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Inspection
The meat industry, with more than a century of regulatory history, is considered by many to be the most highly regulated segment of the food industry. The U.S. meat inspection program began in 1891 when Congress passed a general meat inspection act, providing for the inspection of cattle. Subsequently, the Federal Meat Inspection Act of 1906 made inspection mandatory for all meat that crossed state lines. More recently, the Wholesome Meat Act of 1967 required that inspection of meat sold within a state under an approved state inspection program meet inspection requirements at least as stringent as those of the federal system.

Federal meat inspection is the responsibility of the Food Safety and Inspection Service (FSIS), the public health agency in the U.S. Department of Agriculture (USDA). State meat inspection is the responsibility of each state’s government with partial funding support provided by the federal government. FSIS develops rules and regulations for the production of safe foods, ensuring that meat and poultry products are safe, wholesome and correctly labeled.

The beef industry, however, also takes responsibility for producing the safest products possible. The responsibility for food safety begins with the livestock producer, continues through wholesaler/retailer operations (including meat inspection) and ends with the foodservice operator or the consumer who is ultimately responsible for the food’s preparation.

Providing the safest beef in the world is the number one priority of America’s beef producers. From pasture to plate, each partner in the beef production chain has made significant strides in lowering the rate of foodborne illnesses and remains committed to the fight against foodborne pathogens such as E. coli O157:H7. Producers have invested more than $22 million in beef safety research since 1993, leading to the establishment of best practices which serve as a road map in reducing foodborne pathogens. The steady decline in incidence rates of these pathogens is evidence that the beef supply is safer than ever.
To assist producers in food safety programs on ranches and farms, the National Cattlemen’s Beef Association (NCBA) has initiated the Beef Checkoff-funded “Beef Quality Assurance Program” to educate farmers and ranchers on the proper way to administer animal health products and to address other food safety issues. Farmers and ranchers take their food safety responsibilities seriously when raising livestock, including administering approved animal health products. Similarly, foodservice operators must use safe food preparation and handling practices at all times, to assure not only continued confidence from their customers, but also to avoid potential fines or other legal actions. Several industry trade organizations, including NCBA on behalf of the Beef Checkoff Program, provide educational and training programs to assist foodservice establishments in meeting their food safety responsibilities.

**Federal Meat Inspection**

The Meat Inspection Program assures that only meat from healthy animals enters the food chain, and assures that facilities and equipment meet sanitation standards. However, the Meat Inspection Program also includes:

- Inspection of meat at various stages of processing.
- Temperature monitoring for both fresh and cooked meat.
- Review of packaging and labels used for fresh and processed meat.
- Control and monitoring of the use of approved food additives.
- Control and monitoring of imported meat.

Since meat inspection is mandatory for all beef sold at the foodservice and retail levels, U.S. taxpayers pay for these inspection programs. Therefore the cost of inspection is not included in the cost of the meat purchased.

Cattle and their carcasses are examined for wholesomeness before, during and after the harvesting process by an in-plant FSIS inspector.

Inspectors view organs, lymph nodes and other tissues for abnormalities. If wholesomeness is questionable at any time, the inspector will retain a beef carcass or beef products for further testing. If a carcass or any edible part from an animal is found to be unwholesome, it is condemned and placed in a separate area until it can be disposed of properly, thereby preventing its entrance into the food chain.

Several other tests are routinely performed by inspectors to assure the safety of the meat supply. For example, by using statistical procedures FSIS is able to check for more than 100 unauthorized compounds and monitors approximately 50,000 carcasses per year. If misuse is found, the carcass is traced back to its source. In addition to possible legal action against the source, animals subsequently marketed from the establishment where the misuse or error occurred are closely monitored until the problem is completely corrected.

