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AN ALTERNATIVE CARCASS FABRICATION METHOD TO OPTIMIZE BEEF VALUE

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Introduction

Traditionally, the beef industry has changed little to manipulate the fabrication of beef carcasses into more efficiently used primals and subprimals. In the past, most of the breaking points had been done out of tradition rather than optimization of the muscles. Cuts even as major as the separation of the chuck and round from the rib and loin should be questioned since multiple muscles and muscle groups are bisected. With current retail trends moving towards merchandising single muscles and/or muscle groups, there is a growing need to better utilize beef carcasses.

With this trend in mind, the Beef Value Cuts Program (NCBA, 2001) and the Muscle Profiling and Bovine Myology studies (Jones, Burson, & Calkins, 2001) began. The goal of these studies was to increase utilization of individual muscles instead of marketing beef in the traditional multi-muscle cuts. Using these concepts, we used an innovative fabrication method to improve yields and value of beef carcasses.

Objectives

To examine alternative styles of carcass fabrication and how they would: (1) impact subprimal and total yields, and (2) impact the overall carcass value.

Methodology

Carcass selection

Beef carcasses (n = 30) were selected from a commercial packing facility and transported to Texas A&M University for subsequent fabrication. Carcasses were selected by trained evaluators to obtain an equal mix of USDA (1997) Choice and Select, yield grade 2 and 3 carcasses. Additional criteria included: sex (steer), approximate weight range (325 to 390 kg), and minimal slaughter/dressing defects (e.g., incorrect carcass splits, major fat tears, large bruises, excess trimming of lean and/or fat).

Carcass fabrication

Carcasses were separated into beef quarters and transported by refrigerated carrier. Comparisons were made by fabricating one side of each carcass in a conventional manner, whereas the opposite side was fabricated by an innovative method.

Conventional style

Carcasses were fabricated into boneless and semi-boneless, closely-trimmed subprimal cuts by Texas A&M personnel. Carcasses were fabricated to produce cuts (Table 1) following the Institutional Meat Purchase Specifications (IMPS) described by NAMP (2003) and USDA (1996).

Table 1. USDA (1996) Institutional Meat Purchase Specifications (IMPS) descriptions of subprimals used in conventional fabrication

IMPS #	Subprimal
112A	Beef Rib, Ribeye, Lip-On[a]
114	Beef Chuck, Shoulder Clod
116	Beef Chuck, Chuck Roll
120	Beef Brisket, Deckle-Off, Boneless
121C	Beef Plate, Outside Skirt (IM)[b]
121D	Beef Plate, Inside Skirt (IM)[b]
124	Beef Rib, Back Ribs
130	Beef Chuck, Short Ribs
167A	Beef Round, Tip (Knuckle), Peeled
168	Beef Round, Top (Inside), Untrimmed
171B	Beef Round, Outside Round (Flat)
171C	Beef Round, Eye of Round (IM)[b]
180A	Beef Loin, Strip Loin, Boneless (1 × 0)[c]
184	Beef Loin, Top Sirloin Butt, Boneless
185A	Beef Loin, Bottom Sirloin Butt, Flap, Boneless (IM)[b]
185B	Beef Loin, Bottom Sirloin Butt, Ball Tip, Boneless
185C	Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless (IM)[b]
189A	Beef Loin, Tenderloin, Full, Side Muscle On, Defatted
193	Beef Flank, Flank Steak (IM)[b]

[a] Lip = *M. serratus dorsalis, M. longissimus costarum* and related intermuscular fat lateral to the *M. longissimus thoracis* (USDA, 1996).
[b] IM = Individual muscle.
[c] (1 × 0) = The flank side shall be lateral to, but not more than 2.54 cm from, the *M. longissimus lumborum* at the rib end to a point on the sirloin end immediately lateral to the *M. longissimus lumborum* (USDA, 1996).

