (IMPS #115D), when evaluated on a total bag basis, tended to begin with a larger net weight when compared to the Choice pectoral meat (Table 12). Select pectoral meat assessed on an individual piece basis had a significantly heavier initial net weight and required a greater amount of time to cut into retail product (Table 13). Pectoral meat classified as Choice possessed a greater amount of purge when compared to Select ($P<0.04$). The Choice pectoral meat also tended to have a greater amount of trimmable fat, and Select yielded a higher percentage of saleable product than Choice pectoral.

Select Beef Chuck, Chuck Rolls (IMPS #116A) required a significantly longer time to open the bags and remove the product when compared to Choice chuck rolls. Choice chuck rolls tended to yield a greater percentage of underblade steaks and fat. Lean trimmings and beef for stew appeared to have higher yield percentages for Select chuck rolls when compared to Choice chuck rolls (Table 14).

Beef Plate, Inside Skirt (IM) (IMPS #121D) retail yields and processing times are reported in Table 15. Observed differences included a higher percentage of skirt steak and fat from Select skirt steaks when compared to Choice steaks and a greater amount of lean trim and a longer cutting time required for Choice skirt steaks.

Choice Beef Round, Top (Inside) rounds (IMPS #168) possessed a greater net weight ($P<0.01$) and a higher percentage of trimmed fat ($P<0.001$), thus resulting in a greater amount of time required for cutting ($P<0.03$) and total time ($P<0.04$) when compared to Select inside rounds. Select inside rounds displayed a

Table 12. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Chuck, Square Cut, Pectoral Meat (IM) (IMPS #115D), from different USDA quality grade groups on per bag basis

Item	Choice (n=6)	Select (n=6)	SEM ^b	<i>P</i> -value
Net weight, kg	7.29	8.05	0.57	0.11
Retail yield	_____ % _____			
Pectoral meat	97.47	97.52	0.32	0.93
Purge	0.41	0.43	0.06	0.79
Total saleable yield	97.47	97.52	0.32	0.93
Processing time, per subprimal	_____ s _____			
Bag opening time	21.55	22.24	0.84	0.59

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 13. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Chuck, Square Cut, Pectoral Meat (IM) (IMPS #115D), from different USDA quality grade groups on per piece basis

Item	UPC ^a	Choice (n=18)	Select (n=18)	SEM ^b	P-value
Net weight, kg		1.35	1.55	0.04	0.002
Retail yield		%			
Braising strips		67.29	68.58	1.27	0.48
Beef for stew	1727	10.82	10.48	0.67	0.72
90% Lean trim	1653	16.67	17.40	0.98	0.61
Fat		2.61	1.57	0.65	0.27
Purge		2.56	2.17	0.13	0.04
Cutting loss		0.26	0.02	0.10	0.10
Total saleable yield		94.78	96.46	0.63	0.07
Processing time, per subprimal		s			
Trimming/Cutting time		88.48	107.81	6.19	0.04

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 14. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Chuck, Chuck Roll (IMPS #116A), from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		10.35	11.63	0.66	0.21
Retail yield		%			
Underblade steak, bnls	1158	5.86	3.16	1.63	0.28
Short ribs, bnls	1092	2.33	2.40	0.23	0.84
Chuck eye roast	1095	48.60	47.40	2.01	0.68
Chuck eye steak	1102	6.48	5.20	0.60	0.17
Chuck eye edge pot roast	1092	3.64	3.34	0.21	0.36
Beef for stew	1727	5.77	7.94	1.06	0.19
90% Lean trim	1653	18.63	21.89	1.40	0.14
Fat		7.90	6.64	1.02	0.40
Purge		0.72	0.58	0.06	0.15
Cutting loss		0.16	2.56	1.70	0.37
Total saleable yield		90.69	91.01	1.68	0.90
Processing time, per subprimal		s			
Bag opening time		9.26	11.83	0.50	0.01
Trimming/Cutting time		712.85	727.79	49.44	0.84
Total time		722.10	739.62	49.60	0.81

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 15. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Plate, Inside Skirt (IM) (IMPS #121D), from different USDA quality grade groups

Item	UPC ^a	Choice (n=5)	Select (n=5)	SEM ^b	P-value
Net weight, kg		8.49	8.39	0.46	0.90
Retail yield		%			
Skirt steak, bnls	1607	74.96	76.12	0.90	0.45
90% Lean trim	1653	14.80	12.57	1.09	0.24
Fat		8.87	9.60	0.66	0.50
Purge		1.35	1.57	0.41	0.74
Cutting loss		0.02	0.14	0.13	0.58
Total saleable yield		89.76	88.69	0.60	0.30
Processing time, per subprimal		s			
Bag opening time		16.52	16.98	1.56	0.86
Trimming/Cutting time		816.30	767.15	58.62	0.61
Total time		832.82	784.12	59.21	0.61

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

significantly higher percentage of roasts and purge when compared with Choice rounds. Bag opening time also was significantly different between Choice and Select rounds (11.36 versus 15.72 seconds, respectively) (Table 16).