When beef or beef products have passed the meat inspection process, a round inspection legend containing an abbreviation “U.S. Inspected and Passed” and the official establishment number assigned to that specific processing plant is stamped on each primal cut (with edible ink). If a beef cut or product is packaged in a box, the inspection stamp is placed on the outside of that
State Meat Inspection
Foodservice operators typically purchase beef and beef products that have been processed under the Federal Meat Inspection program, because most distributors sell products in several states, if not nationally. However, 28 U.S. states do maintain federally-approved state inspection programs. A processing plant that sells meat products exclusively within its state may operate under a state regulated inspection program, which must meet the same criteria as USDA (federal) inspection. State meat inspection stamps also use edible ink and a symbol that is often the outline of the shape of that state, with the official establishment number within the stamp.

Kosher Inspection
The term “kosher” is derived from the Hebrew word meaning “fit and proper” or “properly prepared.” Kosher meat is processed under the supervision of persons authorized by the Jewish faith to meet the requirements of the Mosaic and Talmudic laws.

While the kosher inspection procedures are independent of the requirements for federal or state meat inspection, kosher meats must also be inspected concurrently by federal or state meat inspectors and must also meet the federal/state inspection requirements prior to sale.

A primary requirement for kosher meat is that it comes from an animal that has split hooves and chews its cud. Since hogs do not meet this requirement, ham, bacon and other pork products cannot be kosher.

A specially trained rabbi must perform the ritual harvest of the animal. Following carcass cutting, the fresh meat is soaked and salted on all parts, and the meat is then allowed to drain. Salting is critical to the koshering process, since it draws out the remaining blood from the meat as required by biblical law (Leviticus 17:14, “You shall not eat the blood of any creature, for the life of every creature is blood; whoever eats it shall be cut off.”) Cuts of meat from the hindquarter are not available as kosher meat because the sciatic nerve and its adjoining muscles may not be eaten.

Once the beef carcass has met both kosher and federal/state inspection requirements, the kosher inspection stamp is applied to the appropriate parts of the carcass. The kosher designation may then be applied to cuts and packages of kosher products.

Halal Beef
Halal is the Arabic word meaning “lawful” or “permitted” and is the dietary standard of Muslims. USDA has had a policy on Halal labeling in effect since 1996. The general requirements for Halal state that an animal must be humanely treated en route to and at the processing plant. The throat must be slit in a certain way, while the word “Allah” (God) is said. The blood must then be drained from the body.

Essentially, all foods are considered Halal except for the following:
- Swine/pork and its by-products
• Animals improperly harvested
• Animals killed in the name of anyone other than Allah (God)
• Alcohol and intoxicants
• Carnivorous animals, birds of prey and land animals without external ears
• Blood and blood by-products
• Foods contaminated by any of the above

The requirements for halal meat are that an animal or poultry has to be harvested in a ritual way known as Zibah. Zibah requires that animals be alive and healthy at the time of harvest, that a Muslim perform the ritual and that the carcass be drained of all blood. In addition, there are other rules and edicts that have to be followed, including Halal processing must not be done anywhere where pigs are processed (as pork is forbidden), the animal must be fed and given water prior to harvest, one animal cannot see another animal being harvested and, whenever possible, the animal should face Mecca.

Products prepared by federally inspected meat packing plants identified with labels bearing references to Halal or Zabiah Halal must be handled according to these and other Islamic law and under Islamic authority.

Grading
The acceptability and value of beef carcasses is determined primarily by: (1) the quality of the beef, and (2) the yield of saleable beef. U.S. Department of Agriculture (USDA) grades for beef carcasses provide a system of sorting a rather heterogeneous (varied) supply of beef into smaller, more homogeneous (uniform) groups (i.e., Quality Grade Choice-Yield Grade 2) for marketing. These grades promote uniform market reporting, provide a tool for expressing and comparing value and prices, and enhance foodservice and consumer marketing.

Established in 1927, the USDA meat grading program, administered by the Agricultural Marketing Service (AMS) of the USDA, sets “standards” (which are written descriptions) of quality and cutability (yield of edible meat) that are used in buying and selling meat. These standards allow livestock owners to gear production for specific grades based on market demand. Packers can segregate carcasses and cuts into groups of similar grades and retailers can buy the grades of meat appropriate for their markets. For consumers, grading provides assurance that the product conforms to an established set of standards that predict palatability. Today, in larger plants computer imaging technology assists USDA graders.