Additionally, special trim items including cap and wedge meat, chuck tender, pectoral muscle and flank muscle were removed intact from each carcass. Finally, lean trimmings (approximately 80% lean determined visually), fat, and bone were obtained from each carcass. Further details of conventional fabrication can be found in Pfeiffer (2004).

Innovative style

The following describes the fabrication of the innovative forequarter, which was initiated with the quarter hung on the rail. The inside and outside skirt muscles were removed, and all major connective tissue and fat was trimmed in preparation. The *M. rhomboideus*, *M. trapezius*, and the *M. latissimus dorsi* were removed, leaving the *M. serratus ventralis* exposed. Collectively, the muscles were trimmed practically free of fat and weighed as blade meat. The shoulder was removed through the natural seam. The *M. serratus ventralis* then was removed intact from the carcass. The thoracic limb was hung by the foreshank and a subprimal similar to the IMPS #114 Outside Shoulder Clod was removed and trimmed practically free of fat. The IMPS #116B Chuck (Mock) Tender was fabricated by removal from the scapula. Innovative brisket fabrication included removal of the *M. pectoralis profundus* from the ventral edge of the forequarter. The deckle and hard fat, along the ventral edge, were trimmed flush with the lean surface.

The rib/chuck separation was made by a saw cut between the fourth and fifth ribs, instead of the conventional fifth/sixth rib separation. The rib/plate separation was made by a saw cut 10.16 cm from the ventral edge of the *M. longissimus thoracis* on the anterior end and 7.62 cm from the ventral edge of the *M longissimus thoracis* on the posterior end. The back ribs (similar to the IMPS #124 Back Ribs) were removed. The tail was reduced to 2.54 cm on both ends. A saw cut between the fifth and sixth cervical vertebra was made to separate the neck from the chuck. The sternum and associated ribs were separated from the chuck by a saw cut immediately ventral to the vertebral column. All bones and *ligamentum nuchae* were removed in fabrication of the chuck roll, and the tail was reduced to 2.54 cm on both ends, creating a subprimal similar to the IMPS #116D Chuck Eye Roll. The remaining neck, plate, foreshank, and rib portions were separated into lean trimmings, excess fat, and bone components.

The following describes the fabrication of the innovative hindquarter which was initiated with the quarter hung on the rail. The IMPS #193 Flank Steak was fabricated by removal from carcass and trimming all fat and heavy connective tissue. Kidney and pelvic fat then was removed. The *M. tensor fasciae latae* was removed and trimmed practically free of fat to create the IMPS #185C Bottom Sirloin Butt, Tri-Tip, Boneless, Defatted. The bottom sirloin flap was removed and trimmed practically free of fat. Starting at the patella, the entire *M. quadriceps femoris* was removed through the natural seam and trimmed of any bone (patella) and fat. The entire *M. gluteobiceps* was removed, as suggested by Reuter, Wulf, and Maddock (2002a), resulting in a subprimal similar to the IMPS #184D Top Sirloin, Cap. The top sirloin cap was completely trimmed of fat and connective tissue. The remainder of the *M. gluteobiceps* was trimmed, and the heavy connective tissue ("silver skin") was completely removed creating a subprimal similar to the IMPS #171B Outside Round (Flat). The IMPS #168 Top (Inside) Round was removed through the natural seam and was trimmed practically free of fat. The IMPS #189A Tenderloin, Full, Side Muscle On, Defatted was fabricated from the full loin. The sirloin-short loin separation was made by a saw cut immediately anterior to the tuber coxae (hip bone) and the IMPS #184B Top Sirloin Butt, Center-Cut, Boneless, Cap Off was fabricated. In preparation of the IMPS #180A Strip Loin, the body of the vertebrae and all other bones were removed from the short loin. In addition, the tail was reduced to 2.54 cm from the ventral edge of the *M. longissimus thoracis* on the anterior end and 0.00 cm from the ventral edge of the *M. longissimus lumborum* on the posterior end. The hindshank (including the aitch bone) was separated into lean trimmings, excess fat, and bone components.