Retail yield cutting percentages and times for the initial cutting style of Beef Round, OutsideRounds (IMPS #171B) consisting of steaks, bottom round roasts, and cubed steaks are reported in Table 17. Select outside rounds displayed a significantly larger initial net weight as well as a higher percentage of steaks, and Choice outside rounds had a three-percentage point lower ($P<0.05$) saleable yield value than Select outside rounds, with most of the difference accounted for by more ($P<0.05$) trimmable fat when compared to Choice rounds. Purge and cutting loss was also significantly greater for Select outside rounds preventing an even larger difference in saleable yield between Select and Choice. The second outside round cutting style included steaks, a rump roast, and bottom round roasts (Table 18). Select outside rounds yielded a higher percentage of bottom round roasts ($P<0.001$) when compared with Choice outside rounds, as well as a significantly greater amount of purge loss. The Choice outside rounds had a significantly higher percentage of lean trim and trimmable fat, and required a greater amount of time for cutting ($P<0.03$) and total time ($P<0.04$). The total saleable yield of beef round, outside round, was very similar to results found by Garrett et al. (1991) (92%) and by McKenna et al. (2003) (91%). The second cutting style had an increased saleable yield of two percent over that of the first cutting style and is most likely due to the greater amount of fat trim in the initial style. The second cutting style produced a greater percentage (78-86%) of roasts and steaks when compared to the

Table 16. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Round, Top (Inside) (IMPS #168), from different USDA quality grade groups

Item	UPC ^a	Choice (n=9)	Select (n=9)	SEM ^b	P-value
Net weight, kg		11.0	9.10	0.48	0.01
Retail yield		%			
Top round roast, cap off	1454	23.79	28.92	1.32	0.02
Top round steak	1553	21.11	20.81	0.99	0.83
Top round steak, 1 st cut (London Broil)	1556	7.09	8.29	1.38	0.55
Cap		6.38	7.44	0.40	0.08
Beef cubed steak	1577	5.05	6.73	0.66	0.09
90% Lean trim	1653	16.71	15.15	0.90	0.24
Fat		18.93	10.94	1.09	<0.001
Purge		0.90	1.75	0.22	0.02
Cutting loss		0.04	0.00	0.04	0.24
Total saleable yield		80.13	87.34	1.13	0.004
Processing time, per subprimal		s			
Bag opening time		11.36	15.72	1.38	0.04
Trimming/Cutting time		605.98	509.52	28.71	0.03
Total time		617.34	525.24	28.82	0.04

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 17. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Round, Outside Round (IMPS #171B) cut to include roasts, steaks, and cubed steak from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		5.60	6.44	0.22	0.02
Retail yield		%			
Bottom round steak	1466	47.05	49.88	0.72	0.02
Bottom round roast	1464	12.33	13.33	0.55	0.22
Beef cubed steak	1577	5.89	9.87	1.81	0.14
90% Lean trim	1653	22.34	17.20	2.13	0.11
Fat		10.82	6.03	0.73	0.001
Purge		1.44	3.38	0.51	0.02
Cutting loss		0.13	0.31	0.04	0.01
Total saleable yield		87.61	90.28	0.84	0.05
Processing time, per subprimal		s			
Bag opening time		14.30	12.81	0.99	0.30
Trimming/Cutting time		405.78	306.09	33.40	0.06
Total time		420.08	318.90	33.91	0.06

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 18. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Round, Outside Round (IMPS #171B) cut to include steaks and roasts from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		5.86	6.27	0.37	0.44
Retail yield		%			
Bottom round steak	1466	6.88	7.59	1.41	0.72
Bottom round rump roast	1519	30.83	31.58	0.78	0.50
Bottom round roast	1464	40.48	46.83	0.95	<0.001
90% Lean trim	1653	11.31	6.09	1.15	0.01
Fat		8.73	4.33	1.08	0.02
Purge		1.54	3.57	0.53	0.02
Cutting loss		0.25	0.007	0.09	0.09
Total saleable yield		89.49	92.09	1.22	0.16
Processing time, per subprimal		s			
Bag opening time		10.93	12.81	15.0	1.87
Trimming/Cutting time		337.33	240.39	27.32	0.03
Total time		348.26	255.38	27.74	0.04

^aUPC = Universal product code.

^bSEM is the standard error of the least squares means.

initial cutting style (65-73%), mainly due to the increased percentage of lean trim produced in the initial cutting style. Select Beef Round, Eye of Rounds (IMPS #171C), cut to include steaks and a roast, showed a significant increase in the percentage of purge loss when compared to Choice eye of rounds that displayed a significant difference in cutting loss (Table 19). Choice eye of rounds also tended to yield a greater percentage of saleable product partly due to a higher trimmed fat percentage in the Select eye of rounds. Choice eye of rounds cut to include two roasts appeared to yield a slightly higher percentage of roasts when compared to the fatter Select eye of rounds (Table 20). Retail yields and processing times for eye of rounds left as intact roasts are presented in Table 21. Choice eye of rounds tended to have a greater percentage of roast weight thus resulting in a higher percentage of total saleable product when compared to Select eye of rounds. Eye of rounds from the Select grade had a higher percentage of trimmable fat, and although there were no statistically significant differences found for processing time, Choice eye of rounds tended to require a slightly longer cutting time. The initial eye of round cutting style of steaks and a roast resulted in a numerically greater percentage of lean trim and required a longer processing time when compared with the cutting styles containing only roasts. McNeill et al. (1998) and Weatherly et al. (2001) found similar results, observing total processing time increasing as the number of retail or foodservice cuts from subprimals increased.

