

Introduction

The meat industry is currently faced with the challenge of producing food for the busy consumer. Numerous quick and easy to prepare foods are finding their way on to the grocery shelves in order to match the consumer's busy way of life. The consumer's desire to speed through life with less effort, addiction to the convenience habit and the emerging generations of less experienced cooks has created a demand for more convenience items. These items come in the form of pre-seasoned, pre-sliced, pre-cooked and ready to cook meals. This convenience trend shows great opportunities for the meat industry to add value to less valuable cuts while providing a convenience for the consumers.

People have less time to cook a meal from scratch but still find the family meal an important family tradition. However, many people make the familiar question of "what is for supper" at 4:00 PM that day. Today many married women (65%) work outside the home and have less time to prepare the family meal (Lyons, 2000). As compared to the 1920's where 20.6% of the women worked outside of the home and 44 hours were spent a week to prepare and clean up after meals each week (Lyons, 2000). Due to the lack of time available for food preparation today's consumers are in demand of convenient type food items.

Many conveniences have made meal preparation easier over the years. Refrigeration and canned foods help preserve items used in meals and various mixes and cereals are easily purchased and included in many recipes. Also, many technologies have made meal preparation easier and the trend continues today. The microwave, which is found in over 90% of American households, has propelled the movement towards convenient food preparation (Bowers, 2000). Because of this drive towards convenience, heat and serve items have been able to make a large impact on the meat industry as people look for convenient items to aid in dinner preparation, for both side dishes and center-of-the-plate entrees.

Convenience is also sought after in the restaurant industry. Meals purchased at commercial restaurants and not consumed at home have been on a steady increase. According to the NPD Group (a global market research company), Americans consumed 139 restaurant meals per person during the year ending in February 1999 (Singer, 1999). This represents a 14% increase over 1990, when Americans ate 122 restaurant meals per capita. The data also showed that fast food and/or quick service restaurants captured more than 80% of the growth in restaurant meals during the past five years.

Due to the demand for out of home meals and convenience, restaurants and retail outlets that offer ready-to-eat and home meal replacements (HMR) are

examples of other outlets for many convenience based value-added meat products. With increases in the number of people eating meals away from home, more demand has been placed on adequate labor and user-friendly products in the restaurant and retail industries. Therefore, items that are easy to prepare and/or reduced steps of preparation are required to serve the growing population that is “going out to eat”.

The round and chuck portions of beef carcasses are underutilized because the tradition cuts from these primals do not readily lend themselves to quick and/or easy preparation. Therefore, this study evaluated 13 different muscles or groups of muscles from the round and chuck to identify and develop convenient value-added beef products.

Muscles used in this study were isolated from carcasses of similar size, sex, Yield Grade and Quality Grade. The carcasses used in this study were from steers fed a high-energy diet and had hot carcass weights ranging from 700 to 800 pounds. The carcasses qualified for USDA Yield Grade 3 and 4 and qualified for a USDA Quality grades ranging from Low Choice to High Choice.

The muscles used in this study were removed from the carcass using an alternative fabrication process. This process simply allowed for the removal of whole individual muscles as traditional fabrication processes generally cut some of the targeted muscles into various pieces. After the muscles were removed, they were denuded (all fat and external connective tissue removed) and aged for 21 to 28 days in a 34°F cooler.

Muscle Evaluation

Muscles from the Chuck

Infraspinatus

The Infraspinatus extends from the juncture of the arm bone and scapula lying on top of the blade bone. This muscle is often referred to as the “Top Blade” or “Flat Iron”. It can be characterized by the appearance of a heavy sheet of internal connective tissue that runs the length of the muscle and heavy layers of connective tissue on the external surface of the muscle. The Infraspinatus weighed approximately 3.6 pounds. In addition, the Infraspinatus is one of the most tender muscles found in the beef carcass. In this study, the Infraspinatus had a shear force value of 4.6 pounds.

Pectoralis perfundi

The Pectoralis perfundi is a coarse textured, flat muscle located at the most anterior portion of the carcass under the sternum bone and extends under the ribs. This muscle is often referred to as the “Brisket” and weighed approximately 6.00 pounds.