Carcass value

Data collected during carcass fabrication were used in determination of value differences that may have occurred between cutting styles. Subprimal and component prices used in the analysis were obtained from the United States Department of Agriculture, Agricultural Marketing Service (USDA, 2001; USDA, 2002; USDA, 2003). Subprimal and component prices were averaged over the three-year period to minimize any seasonal or annual price biases.

Many subprimals generated from the innovative side were not identical to that of the conventional style, thus were not identical in terms of IMPS numbers and would most likely be priced independently by the market. For comparative purposes, the innovative brisket, shoulder clod, chuck roll, ribeye roll, back ribs, blade meat, 2-piece top sirloin butt, round tip, and outside round flat from this study were priced identical to their conventional counterparts. The *M. serratus ventralis* was priced using the reported prices for the IMPS # 109B Rib, Blade Meat.

Statistical analysis

Subprimal weights, percentages, and values were analyzed using the MIXED procedure of SAS (Version 9, SAS Institute, Inc., Cary, NC). Models included cutting style and quality grade as main effects, and carcass number was included as a randomized effect. Least squares means were generated, and when an alpha-level of $P < 0.05$ was found, they were separated using the PDIFF option.

Results & Discussion

Carcass fabrication

Forequarter wholesale cuts and carcass component percentages were analyzed by cutting style and reported in Table 2. The innovative brisket comprised a greater ($P < 0.001$) percentage of the beef forequarter than the conventional brisket. Inclusion of the pectoral meat with the conventional brisket still resulted in a lighter combined subprimal weight than the innovative brisket.

The conventional shoulder clod was higher ($P < 0.001$) yielding than the innovative shoulder clod. This was expected due to the portions of the *M. trapezius* and *M. latissimus dorsi* that remained on the conventional shoulder clod, but were removed from the innovative shoulder clod and were included as a portion of the blade meat.

Reuter, Wulf, Shanks, and Maddock (2002b) concluded that a rib/chuck separation between the fourth and fifth rib could result in merchandizing four additional ribeye steaks per carcass without decreasing tenderness or consumer acceptance of these steaks. Based on their conclusions, the innovative rib/chuck separation was made between the fourth and fifth ribs instead of the conventional fifth/sixth rib separation. Consequently, the innovative ribeye represented a greater ($P < 0.001$) percentage of the forequarter, and the innovative chuck roll was a lesser ($P < 0.001$) percentage.

Table 2. Least-squares means for forequarter subprimal and component percentages stratified by conventional (CONV) and innovative (INNOV) cutting styles

Subprimal	CONV	INNOV	SEM[a]	P > F
	——— % ———			
Brisket	5.77	8.41	0.12	<0.001
Shoulder clod	9.70	8.60	0.08	<0.001
Chuck tender	1.57	1.57	0.02	0.81
Pectoral meat	1.16	-	0.04	-
Chuck roll	8.01	3.02	0.10	<0.001
M. Serratus ventralis	-	4.69	0.09	-
Chuck short rib	1.65	-	0.04	-
Inside skirt	1.22	1.25	0.03	0.29
Outside skirt	0.68	0.68	0.02	1.00
Ribeye roll	5.53	6.19	0.08	<0.001
Back ribs	1.75	1.96	0.03	<0.001
Blade meat	1.85	4.19	0.09	<0.001
Subprimal total	38.86	40.55	0.29	<0.001
Lean trimmings (85% lean)	27.23	26.12	0.35	<0.001
Fat	15.75	15.39	0.47	0.27
Bone	18.16	17.94	0.23	0.27

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

It was a priority to remove the three extrinsic muscles of the forelimb (*M. rhomboideus*, *M. trapezius*, and *M. latissimus dorsi*) in their entirety. Conventionally, these muscles are portioned throughout several subprimals and are primarily merchandized as lean trimmings. The innovative fabrication style optimized the merchandizing potential of these individual muscles by removing them as whole muscles. Blade meat fabricated from the innovative side was heavier (3.82 vs. 1.65 kg), comprising a greater ($P < 0.001$) forequarter percentage than the conventional blade meat. The chuck tender, inside skirt, and outside skirt were not affected ($P > 0.05$) by fabrication style. The combined forequarter subprimal yield of the innovative fabrication style was greater ($P < 0.001$) than the combined yield of the conventional cuts, and less ($P < 0.001$) lean trimmings were generated by the innovative fabrication style.