Select Beef Loin, Strip Loins (IMPS #175) tended to have a greater percentage of center top loin steaks and consequently a higher percentage of saleable yield when compared to Choice bone-in strip loins (Table 22). Choice bone-in strip loins appeared

Table 19. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Round, Eye of Round (IMPS #171C) cut to include steaks and a roast from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		2.60	2.99	.037	0.14
Retail yield		%			
Eye of round steak	1481	38.84	37.27	1.78	0.55
Eye of round roast	1480	52.65	52.62	2.26	0.99
90% Lean trim	1653	3.56	3.80	0.63	0.80
Fat		3.63	4.49	1.02	0.57
Purge		0.87	1.72	0.17	0.006
Cutting loss		0.44	0.10	0.06	0.002
Total saleable yield		95.06	93.69	1.07	0.39
Processing time, per subprimal		s			
Bag Opening time		9.16	7.74	0.89	0.29
Trimming/Cutting time		100.41	90.81	10.77	0.54
Total time		109.57	98.55	11.25	0.51

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 20. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Round, Eye of Round (IMPS #171C) cut into two roasts from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		2.35	2.47	0.10	0.38
Retail yield		%			
Eye of round roast	1480	93.50	92.61	0.87	0.49
90% Lean trim	1653	1.41	2.76	0.58	0.20
Fat		3.84	4.48	0.85	0.61
Purge		1.63	1.74	0.34	0.83
Cutting loss		0.45	0.08	0.16	0.20
Total saleable yield		93.31	92.17	1.15	0.54
Processing time, per subprimal		s			
Bag Opening time		6.96	6.33	0.66	0.52
Trimming/Cutting time		55.32	59.16	7.27	0.72
Total time		62.28	65.49	7.64	0.77

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 21. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Round, Eye of Round (IMPS #171C) cut into one roast from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		2.31	2.47	0.32	0.52
Retail yield		%			
Eye of round roast	1480	92.01	89.76	1.63	0.36
90% Lean trim	1653	2.52	2.24	0.73	0.79
Fat		4.03	6.84	1.33	0.17
Purge		1.24	1.39	0.29	0.70
Cutting loss		0.20	0.09	0.13	0.56
Total saleable yield		94.53	91.16	1.36	0.12
Processing time, per subprimal		s			
Bag opening time		6.51	6.89	0.28	0.55
Trimming/Cutting time		74.18	67.07	9.65	0.61
Total time		80.69	73.93	9.90	0.64

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 22. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Strip Loin (IMPS #175) from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		6.36	6.00	0.60	0.38
Retail yield		%			
Top loin steak, bone in (center)	1398	60.94	66.75	2.40	0.14
Top loin steak, bone in (vein) ^c	1398	17.62	15.44	1.53	0.35
90% Lean trim	1653	4.36	3.62	0.54	0.37
Fat		12.45	12.22	1.28	0.91
Purge		0.37	0.29	0.11	0.62
Cutting loss		1.36	1.25	0.11	0.48
Total saleable yield		82.93	85.81	1.60	0.25
Processing time, per subprimal		s			
Bag opening time		13.54	12.82	2.35	0.84
Trimming/Cutting time		435.75	427.13	12.51	0.64
Total time		449.29	439.95	13.75	0.65

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

^c Steaks with the *M. gluteus medius* present on both cut surfaces.

to have a larger percentage of vein top loin steaks when contrasting the cutout of Select strip loins. For the purpose of this study, vein steaks were defined as those with the *M. gluteus medius* present on both sides of the steak. Retail yields and processing times for Beef Loin, Strip Loin, Boneless (IMPS #180) are presented in Table 23. Select strip loins had a significantly greater percentage of purge when compared to Choice strip loins. Retail cutting percentages are relatively similar between Choice and Select grade strip loins; however, there does appear to be a slight increase in the percentage of Select lean trim.

Select Beef Loin, Top Sirloin, Boneless, 2 Pc bags (IMPS #184E) displayed a greater net weight, thus resulting in a longer bag opening time when compared with the Choice top sirloin butts (Table 24). Select top sirloin butts also possessed a larger percentage of purge when compared to their Choice counterparts. The initial weight of Select Beef Loin, Top Sirloin Butt, Center-Cut, Boneless (IM) (IMPS #184B) was heavier ($P<0.05$) than Choice center-cut top sirloin butts (Table 25). Choice center-cut top butts had a greater percentage of trimmable fat ($P<0.04$), as well as a greater amount of lean trim, thus resulting in a longer cutting time. Select center-cut top butts also tended to have a slightly higher yield of steaks. Choice Beef Loin, Top Sirloin, Cap (IMPS #184D) reported a higher numerical percentage yield of steaks when compared to Select top sirloin caps (Table 26). Select top sirloin caps seemed to possess a higher percentage of purge loss than did Choice. Saleable yield for Choice top sirloin caps (98%) was higher than Weatherly et al. (2001) findings, which were reported to be between 94 and 96%.

Table 23. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Strip Loin, Boneless (IMPS #180) from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		4.87	4.71	0.32	0.73
Retail yield		%			
Top loin steak, bnls (center)	1404	67.39	66.88	1.43	0.81
Top loin steak, bnls (vein) ^c	1404	17.92	17.04	1.58	0.70
90% Lean trim	1653	1.88	2.35	0.42	0.50
Fat		11.26	11.21	0.89	0.97
Purge		1.50	2.36	0.08	<0.001
Cutting loss		0.04	0.16	0.08	0.30
Total saleable yield		87.20	86.27	0.82	0.45
Processing time, per subprimal		s			
Bag opening time		8.49	8.47	0.61	0.99
Trimming/Cutting time		223.24	227.20	9.89	0.78
Total time		231.73	235.68	10.05	0.79

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

^c Steaks with the *M. gluteus medius* present on both cut surfaces

Table 24. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Top Sirloin, Boneless, 2 Pc (IMPS #184E) from different USDA quality grade groups on a bag basis

Item	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg	4.30	5.09	0.11	0.547
Retail yield	%			
Top sirloin butt	98.44	97.43	0.97	0.60
Purge	1.56	2.66	0.53	0.24
Total saleable yield	98.44	97.43	0.97	0.60
Processing time, per subprimal	s			
Bag opening time	8.71	10.43	0.31	0.06