There are federal grade standards for beef, veal, pork and lamb. However there are more grade designations for beef carcasses due to the wider variation in age and weight of cattle compared to other meat animals. The meat grading standards designate eight “quality” grades for beef (Prime, Choice, Select, Standard, Commercial, Utility, Cutter and Canner) and five “yield” grades (depicted numerically from 1 to 5).

Only beef carcasses (not individual cuts) are graded. However, this grade designation is carried forward to all wholesale/primal and retail cuts derived from a graded carcass.
Unlike meat inspection, which is mandatory, participation in the meat grading program is voluntary, and the cost of this service is paid for by the meat packers. This cost may be included in the cost of meat purchased by consumers or foodservice operators.

Today, approximately 95% of all federally inspected slaughter gets a grade. Fed cattle are young cattle marketed out of feedlots after an average of 100-150 days on a grain based diet.

Of the carcasses graded in the U.S., the quality grade distribution is approximately 3% Prime, 57% Choice and 40% Select. The yield grade distribution is approximately 11% Yield Grade 1, 40% Yield Grade 2, 40% Yield Grade 3, and 9% Yield Grades 4 and 5. Less than 1% of older cattle that could qualify for Commercial or Utility are graded.

Since beef grading is a voluntary program, packers are not required to quality grade and/or yield grade every carcass. Therefore, the packer has the option to quality grade only, to yield grade only, to grade for both quality and yield grades, or to not grade a carcass at all.

The packer may instruct the USDA grader to officially quality and/or yield grade only those carcasses meeting specific marketing needs. Often a packer will specify, for instance, that only USDA Quality Grade Prime, Choice and Select and Yield Grade 1, 2, and 3 be identified with a grade stamp. A carcass that is officially graded is “rolled” with a blue ink stamp or “shield” (using edible ink) to designate the grade. The stamp is rolled along the back from the round to the chuck and over the clod and brisket regions.

“No roll” is a term given to those carcasses that do not officially receive a grade stamp “roll” at the packing facility. Therefore, they are not rolled with either an official quality or yield grade stamp. There is no official USDA grade standard for “no roll”, nor is there an official “no roll” stamp.

With the increased use of the Select grade in both retail and foodservice operations, and since carcasses can have a combination of grading options (yield, quality or both), fewer carcasses are remaining as “no roll” beef. However, any carcass of any quality or yield grade may be a “no roll” carcass, if the packer decides not to have a grading roll applied to it. Therefore, purchases from a “no roll” sales category are less likely to be as uniform in quality or yield as those carrying an official USDA grade designation.

Carcasses from the lower beef quality grades (Commercial, Utility, Cutter and Canner) are normally not graded, since they are seldom sold directly to the public. The meat from these carcasses is both wholesome and nutritious, but because these cuts are less tender, they are commonly used in ground beef, sausages and other manufactured meat products. However, some of the more tender cuts (ribs and loins) of the lower grades may be tenderized and used in restaurants that feature lower-priced beef entrees.

As will be seen in the following sections, carcass fat plays an important role in determining both quality and yield grades of beef carcasses. There are several types of fat associated with a beef carcass:

- Marbling, or intramuscular fat, is the fat deposited within the muscle
- Subcutaneous, or external fat, covers the outside of the carcass
- Seam fat, or intermuscular fat, is the fat lying between the muscles
- Internal fat (KPH - kidney, pelvic, heart) protects the internal organs

Marbling is an important factor in determining the quality grade of a beef carcass, typically having a positive effect on the palatability of the cooked meat. However, subcutaneous, seam and internal fats, all factors in determining the yield grade of a carcass, each have a negative impact on the final yield grade.

**Quality Grading**
This part of the grading system provides the foodservice operator with an estimate of the palatability, or taste appeal (tenderness, juiciness and flavor), of the cooked meat from a carcass. The quality grade is determined by evaluating the following characteristics of a beef carcass:

**Marbling**
“Marbling” (intramuscular fat) is the small flecks of visible fat on the cut surface of fresh meat. In determining the grade of a beef carcass, the marbling is evaluated on a cut surface of the ribeye muscle between the 12th and 13th ribs.