Latissimus dorsi

The Latissimus dorsi is a flat muscle that lies underneath and posterior to the Triceps brachii. This muscle is often referred to as a “Cap Muscle” as it is found lying dorsal to the ribs and portions of the chuck like a cap. The Latissimus dorsi weighed approximately 3.5 pounds.

Longissimus dorsi, Multifidus, and Spinalis dorsi

The Longissimus dorsi, Multifidus, and Spinalis dorsi make up the “Chuck Eye Roll”. Weighing approximately 4.5 pounds, this combination of muscles is located lateral to the spinous processes of the thoracic and cervical vertebrae. The Longissimus dorsi extends to the second rib and the Multifidus and Spinalis dorsi extend the neck. Great amounts of intermuscular fat (seam fat) are often found between these muscles.

Serratus ventralis

The Serratus ventralis is a large fan shaped muscle lying from the dorsal region of the chuck to just over the ribs ventral towards the sternum. This muscle is often associated with the chuck roll. The Serratus ventralis has heavy sheets of surface connective tissue and contains large amounts of intramuscular fat or marbling. This muscle weighed approximately 5.25 pounds. The Serratus ventralis is a very tender muscle that had a shear force of 4.2 pounds

Supraspinatus

The Supraspinatus is often referred to as the “Chuck Tender” or the “Mock Tender”. This coned shaped muscle lies on top of the blade bone. It begins at the juncture of the arm bone and scapula and follows the ridge of the blade bone. The Supraspinatus has a characteristic piece of connective tissue that runs from the thick end of the muscle towards the thin end. The muscle weighed approximately 2.2 pounds and had a shear force value of 6.5 pounds.

Trapezius

The Trapezius is a surface muscle that extends from the neck portion of the chuck to the middle of the blade bone. This muscle is often associated with the chuck as a cap muscle and weighs 1.4 pounds.

Triceps Brachii

The Triceps brachii is made up of three different heads: long head, lateral head and medial head. Together these muscles make up the triceps and are located posterior and dorsal to the humerus and run along the posterior edge of the blade bone. This combination of muscles has external connective tissue and sheets of connective tissue separating the various heads. The long head of the Triceps brachii weighs approximately 5.6 pounds and the lateral head weighs approximately 1.5 pounds. The long head had a shear force value of 6.2 pounds and the lateral head had a shear force value of 8.6 pounds.

Muscles from the Round

Biceps femoris

This large muscle lies on the outside or bottom side of the round and originates from the pelvic bone and extends to the Achilles tendon. The Biceps femoris is often referred to as the “Bottom Round” or “Outside Round” and is also noted for heavy sheets of external connective tissue. This muscle weighed approximately 10 pounds and had a shear force value of 9.5 pounds.

Rectus femoris, Vastus intermedius, Vastus lateralis, and Vastus medius

The Rectus femoris, Vastus intermedius, Vastus lateralis, and Vastus medius together make up the quadriceps more commonly known as the “Knuckle” or “Sirloin Tip”. This combination of muscles extends from the round – sirloin junction to the patella (kneecap). The quadriceps weighs approximately 10 pounds and had a shear force value of 6.4 pounds.

Semimembranosus, Adductor and Gracilis

The Semimembranosus, Adductor and Gracilis muscles make up the “Top Round” or “Inside Round”. The Semimembranosus extends from the aitchbone (pelvis) to the hind shank on the inside portion of the round. The adductor is a triangular muscle that lies between the femur and the Semimembranosus. The Gracilis is a flat, coarse-fibered muscle that lies directly over the Semimembranosus and

Adductor muscles. In combination, these muscles weighed approximately 14.25 pounds. The top round had a shear force value of 8.3 pounds.

Semitendinosus

The Semitendinosus is a round tubular muscle that extends from the aitchbone (pelvis) to the Achilles tendon and lies adjacent to the Biceps femoris. This muscle is often referred to as the “Eye of Round”. The Semitendinosus were approximately 3.00 pounds and had shear force value of 8.9 pounds.

Value-Added Products

Heat and Serve BBQ Beef Brisket

Heat and Serve BBQ Beef Brisket is a fully cooked item that was made from the Pectoralis perfundi muscle. The Pectoralis perfundi was cut into 1.5 pound sections and coated with a dry rub, which included salt, chili powder, black pepper, garlic powder, onion powder, oregano, thyme, and rosemary. The pieces were then individually packaged in cook-in bags and allowed to sit over night in a 34°F cooler. The brisket was then cooked in a smokehouse for 5.5 hours using a moist heat cooking cycle. The brisket was allowed to cool to an internal temperature of 40°F.