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 25. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Top Sirloin Butt, Center-Cut, Boneless, (IM) (IMPS #184B) from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		3.65	4.21	0.07	0.04
Retail yield		%			
Steaks		79.39	82.72	1.41	0.17
90% Lean trim	1653	10.26	9.32	0.96	0.53
Fat		8.82	6.03	0.68	0.04
Purge		0.12	0.25	0.04	0.14
Cutting loss		0.00	0.00	0.01	0.86
Total saleable yield		89.65	92.05	1.21	0.24
Processing time, per subprimal		s			
Trimming/Cutting time		147.74	133.17	11.75	0.43

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 26. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Top Sirloin, Cap (IM) (IMPS #184D) from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		0.66	0.82	0.06	0.08
Retail yield		%			
Steaks		75.06	73.23	1.98	0.55
90% Lean trim	1653	23.17	24.84	2.14	0.61
Fat		0.00	0.00	0.00	-----
Purge		1.56	2.66	0.53	0.24
Cutting loss		0.22	0.23	0.44	0.98
Total saleable yield		98.22	98.07	0.80	0.90
Processing time, per subprimal		s			
Trimming/Cutting time		9.51	9.27	1.26	0.90

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Retail yields and processing times for Beef Loin, Bottom Sirloin Butt, Flap, Boneless (IMPS #185A) are presented in Table 27. Select sirloin flaps yielded a greater percentage of flap meat steaks ($P<0.03$) when compared to Choice bottom sirloin flaps. Choice flaps tended to possess a greater amount of trimmable fat and consequently a longer cutting time. Select Beef Loin, Bottom Sirloin Butt, Ball Tip, Boneless (IMPS #185B) yielded a significantly larger percentage of ball tip steaks, thus resulting in a slightly greater percentage of total saleable yield when compared to Choice ball tips (Table 28). Select ball tips also possessed a significantly heavier net initial weight and a greater amount of purge loss ($P<0.04$) than Choice ball tips, but Choice ball tips yielded a significantly larger percentage of beef for kabobs and fat ($P<0.01$) when compared to the Select cuts.

Although there were no significant findings within the Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless (IMPS #185C) cutting tests on a bag basis, Select tri-tip bags showed a slight difference in initial net weight and time required for bag opening (Table 29). Retail yields and processing times for bottom sirloin butt tri-tips cut to include steaks are presented in Table 30. Select tri-tips displayed a significantly greater initial net weight, percentage of trimmable fat ($P<0.05$), and a significantly longer cutting time when compared to Choice tri-tips. Tri-tips from the Choice grade were reported to have a greater percentage of lean trimmings. Select tri-tips remaining intact as a roast had significantly greater initial net weight, thus resulting in a requirement for a longer cutting period ($P<0.01$) than Choice tri-tips (Table 31). Although no other yield percentages were significant, Choice tri-tips tended to possess a greater percentage of

Table 27. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Bottom Sirloin Butt, Flap, Boneless (IMPS #185A) from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		8.98	7.68	0.63	0.21
Retail yield		%			
Flap meat steak	1326	60.77	65.66	1.19	0.03
90% Lean trim	1653	31.91	30.45	1.68	0.57
Fat		6.04	2.94	1.87	0.32
Purge		1.36	1.57	0.38	0.73
Cutting loss		0.00	0.14	0.10	0.20
Total saleable yield		92.68	96.11	1.77	0.23
Processing time, per subprimal		s			
Bag Opening time		8.52	9.34	0.73	0.47
Trimming/Cutting time		533.91	479.75	59.46	0.56
Total time		542.43	489.09	59.81	0.56

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 28. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Bottom Sirloin Butt, Ball Tip, Boneless (IMPS #185B) from different USDA quality grade groups

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		6.38	8.63	0.22	0.001
Retail yield		%			
Ball tip steak	1308	56.08	65.97	2.55	0.05
Beef for kabobs	1576	15.47	10.66	0.98	0.02
90% Lean trim	1653	14.35	9.73	1.89	0.17
Fat		10.58	7.30	0.58	0.01
Purge		3.43	6.21	0.67	0.04
Cutting loss		.09	0.13	0.02	0.40
Total saleable yield		85.89	86.36	0.63	0.65
Processing time, per subprimal		s			
Bag opening time		19.23	20.38	2.17	0.74
Trimming/Cutting time		511.37	529.45	33.48	0.74
Total time		530.60	549.83	33.66	0.72

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 29. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless (IMPS #185C), from different USDA quality grade groups on per bag basis

Item	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg	6.92	7.88	0.51	0.16
Retail yield	%			
Tri-tip meat	99.61	99.56	0.05	0.61
Purge	0.36	0.40	0.04	0.58
Total saleable yield	99.61	99.56	0.05	0.61
Processing time, per subprimal	s			
Bag opening time	16.12	18.68	0.81	0.10

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 30. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless (IMPS #185C) cut to include steaks from different USDA quality grade groups on per piece basis

Item	UPC ^a	Choice (n=9)	Select (n=9)	SEM ^b	P-value
Net weight, kg		1.17	1.59	0.04	<0.001
Retail yield		%			
Tri tip steak	1430	59.24	62.05	2.11	0.34
Beef for kabobs	1576	13.37	11.16	1.30	0.24
90% Lean trim	1653	14.95	10.46	1.22	0.02
Fat		12.12	15.87	1.44	0.05
Purge		0.36	0.33	0.03	0.37
Cutting loss		0.00	0.13	0.13	0.34
Total saleable yield		87.55	83.68	1.44	0.07
Processing time, per subprimal		s			
Trimming/Cutting time		108.15	129.96	4.67	0.004

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 31. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless (IMPS #185C) left intact as a roast from different USDA quality grade groups on per piece basis

Item	UPC ^a	Choice (n=6)	Select (n=6)	SEM ^b	P-value
Net weight, kg		1.25	1.62	0.05	<0.001
Retail yield		%			
Tri tip roast	1429	70.65	74.66	1.61	0.09
90% Lean trim	1653	13.51	12.65	1.02	0.55
Fat		15.46	12.23	1.24	0.08
Purge		0.43	0.44	0.05	0.86
Cutting loss		0.00	0.02	0.13	0.69
Total saleable yield		84.16	87.31	1.26	0.09
Processing time, per subprimal		s			
Trimming/Cutting time		73.16	95.87	5.04	0.01

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

fat, and Select tri-tips had a larger percentage of roasts, thus creating a higher percentage of total saleable product when compared to Choice tri-tips. Saleable yield and trim percentages were very similar between the two cutting styles; however, the initial style including tri-tip steaks did require a longer processing time.