The amount and distribution of marbling is a major criterion for grading beef. The marbling fat melts during cooking, thereby increasing the juiciness of the meat, contributing to its flavor and increasing its perceived tenderness.

The “Official United States Standard for Grades of Carcass Beef” recognizes ten degrees of marbling. The six common degrees of marbling are - Moderately Abundant, Slightly Abundant, Moderate, Modest, Small and Slight.

**Maturity**
The younger the animal the more likely the meat will be tender, because as the animal matures, the connective tissue increases in amount, becomes tougher, and will not break down as easily when cooked. Younger cattle can qualify for Prime, Choice, Select or Standard. Meat from older cattle (over 42 months of age) can qualify only for Commercial, Utility, Cutter or Canner grades.

During the grading process, the USDA grader does not have information as to the exact age of the animal from which the carcass originated. Consequently, the grader determines the physiological maturity of the animal on the basis of skeletal characteristics and the color and texture of the ribeye muscle. The bones of young animals are soft, porous and red. As the animal gets older, bones and cartilage ossify, that is, they grow harder and turn white.

The color and texture of the ribeye muscle is also considered when determining the final maturity group for carcasses. Young cattle have lean that is bright cherry-red and finely textured. The color of beef becomes progressively darker and the texture coarser as the animal matures.

In determining the physiological maturity of the animal from which the carcass originates, the grader places each carcass into one of five maturity groups: A, B, C, D and E. A and B maturity...
groups represent carcasses from younger cattle (under 42 months of age), while C, D, and E maturity groups represent carcasses from older cattle (over 42 months of age).

Having determined the maturity group (i.e., A, B, C, etc.) and the degree of marbling (i.e., Modest, Small, Slight, etc.), the grader uses this chart to determine the relationship between the two factors, thereby arriving at the final Quality Grade.

For instance, a carcass from a younger animal in the “A” maturity group with a “Modest” degree of marbling would be designated as a “USDA Choice” carcass. However, a “C” maturity carcass with the same degree of marbling (“Modest”) would be a “USDA Commercial” carcass.

**Yield Grading**

Yield grading is accomplished at the same time as quality grading and is performed by the same grading personnel. However, yield grading is not directly related to quality grading, and serves a different purpose for the industry.

Yield grades identify differences in carcass cutability. Cutability is defined as the amount of saleable meat obtained from the carcass as boneless, closely trimmed retail cuts from the round, loin, rib and chuck.

Yield Grades are especially useful at the purchasing level since they can help the foodservice operator identify which carcasses or cuts will provide the greatest yield of edible meat per pound. The lower the yield grade number (i.e., Yield Grade 1), the smaller the cutting losses, the less seam fat will be found within individual cuts, and the higher the cooking yield. Yield grades are of lesser direct value to the retail consumer since retail cuts are usually trimmed of excess fat prior to presentation for sale.

However, yield grades can affect all purchasers of fresh beef, because cutting losses are an important factor in determining product price, and in turn, can directly impact foodservice and retail pricing strategies.

There are five USDA Yield Grades, identified numerically as “USDA Yield Grade 1” to “USDA Yield Grade 5”. A Yield Grade 1 carcass has the greatest amount of saleable meat while a Yield Grade 5 carcass has the least.

Since it is not practical to cut and fabricate every carcass into muscle, fat and bone to determine the boneless retail yield, a quick, repeatable and reliable procedure must be used to estimate carcass cutability. To do this, the USDA grader uses four carcass characteristics:

1. External fat thickness measured in tenths of an inch at a specific point over the ribeye muscle at the 12th rib (the same location as marbling is determined for quality grading);
2. The amount of internal fat (kidney, pelvic and heart fat) expressed as a percentage of the carcass weight (%KPH fat);
3. The area of the ribeye muscle (in square inches) again measured at the 12th rib; and,
4. The carcass weight (an actual measure of carcass weight in pounds taken on the harvesting floor)
Fat thickness over the ribeye and percent of kidney, pelvic and heart fat are indicators of total carcass fatness. As these measurements increase, the yield grade number increases (moves closer to Yield Grade 5), and the carcass becomes less desirable.