The brisket was reheated in the microwave in the same bag it was cooked in, which produced a moist product with minimal product loss. This is a flavorful, juicy and tender product that offers great ease in preparation and a satisfying eating experience.

Further advancements of the product could be to include a barbecue sauce with the meat or a variety of spices to meet any desired ethnic flavor profile. The product could also be pre-sliced or shredded for a pulled beef barbecue item.

Top Blade Strips

Due to the flat shape and natural tenderness of the Infraspinatus, an appetizer/finger food was developed using this muscle. The heavy external and internal connective tissue of the Infraspinatus was removed, which resulted in two portions of the muscle. The Infraspinatus was then cut into 3-inch long, half-inch thick strips. The strips were coated with dry rubs in the flavors of pizza, barbecue and salsa. The strips were cooked in cook in bags in a smokehouse for an hour

and a half or until an internal temperature of 152°F was reached. The strips were cooled to an internal temperature of 40°F. The strips were reheated in the microwave or browned in a skillet. The results of both cooking techniques were found to be satisfactory. Warming in the original cook in bag could be convenient to the consumer. Browning in a skillet is also easy and adds an appealing dark brown color to the surface.

This product offers convenience to consumers and offers a way beef can appear as an appetizer/finger food in the restaurant or in the home. The product's size, tenderness and flavor offer a great eating experience that can be enjoyed as an appetizer or a whole meal. Dipping sauces could also be included to enhance the flavor of the product. This product is also very versatile and can be used as a meat portion on salads, pizzas, nachos and other dishes. The multiple uses of this product would make it more user friendly in restaurant or food service markets.

Fajita/Philly steak strips

A pre-seasoned, pre-sliced product that aids in the preparation of fajita or other Mexican style dishes or aid in the preparation of Philly style sandwiches was developed. The Latissimus dorsi and Trapezius muscles were cut across the muscle fibers at a 45° angle into .25-inch thick strips, which were of various lengths ranging from 2 to 4 inches. The strips were then tumbled with either a fajita seasoned marinade with red and green dried peppers or an onion marinade with dried onions and green peppers in a vacuum tumbler for 30 minutes. The marinade was incorporated into the strips to increase the strips' weight by 10%. After tumbling, the fajita seasoned strips and the onion seasoned strips were vacuum packaged as fajita and Philly steak strips, respectively.

The value of the muscles used was greatly increased by the production of this product. These muscles typically end up as lean trim and then ground into lean ground beef and are rarely used in any other fashion. The addition of a marinade combined with thinly slicing improved the overall tenderness of these muscles. Additionally, the marinade enhanced the product's flavor profile and improved the juiciness by increasing the water holding capacity of the strips. Thinly slicing the product greatly decreased the cooking time. This product offers a great opportunity for consumers that are challenged in the preparation of a tender fajita or Philly steak style meal. The steak strips would also be a great addition to salads. As fajitas are a popular item these two muscles can be used to help supply the demand for this type of product.

Chuck Eye Steaks

Two “Chuck Eye Rolls”, which include the Longissimus dorsi, Multifidus, and Spinalis dorsi, were used to create this reformed product. The two “Chuck Eyes” were trimmed of excess fat and tumble in a solution of phosphate, sugar, salt and water in order to reach a point that was 115% of their green weight and to obtain protein extraction which would aid in binding the two pieces together. The two chuck eyes were then placed on top of each other with opposite ends facing each other. The chuck eyes were then stuffed into a pre-smoked casing and flattened with a ham press. The product was cooked in a smokehouse on a roast beef cook schedule for 6 hours until an internal temperature of 152°F was reached. The product was then cooled to an internal temperature of 40°F.

The product was sliced into 1-inch thick steaks and heated in the microwave or browned in a skillet. The product can also be thinly sliced as deli style roast beef. The restructuring of this group of muscles provides a steak item that is convenient and has a consistent serving size.