Retail yields and processing times are reported for Beef Chuck, Shoulder Clod, *M. teres major* left intact as a whole muscle cut, from USDA Select carcasses are presented in Table 32. Whole muscle (roast) percentage reported was 76.77% and the total saleable yield was 94.74%. Retail yields and processing times also are reported for Select *M. teres major* cut into medallions, lean trim and end pieces in Table 33. The mean medallion percentage was 58.52% and the end piece percentage was 19.36%; thus creating a total saleable yield of 96.14%. Only Select *M. teres major* were reported because the beef processor assisting with product procurement for this study did not separate *M. teres major* based on grade. When comparing the cutting styles of *M. teres major*, the saleable yield percentages were very similar, with the medallion style having a slight advantage mainly due to the increased fat and purge produced in the whole muscle style.

Table 32. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Chuck, Shoulder, Clod, *M. teres major* from USDA Select left intact as a whole muscle cut

Item	UPC ^a	Select (n=4)	SEM ^b
Net weight, kg		7.40	0.25
Retail yield		----- % -----	
Whole muscle (roast)		76.77	1.28
90% Lean trim	1653	17.97	1.15
Fat		2.55	0.13
Purge		2.47	0.03
Cutting loss		0.25	0.06
Total saleable yield		94.74	0.17
Processing time, per subprimal		----- s -----	
Bag opening time		34.17	2.14
Trimming/Cutting time		855.85	49.09
Total time		920.02	48.24

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

Table 33. Least squares means of retail yields (%) and processing times (s) for fabrication of Beef Chuck, Shoulder, Clod, *M. teres major* from USDA Select cut into medallions

Item	UPC ^a	Select (n=4)	SEM ^b
Net weight, kg		6.06	0.66
Retail yield		----- % -----	
Medallions		58.52	1.92
End pieces		19.36	1.50
90% Lean trim	1653	18.26	0.71
Fat		1.95	0.17
Purge		1.68	0.57
Cutting loss		0.24	0.14
Total saleable yield		96.14	0.58
Processing time, per subprimal		----- s -----	
Bag opening time		39.12	6.24
Trimming/Cutting time		904.35	117.82
Total time		943.67	123.40

^a UPC = Universal product code.

^b SEM is the standard error of the least squares means.

CHAPTER V

CONCLUSIONS

In general, Select beef subprimals had higher saleable retail yields than Choice subprimals. Select subprimals also had less trimmable fat than Choice subprimals and differences in retail yields appeared to follow these factors. Very few significant differences were observed for processing times between the USDA quality grade groups.

The results found in this study will be used for updating the current Beef CARDS program. Focus is geared toward both the retail and foodservice industries, in an effort to provide these sectors with an expanded database of processing yields and time allocations for commonly used, ready-to-cook retail and foodservice cuts. Capabilities of the program include: evaluating combinations of retail pricing and wholesale (subprimal) product costs; considering the effects of varying labor times and costs; adjusting retail or subprimal prices to meet specific marketing goals; and the retailer or foodservice operator can load their own cutting test data in the program for use. This research will provide retail and foodservice personnel with additional tools to evaluate the feasibility and profitability of the cuts examined.

LITERATURE CITED

- Boleman, S. L., S. J. Boleman, W. W. Morgan, D. S. Hale, D. B. Griffin, J. W. Savell, R. P. Ames, M. T. Smith, J. D. Tatum, T. G. Field, G. C. Smith, B. A. Gardner, J. B. Morgan, S. L. Northcutt, H. G. Dolezal, D. R. Gill, and F. K. Ray. 1998. National Beef Quality Audit-1995: Survey of producer related defects and carcass quality and quantity attributes. *J. Anim. Sci.* 76:96-103.
- Cross, H. R., J. W. Savell, and J. J. Francis. 1986. Natl. Consumer Retail Beef Study. *Proc. Recip. Meat Conf.* 39:112-116.
- Garrett, R. P., R. W. Theis, J. P. Walter, D. B. Griffin, J. W. Savell, H. K. Johnson, T. R. Dockerty, J. W. Allen, and T. R. Pierson. 1991. Communicating Cutability to the Retailer. Final Report to the National Live Stock and Meat Board. Dept. Animal Science, Texas A&M Univ., College Station.
- Industry-Wide Cooperative Meat Identification Standards Committee. 2003. Uniform retail meat identity standards. Natl. Cattlemen's Beef Assoc., Centennial, CO.
- Lorenzen, C. L., D. S. Hale, D. B. Griffin, J. W. Savell, K. E. Belk, T. L. Frederick, M. F. Miller, T. H. Montgomery, and G. C. Smith. 1993. National Beef Quality Audit: survey of producer-related defects and carcass quality and quantity attributes. *J. Anim. Sci.* 71:1495-1502.
- Lorenzen, C. L., D. B. Griffin, T. R. Dockerty, J. P. Walter, H. K. Johnson, and J. W. Savell. 1996a. Subprimal purchasing and merchandising decisions for pork: relationship to retail yield and fabrication time. *J. Anim. Sci.* 74:5-12.
- Lorenzen, C. L., J. P. Walter, T. R. Dockerty, D. B. Griffin, H. K. Johnson, and J. W. Savell. 1996b. Subprimal purchasing and merchandising decisions for pork: relationship to retail value. *J. Anim. Sci.* 74:13-17.
- Lorenzen, C. L., A. M. Martin, D. B. Griffin, T. R. Dockerty, J. P. Walter, H. K. Johnson, and J. W. Savell. 1997. Influence of wholesale lamb marketing options and merchandising styles on retail yield and fabrication time. *J. Anim. Sci.* 75:1-6.
- McKenna, D. R., D. L. Roeber, P. K. Bates, T. B. Schmidt, D. S. Hale, D. B. Griffin, J. W. Savell, J. C. Brooks, J. B. Morgan, T. H. Montgomery, K. E. Belk, and G. C. Smith. 2002. National Beef Quality Audit-2000: Survey of targeted cattle and carcass characteristics related to quality, quantity, and value of fed steers and heifers. *J. Anim. Sci.* 80:1212-1222