The ribeye area is an indicator of carcass muscularity. As the ribeye area increases, the numerical yield grade decreases (moves closer to Yield Grade 1) and the carcass becomes more desirable.

Although USDA has developed a formula for calculating the yield grade, as a practical matter the grader relies upon his or her experience and training to make this determination. However, the grader may check using the formula occasionally when requested to do so. The same process holds true for the USDA grader when determining the USDA Quality Grade.

USDA Yield Grades are “rolled” onto the beef carcass at the same time as the USDA Quality Grade. However, the Yield Grade number placed on the carcass is “rounded down” in all cases by dropping any decimal. Therefore, a calculated Yield Grade of “3.1” for one carcass and one of “3.8” for another would result in both carcasses being rolled as “USDA Yield Grade 3” for marketing purposes.

**Certification**

Although “branding” is an increasingly popular concept in merchandising beef today, it is certainly not a new concept. Decades ago, recognized brands were commonplace, and names such as “Swift Premium” and “Armour Star” reflected a certain level of quality that was both understood and trusted by most consumers.

In today’s increasingly competitive marketplace, however, it is difficult for beef marketers with less recognizable names to introduce branded products that will instill immediate customer confidence. However, by structuring such programs to include elements of federal programs that are both recognized and trusted by customers, the opportunity for success is enhanced.

The Agricultural Marketing Service (AMS) of the U.S. Department of Agriculture (USDA) provides voluntary certification services to assist in the marketing of branded beef programs. This service provides for certification of specific carcass characteristics that are contained within each program’s published requirements. This AMS certification provides confidence throughout the marketing chain that the claims made were substantiated by independent third party oversight. AMS currently has approved certification services for over 40 beef programs, with each beef certification program varying in the level of claims for “quality”.

Foodservice operators can review the descriptions of these certified beef programs to determine if one or more meets their specific needs with the confidence that the USDA has certified the claims made in each program.

For further information on certified beef programs, visit the USDA’s web site at [www.ams.usda.gov/lsg/certprog/certbeef.htm](http://www.ams.usda.gov/lsg/certprog/certbeef.htm)
Aging
“Aging” refers to beef that is held under controlled refrigerated conditions for a period of time in order to maximize the tenderness of the product, and is used most commonly in loin and rib cuts. Aging occurs “postmortem” (after harvesting) as a natural enzymatic process in all muscles, and takes place whether beef is vacuum packaged or is in the form of carcasses or whole cuts.

Two types of postmortem aging are used commercially:

“Dry aging” refers to longer storage of carcasses or beef wholesale cuts at refrigerated temperatures with no protective packaging. It is critical with dry aging to carefully control refrigeration conditions to minimize microbial growth and dehydration losses.

Aging in a refrigerated room at 32 – 34°F and 80-85% relative humidity, with air velocity of 0.5 to 2.5 m/sec, is typical. Dry aging under these conditions is sometimes continued for 21 to 28 days, and may impart a distinct “aged” flavor considered desirable by some consumers.

“Wet aging” refers to storage at refrigerated temperatures in a sealed vacuum packaged bag. While relative humidity and air movement are not factors when wet aging, strict temperature control is important, and should be maintained at 32 - 36°F. Foodservice operators who desire to further age beef received in vacuumed bags in their refrigerators should keep in mind that if they open these bags they are, in effect, “dry aging” the cuts, and should therefore maintain the appropriate dry aging conditions.

Both types of aging have the same effect on tenderness, since the natural enzymes in the muscle continue to break down the connective tissue and enhance meat tenderness in either case.