Heat and Serve Serratus Steaks

The Serratus ventralis is a tender muscle that can be cut into steaks that have the same shape as top loin steaks. Since this muscle is very malleable and can expand during cooking, a heat and serve product was produced in order to maintain shape and aid in consumer preparation.

All external connective tissue was removed from the Serratus ventralis and steaks were cut 1-inch thick across the fibers of this muscle. The steaks were then seasoned with salt and pepper, formed by hand into the desired shape and vacuum packaged in cook-in bags. The steaks were cooked using moist heat for one hour until an internal temperature of 152°F was reached and then cooled to reach an internal temperature of 40°F.

The steaks were then reheated in a microwave in the cook-in bag. The steaks could also be heated in a skillet or on the grill. These steaks look similar to top loin steaks and deliver a convenient way to have a juicy, flavorful and tender eating experience. Again, this is a muscle that is often ground into ground beef but can be merchandized as a flavorful and attractive center-of-the-plate steak.

Heat and Serve Steaks

Two Supraspinatus or chuck tenders were denuded, macerated and tumbled in a vacuum tumbler with a grill-flavored marinade for 45 minutes. The tumbling process increased the product’s weight by 10% and extracted proteins important for binding the product together. The two chuck tenders were then place on top of

each other with opposite ends facing each other and stuffed into a pre-smoked casing and netted. They were cooked in a smokehouse with moist heat for three hours until an internal temperature of 152°F was reached and then cooled to 40°F.

The product was sliced into 1-inch thick steaks that could be heated in a microwave, skillet or grill to provide a more convenient alternative to the traditional grilling steaks. The product could also be thinly sliced for deli style roast beef. This method again yielded steaks that were consistent in size from one end to the other.

Breakfast Stuffed Steaks

Supraspinatus and Semitendinosus were cored in order to produce a hollow cylindrical shape. The two muscles were then tumbled in a vacuum tumbler with a solution containing 11% salt and 5.5% phosphate in order to produce a product that was 110% of its green weight. They were then stuffed with a mixture of either pork sausage and cheese or pork bacon and cheese and seasoned with salt and coarse black pepper. Each mixture contained approximately 10 % cheese and 90% meat. The product was then cooked in a convection oven at 350°F for one hour or until the stuffing reached 160°F. The breakfast stuffed steaks were then sliced into .5 inch steaks.

This product offers a new alternative to the breakfast meal or could be used in a sandwich. The steaks could be sold precooked or as a fresh roast, which the consumer can cook at home.

Heat and Serve Roast

Triceps

The lateral head of the Triceps brachii weighs approximately 1.5 pounds and is a triangular shape, which lends itself to a great small roast. The heavy surface connective tissue was removed from the muscle and then the muscle was injected with a solution that contained salt and phosphate to a point that was 130% of its green weight. The muscle was then rubbed with a dry rub, which included coarse black pepper, fine black pepper, onion powder, garlic powder, salt and dextrose. The roast was then packaged in a cook-in bag and cooked in a smokehouse under a moist heat cooking cycle for five hours until an internal temperature of 155°F was reached. The roast was then cooled to 40°F.

This roast was quickly heated in its package in the microwave. The size of the roast makes a great meal for a small family. Also, the incorporation of a solution in this muscle improves tenderness by reducing Warner-Bratzler shear

force to half the original value. This product is a flavorful tender product that can be easily prepared in the home for a small family meal.

Eye of Round and Top Round

The eye of round and top round were treated in the same fashion as the Triceps. Both were injected with the above solution to points that were 130% of their green weight. The muscles were rubbed with the same dry rub and cooked in cook-in bags in a smokehouse for seven hours to an internal temperature of 152°F.

Due to the shape and size of the eye of round, this product would be ideal for a heat and serve style roast or sliceable product that could be marketed as a deli roast beef. The top round was more prone to be used as a deli style meat due to its large shape and size. However, the top round could also be cut into one pound portions for a heat and serve roast.

Beef “Ham”

Beef ham was developed in order to provide an old fashion roast that can be served as the main entrée of a dinner holiday dinner or during a celebration. This product can also be made from different muscles for smaller occasions and for deli style ham, which can serve as an alternative to the traditional pork ham for many ethnic groups.