- McKenna, D. R., D. B. Griffin, H. K. Johnson, B. R. Covington, and J. W. Savell. 2003. Retail yields from beef chuck and round subprimals from two grade groups when merchandised as single muscle cuts. *J. Anim. Sci.* 81:1482-1487.
- McNeill, M. S., D. B. Griffin, T. R. Dockerty, J. P. Walter, H. K. Johnson, and J. W. Savell. 1998. Retail yield and fabrication times for veal as influenced by purchasing options and merchandising styles. *J. Anim. Sci.* 76:1613-1620.
- NAMP. 2003. Meat Buyers Guide. North Am. Meat Processors Assoc. Reston, VA.
- NCBA. 1995. National Beef Quality Audit: Executive Summary-1995. Natl. Cattlemen's Beef Assoc., Englewood, CO.
- NCBA. 2001. Beef Value Cuts: New cuts for the consumer. Natl. Cattlemen's Beef Assoc., Chicago, IL.
- NLSMB. 1995a. U.P.C. Identification Numbers. Natl. Live Stock and Meat Board, Chicago, IL.
- NLSMB. 1995b. Uniform Retail Meat Identity Standards. Natl. Live Stock and Meat Board, Chicago, IL.
- Savell, J. W., H. R. Cross, J. J. Francis, J. W. Wise, D. S. Hale, D. L. Wilkes, and G. C. Smith. 1989. National Consumer Retail Beef Study: Interaction of trim level, price, and grade on consumer acceptance of beef steaks and roasts. *J. Food Qual.* 12:251.
- Savell, J. W., J. J. Harris, H. R. Cross, D. S. Hale, and L. C. Beasley. 1991. National Beef Market Basket Survey. *J. Anim. Sci.* 69:2883-2893.
- Savell, J. W. 1993. Value-based marketing of beef. Farmland Industries, Inc., University Advisory Board Meeting, Kansas City, MO, July 22, 1993. Available: <http://meat.tamu.edu/vbm.html>. Accessed July 2, 2004.
- Savell, J. W., J. P. Walter, R. P. Garrett, C. L. Lorenzen, D. B. Griffin, T. R. Dockerty, and H. K. Johnson. 1995. A value based meat marketing program. In: *Proc. Recip. Meat Conf.*, San Antonio, TX. 48:91-95.
- USDA. 1996. Institutional meat purchase specifications for fresh beef products-PDF version. Washington, DC: USDA Agricultural Marketing Service. Available: <http://www.ams.usda.gov/lsg/imps100.pdf>. Accessed November 6, 2003.

- Value Based Marketing Task Force. 1990. The War on Fat! Report from Value Based Marketing Task Force, Beef Industry Council of the Natl. Live Stock and Meat Board, Chicago, Illinois, and Natl. Cattlemen's Assoc., Englewood, Colorado.
- Walter, J. P., R. P. Garrett, R. W. Theis, D. B. Griffin, J. W. Savell, H. K. Johnson, and T. R. Dockerty. 1991. CARDS System- Computer Assisted Retail Decision Support: User's Manual. Department of Animal Science, Texas A&M University, College Station, Texas.
- Weatherly, B. H., D. B. Griffin, H. K. Johnson, J. P. Walter, M. J. De La Zerda, N. C. Tipton, and J. W. Savell. 2001. Foodservice yield and fabrication times for beef as influenced by purchasing options and merchandising styles. J. Anim. Sci. 79:3052-3061.

APPENDIX A
RETAIL CUT PICTURES



A-1 Beef Rib, Blade Meat (IMPS #109B).



A.2 Beef Rib, Ribeye Roll, Lip-On, Bone In (IMPS #109E) cut into roasts.



A.3 Beef Rib, Ribeye Roll, Lip-On, Bone-In (IMPS #109E) cut into steaks.



A.4 Beef Rib, Ribeye Roll (IMPS #112).



A.5 Beef Rib, Ribeye Roll, Lip-On (IMPS #112A) cut into steaks.



A.6 Beef Rib, Ribeye Roll, Lip-On (IMPS #112A) cut into steaks and roasts.



A.7 Beef Rib, Ribeye Roll, Lip-On, Modified 1x1 (IMPS #112A modified).



A.8 Beef Rib, Ribeye (IM) (IMPS #112C).



A.9 Beef Rib, Ribeye Cap (IM) (IMPS #112D).



A.10 Beef Chuck, Shoulder Clod, Trimmed (IMPS #114C).