Hindquarter wholesale cuts and carcass component percentages were analyzed by cutting style and reported in Table 3. The tenderloin fabricated from the innovative side was heavier ($P < 0.001$) than the conventional tenderloin because it contained the most posterior portion of the *M. iliopsoas*, which is typically excluded from the tenderloin by the conventional round/loin break.

Table 3. Least-squares means for hindquarter subprimal and component percentages stratified by conventional (CONV) and innovative (INNOV) cutting styles

Subprimal	CONV	INNOV	SEM[a]	*P* > F
	——— % ———			
Flank Steak	1.08	1.06	0.02	0.34
Tenderloin	3.30	3.46	0.04	<0.001
Bottom sirloin flap	1.94	2.06	0.04	0.01
Strip loin	6.19	6.10	0.09	0.34
Flank muscle	1.24	1.17	0.05	0.15
Center-cut top sirloin	4.73	4.64	0.08	0.30
Top sirloin cap	0.96	1.43	0.03	<0.001
Bottom sirloin ball tip	1.15	-	0.07	-
Bottom sirloin tri-tip	2.28	2.63	0.05	<0.001
Round tip	5.67	6.68	0.09	<0.001
Top round	11.75	11.83	0.12	0.46
Eye of round	3.31	3.24	0.05	<0.01
Bottom round flat	7.70	6.94	0.09	<0.001
Subprimal total	50.32	50.10	0.34	0.38
Lean trimmings (85% lean)	10.72	10.76	0.17	0.86
Fat	24.27	24.53	0.43	0.42
Bone	14.68	14.62	0.19	0.73

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

The top sirloin cap (coulotte) was separated at a point immediately anterior to its caudal origin at the lateral tuberosity of the tuber ischiadicum, which is the point of separation recommended by Reuter et al. (2002a). Their study showed that the *M. gluteobiceps* was most tender at the origin (sirloin section) and was tougher 7 to 10 cm posterior to the conventional round/loin break. In addition, the authors explained that the conventional round/loin separation bisected the most tender portion of the *M. gluteobiceps*. In our study, the innovative top sirloin cap (coulotte) was higher ($P < 0.001$) yielding than the conventional cut, which was a direct result of how the *M. gluteobiceps* was fabricated. This cutting style may provide the beef industry with an opportunity to better utilize the proximal portion of the *M. gluteobiceps*.

The innovative bottom sirloin tri-tip was higher ($P < 0.001$) yielding than its conventional counterpart, because this style included removal of the *M. tensor fasciae latae*, including the distal tip of the muscle that is normally excluded by the round/loin separation. The round tip (*M. quadriceps femoris*) of the innovative style comprised a greater ($P < 0.001$) percentage of the hindquarter due to the inclusion of the bottom sirloin ball tip in the innovative round tip.

Due to the separation that created a larger top sirloin cap (coulotte) from the innovative side, the bottom round flat was lower ($P < 0.001$) yielding in comparison to the conventional bottom round flat. The flank steak, strip loin, special trim flank muscle, center-cut top sirloin, top round, lean trim, bone, and fat were not affected ($P > 0.05$) by cutting style.