The top round (cap off), bottom round and the eye of round were used in creating this product. The muscles were trimmed of external connective tissue and fat. The muscles were then injected with a solution to a point that was 135% of their green weight. The injected solution was made of brown sugar, honey, salt, phosphate, nitrite, erythorbate and water. The injected muscles were then netted and cooked in a smokehouse with a boneless ham cook schedule for twelve hours until an internal temperature of 152 to 155°F was reached.

The top round beef ham weighed approximately 10 pounds, which is an adequate size for a large gathering. The hams had a great smoked outer appearance and a cured pink internal color. The beef ham had a similar taste and texture as pork ham; however, beef ham can be made from whole muscles unlike most pork hams which are made of many muscle which sometimes leads to the presence of unappealing seams and seam fat.

The ham can be thickly sliced for a meal or thin sliced for deli sandwiches. The beef ham can be served cold or re-heated making it a very convenient high quality product. It can also be marketed to ethnic groups as an alternative to the traditional pork ham. Further expansion with this product could be pre-slicing the ham and coating it with a brown sugar glaze.

Beef Pastrami

Quadriceps and Triceps brachii-long head were both used in creating beef pastrami, a cured luncheon meat. The pastrami was made by injecting the muscles with a solution to a point that was 135% of its green weight. The solution contained salt, phosphate, white sugar, nitrite, erythorbate and water. After the muscles were injected they were coated with a dry rub that contained coriander and black pepper. The injected and coated muscles were then vacuum packaged in cook in bags and then cooked in a smokehouse with moist heat for six hours.

The pastrami is a flavorful luncheon meat that is made of two less tender cuts of meat. However, the processing and cooking steps involved with producing the luncheon meat greatly improve the tenderness. This is a very high quality and flavorful product that could be used to make Rueben sandwiches or can simply be marketed as a main line item in a deli case.

Surf and Turf Steaks/Roasts

Surf and Turf Steaks were created to offer a cheaper alternative to the traditional surf and turf meal. Beef top round was cut into thin slices so that the muscle fibers ran perpendicular to the length of the meat. The beef was seasoned with salt and pepper and then a layer of crabmeat was spread onto the beef. The crabmeat included lump crabmeat, breading and seasonings. The beef layered with crabmeat was then rolled so that the muscle fibers of the beef ran parallel to the length of the roll. The rolls were coated in breadcrumbs and coarse ground black pepper. The rolls were then secured with string and cooked in a convection oven at 300°F for 2 to 3 hours or until an internal temperature of 150°F was reached. The rolls were allowed to sit for 10 minutes and then sliced.

The combination of the beef and crab flavors and textures provide a cheaper and more convenient alternative to the typical surf and turf meal. The rolls also had great eye appeal with a dark crusty outer layer and the contrasting colors of the dark beef and light crabmeat in the roll. This product could be marketed as a heat and serve steak or as a ready-made fresh roll to be cooked by the consumer.

Beef Tips

“Bottom Round” is one of the toughest muscles that is sometimes difficult to merchandise as a steak. Therefore, “Bottom Round” was diced into .5 square inch cubes and used in a variety of ways to form value added products. The cubes were seasoned with a dry barbecue rub and others were coated in a dry gravy mixture. Both were packaged separately in cook-in bags and cooked in a

smokehouse with moist heat for four hours. A slow-cook provided that the tenderness of these cubes would be improved by breaking down collagen through the cooking process.

The barbecue cubes were coated in a barbecue sauce and created a different alternative for the traditional beef tips and gravy. The beef cubes and gravy were heated in the microwave in the same cook in bag and could be offered as a convenient meat ingredient to add to the family meal. The beef cubes are convenient to the consumer by taking the long cooking step out of the consumers' hands.

Another group of beef tips were coated in an "Italian rub" which included salt, black pepper, oregano, Italian herbs and basil. One and half pounds of coated beef cubes were then placed in cook in bags along with 32 fluid ounces of canned tomatoes flavored with garlic and onions. The mixture was then vacuum-sealed and cooked for 4 hours in a smokehouse and then allowed to cool over night.

The way this product was packaged makes preparation easy for the consumer. To prepare, the bag is placed in boiling water to heat the mixture for 10-15 minutes and then poured out into a serving bowl. This Italian stew offers a great alternative to the long tedious hours of slow roasting beef for a stew and the consumer can serve as is or combine additional ingredients to personalize their own version.