A.11 Beef Chuck, Shoulder Clod, Top Blade, Roast (IMPS #114D).



A.12 Beef Chuck, Square Cut, Pectoral Meat (IM) (IMPS #115D).



A.13 Beef Chuck, Chuck Roll (IMPS #116A).



A.14 Beef Plate, Inside Skirt (IM) (IMPS #121D).



A.15 Beef Round, Top (Inside) (IMPS #168).



A.16 Beef Round, Outside Round (IMPS #171B) cut into roasts, steaks, and cubed meat.



A.17 Beef Round, Outside Round (IMPS #171B) cut into steaks and roasts.



A.18 Beef Round, Eye of Round (IMPS #171C) cut into steaks and a roast.



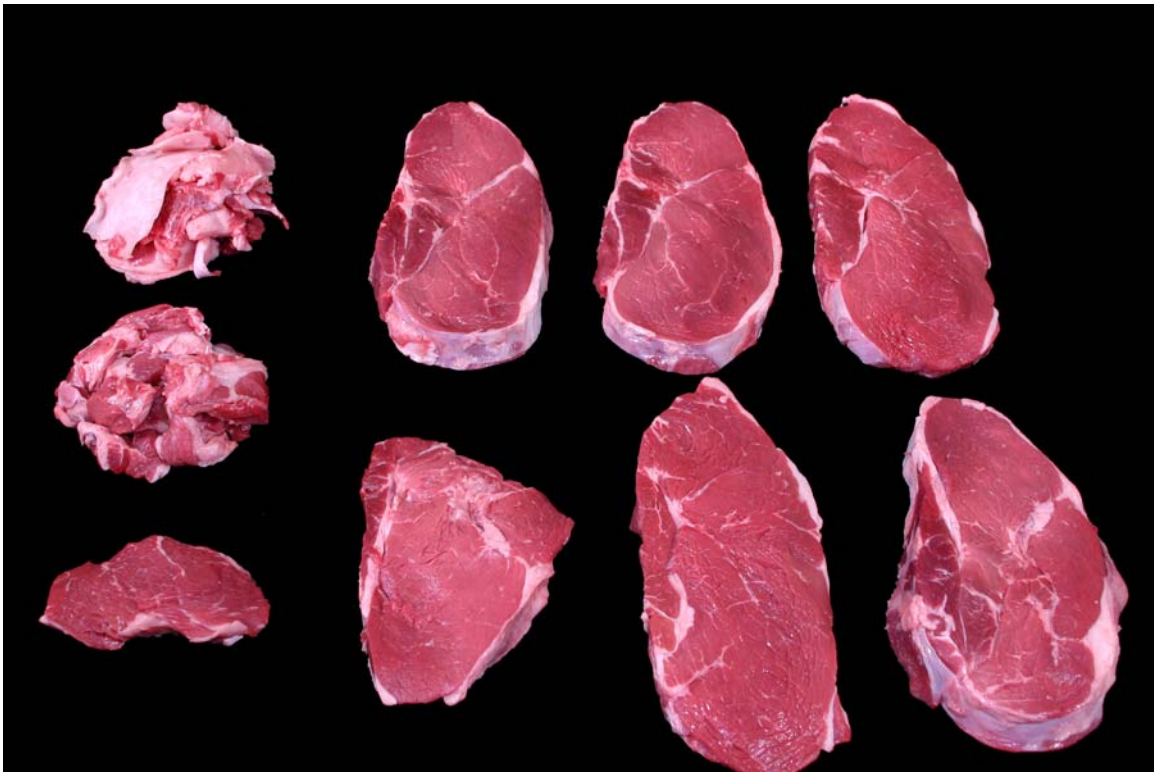
A.19 Beef Loin, Strip Loin (IMPS #175).



A.20 Beef Loin, Strip Loin, Boneless (IMPS #180).



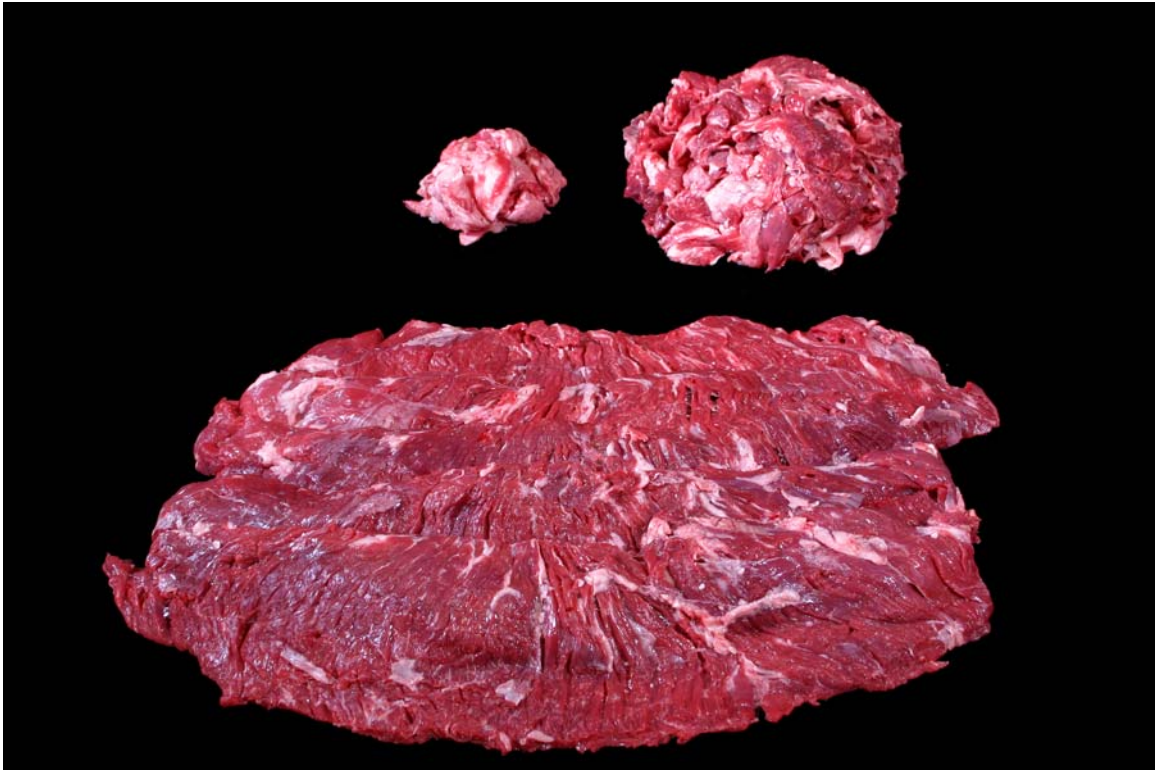
A.21 Beef Loin, Top Sirloin, Boneless, 2 Pc (IMPS #184E).