Carcass value

Forequarter value comparisons were made between cutting styles and reported in Table 4. Value differences parallel weight and yield differences between cutting styles. Due to the weight differential created by fabricating the whole *M. pectoralis profundus*, the innovative brisket was more ($P < 0.001$) valuable than the conventional brisket, whereas the innovative chuck roll generated less ($P < 0.001$) value due to extreme weight differences. The conventional shoulder clod was more ($P < 0.001$) valuable than the innovative shoulder clod, though by excluding the *M. trapezius* and *M. latissimus dorsi*, the innovative shoulder clod should realistically command a higher market price. The innovative ribeye roll was more ($P < 0.001$) valuable, though in a market setting, this cut may not realize the same unit price as the conventional ribeye roll. Overall, total subprimal, saleable yield, and forequarter values were higher ($P < 0.001$) for the innovative style.

Table 4. Least-squares means for forequarter subprimal and component values (U.S. $) stratified by conventional (CONV) and innovative (INNOV) cutting styles

Subprimal	CONV	INNOV	SEM[a]	*P* > F
	——— U.S. $ ———			
Brisket	10.97	15.97	0.25	<0.001
Shoulder clod	24.48	21.70	0.34	<0.001
Chuck tender	4.23	4.24	0.07	0.71
Pectoral meat	3.74	-	0.13	-
Chuck roll	22.13	8.34	0.37	<0.001
M. Serratus ventralis	-	14.36	0.33	-
Chuck short rib	5.45	-	0.15	-
Inside skirt	5.28	5.39	0.14	0.25
Outside skirt	2.93	2.93	0.09	0.99
Ribeye roll	46.64	52.27	0.71	<0.001
Back ribs	4.32	4.85	0.08	<0.001
Blade meat	5.55	12.88	0.34	<0.001
Lean trimmings (85% lean)	57.14	54.84	1.03	<0.001
Fat	3.46	3.38	0.10	0.28
Bone	1.82	1.80	0.03	0.37
Subprimal total value	135.72	142.94	1.68	<0.001
Forequarter total value	198.13	202.96	2.38	<0.001

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

Hindquarter value comparisons were made between cutting style and reported in Table 5. The increased weight of the innovative tenderloin, 2-piece top sirloin butt, and bottom sirloin tri-tip resulted in greater ($P < 0.001$) value, as did the innovative bottom sirloin flap ($P < 0.005$). As was found for the forequarter, total subprimal, saleable yield, and hindquarter values were greater ($P < 0.05$) for the innovative style.

Table 5. Least-squares means for hindquarter subprimal and component values (U.S. $) stratified by conventional (CONV) and innovative (INNOV) cutting styles

Subprimal	CONV	INNOV	SEM	*P* > F
	——— U.S. $	———		
Flank Steak	6.02	5.88	0.16	0.37
Tenderloin	42.77	44.93	0.66	<0.001
Bottom sirloin flap	8.20	8.70	0.21	0.005
Strip loin	43.80	43.27	0.71	0.39
Flank muscle	3.34	3.15	0.13	0.15
2-piece top sirloin butt	29.83	31.82	0.55	<0.001
Bottom sirloin ball tip	3.44	-	0.23	-
Bottom sirloin tri-tip	4.73	5.46	0.11	<0.001
Round tip	14.91	17.61	0.30	<0.001
Top round	30.02	30.31	0.44	0.28
Eye of round	9.66	9.48	0.17	0.002
Bottom round flat	18.27	16.50	0.27	<0.001
Lean trimmings (85% lean)	19.79	19.91	0.41	0.71
Fat	4.69	4.74	0.08	0.46
Bone	1.29	1.29	0.02	0.84
Subprimal total value	214.98	217.12	2.54	0.04
Hindquarter total value	240.75	243.07	2.79	0.01

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

Conclusions

Our focus was to optimize beef carcass value through exploring innovative fabrication styles. Although labor requirements were not measured, in this demonstration, innovative fabrication increased subprimal yield and beef carcass value of approximately U.S. $14. In general, innovative subprimals produced similar steak/roast and saleable yields as compared to conventional subprimals.

As the industry changes with consumer demands, traditional cutting methods will begin to fade away. In their place, new and innovative styles will begin to form as muscles are merchandized individually, creating a more valuable and consistent retail cut for the industry and consumer.

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