Beef "Bacon"

The beef plate, located ventral to the chuck and rib, was used in order to produce an alternative to the traditional pork bacon. This beef bacon is a great alternative for many ethnic groups who wish to include bacon in their meals. The beef plate was injected to a point that was 130% of the green weight with a typical bacon brine, which included salt, phosphate, nitrite, erythorbate, brown sugar and water and cooked in a smokehouse on a pork bacon-cooking schedule. After cooking and cooling, the beef bacon was sliced. Beef bacon serves as a great alternative for any occasions where traditional pork bacon is used, such as in sandwiches, salads and etc. and for those ethnic markets that do not consume pork products.

Cheeseburger Nuggets

Cheeseburger nuggets were developed to mimic the chicken nugget and are also a great way beef can enter the snack food market. Ground beef was seasoned with and salt, black pepper and cheddar cheese. The beef was then shaped into small patties two inches in diameter and one inch thick. The beef patties were

then cooked in a convection oven to an internal temperature of 160°F. After cooling, the patties were coated in flour, dipped in batter then coated in seasoned breadcrumbs. The breaded patties were then frozen.

For preparation, the cheeseburger nuggets were deep-fried in cooking oil at 370°F, which produced a brown crispy breading and juicy meat center. The nuggets achieved similar results when baked in a conventional oven at 375°F for 15 minutes. This product creates a beef snack that can be enjoyed by many consumers. These nuggets can include a host of different flavor profiles that may consist of Mexican, Barbecue, Italian, etc.

Summer Sausage

Summer sausage has long been a great outlet for beef trimmings by being a demanded meat snack. The process of making Summer sausage reduces the pH of the product, which increases shelf life and can make the product shelf stable. In order to give this product even more value the shape can be altered and other various ingredients can be added to alter the flavor profile of the product. Enlarging the diameter of the sausage can make this product a convenient tasty luncheon meat. By using a vary small diameter casing, this product can also be marketed as a beef snack stick. Also, adding cheese can create a great alternative to the typical summer sausage. Different flavor profiles including garlic, spicy and sweet can be further developed to meet any specific market. This product is especially marketable during holiday occasions and parties.

Smoked Sausage/Brats

A wide variety of brat and sausage flavors were developed. A salsa and cheese brat was produced by seasoning ground beef with salt and pepper, combined with salsa, cheese and soy protein. Another variation can be to include cheese and bacon with the ground beef to produce a cheese and bacon brat. Expansion of fresh sausage can also follow ethnic routes in which the famous Mexican Chorizo can be produced.

Fully cooked smoked sausages can also expand on many flavors. A common polish sausage recipe was followed to produce smoked sausage. However, to add variety, pineapple juice and coconut was added to produce a tropical smoked sausage. Also, cheese was added to polish sausage for a cheddar smoked sausage. In addition, the size of the sausage can be altered to meet consumer needs. Small sausages, 1.5 inches in length, were produced for a finger food or appetizer. A variety of flavor profiles were created for beef sausage type products and many more can be developed to meet consumer demand. This area is limitless and certainly provides an opportunity to add value to beef trimmings.

All of the aforementioned products can serve as a template for many other products. Certainly many alternatives could be made to customize new products or enhance product lines and flavor profiles. Unless specifically mentioned, the beef muscles were not pumped/injected with additional solutions. However, to increase juiciness, further enhance tenderness or profit margins, many of the whole muscle and processed products could be injected with various solutions or those that were to higher levels.

Appendix I

Warner-Bratzler Shear force

The measurement most often used to measure tenderness of meat products is Warner-Bratzler shear force. The measure is most consistently highly related to sensory tenderness ratings. The Warner-Bratzler machine measures the force it takes to shear a core sample of meat into two pieces.

In order to obtain core samples, fresh meat cuts are cooked to a consistent internal temperature and allowed to cool to room temperature. Also, cores can be taken from raw samples or pre-cooked processed meats according to the goals of the researcher. A core that is 1.27 cm. in diameter is removed from the sample parallel to the longitudinal orientation of the muscle fibers. Therefore, when the core is placed onto the V-notched blade of the machine the shearing action is perpendicular to the muscle fibers. After the core is placed on the blade pressure is applied by the machine and the amount of force required to cut through the core is measured in either pounds or kilograms. Tenderness is negatively correlated to the force measured therefore, the greater the force required to shear the core the less tender the sample.