A.22 Beef Loin, Top Sirloin Butt, Center-Cut, Boneless (IM) (IMPS #184B).



A.23 Beef Loin, Top Sirloin, Cap (IM) (IMPS #184D).



A.24 Beef Loin, Bottom Sirloin Butt, Flap, Boneless (IMPS #185A).



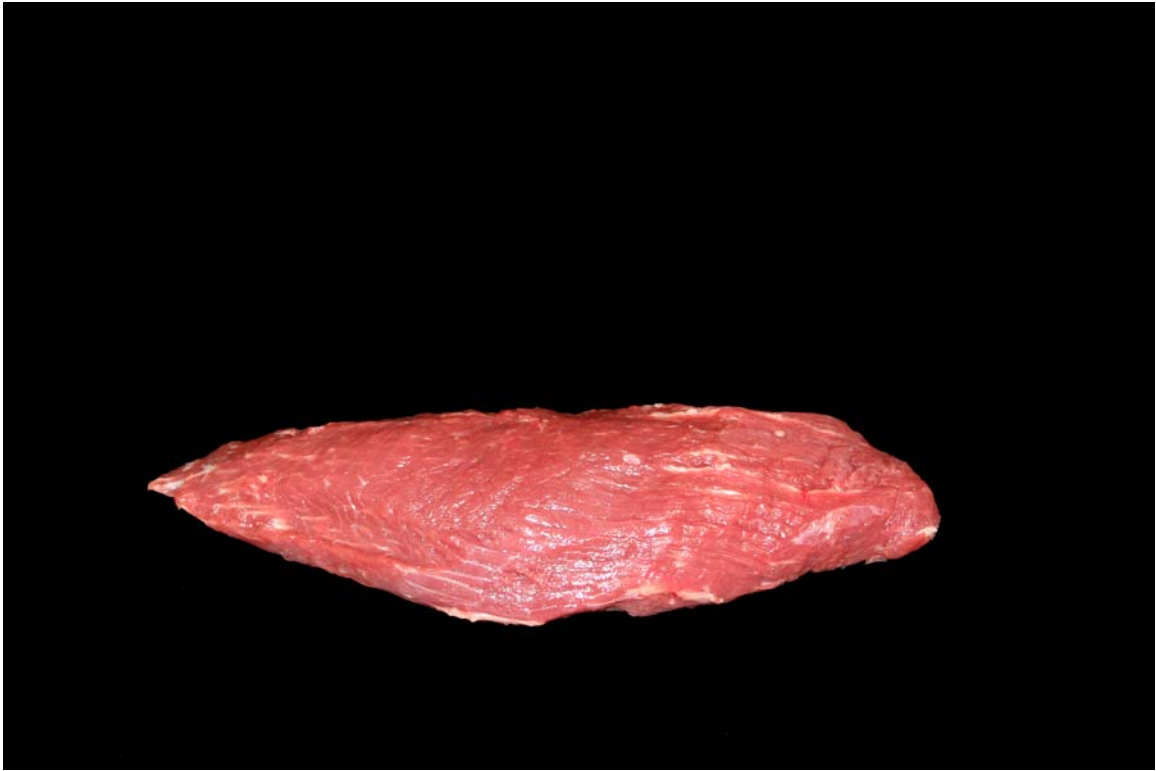
A.25 Beef Loin, Bottom Sirloin Butt, Ball Tip, Boneless (IMPS #185B).



A.26 Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless (IMPS #185C) cut into steaks.



A.27 Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless (IMPS #185C) left intact as a roast.



A.28 Beef Chuck, Shoulder, Clod, *M. teres major* left intact as a whole muscle cut.



A.29 Beef Chuck, Shoulder, Clod, *M. teres major*, cut into medallions.

VITA

Kristin Leigh Voges was born on November 28, 1980 in Hamilton, Texas. She is the middle of three children born to Gary and Lynn Voges. Ms. Voges graduated from Mirabeau B. Lamar High School in May of 1999. In the fall of that same year, Ms. Voges started her undergraduate career in animal science at Texas A&M University. She was a member of the 2000 Wool Judging Team, 2001 Meat Judging Team, 2002 Livestock Judging Team, and the 2003 Meat Animal Evaluation Team, as well as serving as an officer in the Saddle and Sirloin Club and as an Aggie REP for the Department of Animal Science. After graduation, she began graduate school in the meat science section and had the opportunity to coach the 2004 Meat Judging Team. Upon graduation with her Master's Degree, she plans on pursuing her PhD in Meat Science working with Dr. Jeff Savell.

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