When performing the Warner-Bratzler shear force measurements it is important to cut the core in the middle of cooked samples to avoid the hardening that occurs towards the outside of the sample. In addition, samples that are not uniform in diameter or contain connective tissue should not be used. A total of six to eight cores should be measured for each sample in order to obtain a representative measure of tenderness of the sample.

For this study, we adopted the guidelines used for the Beef Muscle Profiling Report from the National Cattlemen's Beef Association (2000). They reported shear force values of less than 9.0 pounds to indicate that the product was of acceptable tenderness. Shear force values between 9.0 and 11.0 pounds were marginally tender and products/muscles above 11.0 pounds may need additional manipulation to reduce their tenderness profiles.

Appendix II

Table 1. Muscles from the beef chuck and their corresponding whole muscle value-added products

Muscle	Common Name	Product
Pectoralis Perfundii	Brisket	Heat and Serve BBQ Brisket
Infraspinatus	Top Blade	Heat and Serve/brown and serve appetizers (BBQ, pizza, salsa)
Latissimus Dorsi	Rib cap muscle	Brown and serve fajita strips and Philly steak
Longissimus Dorsi, Multifidus, and Spinalis Dorsi	Chuck eye roll	Heat and serve chuck eye steaks; RTE ^a deli style roast beef
Serratus Ventralis	Chuck under blade roast	Heat and serve steaks
Supraspinatus	Mock tender, chuck tender	Heat and serve steaks, RTE ^a deli style roast; Breakfast stuffed roast
Trapezius	Rib cap muscle	Brown and serve fajita strips and Philly steak
Triceps Brachii – long head	Triceps	Pastrami
Triceps Brachii – lateral head	Triceps	Heat and serve roast
Obliquos abdominis externus, Tranversus abdominis, and Rectus abdominis	Plate	Beef bacon

^aRTE = Ready to eat

Table 2. Muscles from the beef round and their corresponding whole muscle value-added products

Muscle	Common Name	Product
Biceps Femoris	Bottom round, outside round	Beef “Ham”; beef tips and gravy; BBQ beef tips; Italian beef stew
Rectus Femoris, Vastus Intermedius, Vastus Lateralis, and Vastus Medius	Quadriceps, Knuckle	Pastrami
Semimembranosus and Adductor	Top round/cap off	Beef “Ham”; Surf and turf steaks; Seasoned rolls; Heat and serve roast; RTE ^a deli roast beef
Semitendinosus	Eye of round	Beef “Ham”; Heat and serve roast; RTE ^a deli roast beef; Breakfast stuffed roast

^aRTE = Ready to eat

Table 3. Value-added products developed from beef trim from the round and chuck

Muscle	Common Name	Product
Beef trim	Ground beef	Cheeseburger nuggets; seasoned hamburgers; summer sausage; summer sausage with cheese; lebanon bologna; tropical smoked sausage; smoked sausage with cheese; brats (blue cheese and bacon; salsa and cheese; savory)

Table 4. Warner-Bratzler shear force for muscles and corresponding products

Muscle	Cooked shear force ^a	Processed shear force (cold) ^b	Processed shear force (warmed) ^c
Triceps brachii-lateral head	8.6	3.9	4.2
Triceps brachii-long head	6.2	2.7	2.6
Serratus ventralis ^d	4.2		
Infraspinatus ^d	4.6		
Top Round	8.2	5.6 (roast) 10.0 (ham)	4.8 (roast) 9.8 (ham)
Biceps Femoris	9.5	6.0	8.6
Quadriceps	6.4	3.0	3.0
Semitendinosus	8.9	4.9 (roast) 6.3 (ham)	3.8 (roast) 7.6 (ham)

All values are reported in pounds.

^a product was cooked as whole muscle without additional processing to serve as a control

^b product was processed and chilled and shear force was conducted on cold product

^c product was processed and chilled and shear force was conducted on products that were reheated in the microwave on high temperature setting for 2 minutes

^d products from these muscles required little processing and the control served as the final shear force for the product

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