Wet aging is the typical method of aging beef today. One of the major differences between dry and wet aging is the microbial growth that may occur on the product during dry aging. As might be imagined, prolonged storage in the presence of air (dry aging) creates an excellent environment for bacterial growth and dehydration. Foodservice suppliers can expect to lose 5% to 20% of the product weight because of dehydration and the required trimming of beef cuts if the dry aging procedure is used. Vacuum packaging of beef, on the other hand, minimizes the ability of spoilage bacteria to grow and virtually eliminates trimming losses. Aging beyond 28 days has little benefit in enhancing beef palatability, and, in the case of dry aged product, may be detrimental due to increased microbial and dehydration losses. Aging can also be affected by individual muscle and by USDA Quality Grade.

Research in the past had always been conducted on beef subprimals and not individual muscles. National Cattlemen’s Beef Association on behalf of The Beef Checkoff commissioned researchers at Colorado State University (2006 S. L. Gruber, K. E. Belk, J. D. Tatum, J. A. Scanga, G. C. Smith) to conduct a study to characterize postmortem aging (wet aging) of fresh (never frozen) individual beef muscles of two different quality grades (upper 2/3 USDA Choice and USDA Select). Overall findings of this study suggest that tenderness of cooked beef was affected by individual muscle, USDA Quality Grade and length of aging. In general, USDA Select took longer than USDA Choice (upper 2/3) to complete the majority of all aging response.
To download a copy of the Industry Guide for Beef Aging, visit www.beefresearch.org/FeaturedResearch.htm

**Packer/Processor Enhancements**

Most consumers enjoy beef “just the way it is” – that is, as tender and juicy cooked steaks, roasts or ground beef. Traditional methods of fabricating carcasses into individual steaks and convenient sized roasts and separating more tender from less tender cuts have contributed to great eating experiences for decades.

However, as consumers’ tastes have evolved and our society has been introduced to an ever-growing variety of ethnic cuisines, today’s discerning customer often searches out those establishments that provide a variety of dining options.

To give foodservice operators the opportunity to provide a wider variety of menu options to customers, progressive packers and processors are enhancing beef products at the processing level. By using such prepackaged, ready-to-cook entrees, foodservice establishments can expand menu offerings without extensive modifications to facilities or staff. One popular enhancement is the use of “marinating” technologies. The food industry defines a marinade as “… a mixture in which food is soaked, massaged, tumbled and/or injected to improve taste, tenderness or juiciness, or to impart other sensory attributes, such as color or flavor.” All prepackaged products must disclose on the label the amount of marinade and the ingredients used.

Marination technology incorporates four basic elements: 1) closely trimmed beef, 2) a marinade solution, 3) a marination process and 4) a packaging system. The key difference among various marination processes is the degree of penetration and dispersion of the marinade, the amount of marinade absorbed, and the extent of tenderizing. A processor may use a variety of equipment (injectors, vacuum tumblers, vacuum massagers, etc.) that promote uniform distribution of marinade in beef. An unevenly distributed marinade can result in discoloration, a rubbery texture, pockets of strong flavor and/or uneven cooking.


Primary marinade ingredients increase the meat’s water-holding capacity. Meat proteins, which make up about 20% of beef’s composition, can hold approximately four times their weight in water. Salts and phosphates enhance meat’s ability to hold water. This results in less moisture loss during cooking, thereby increasing the juiciness and perceived tenderness, and can help minimize the impact of overcooking.

Secondary ingredients (e.g., seasonings, sodium lactate, potassium lactate, sodium citrate, etc.) impart specific flavors, visual appeal and can provide extended shelf life. Trendy ethnic cuisines, such as Asian, Caribbean and Nuevo Latino, often influence marinade flavors. Today’s standby marinades, such as lemon pepper and teriyaki, are being joined by chili peppers, cilantro and
other herbs. Care needs to be taken when adding seasonings to beef to complement its flavor. Unlike chicken and pork, beef has a distinct, stand-alone flavor that your customers crave. Successful marinating depends on a balanced formulation and an effective processing technique. The challenge is to avoid certain pitfalls that could ultimately impact foodservice operations.

For example, maximizing water-holding capacity can result in a product with a rubbery texture and/or high sodium content. A rubbery texture can be minimized by incorporating less of certain ingredients (such as phosphates and salt) and by reducing the time and action in mixing and tumbling. This, however, can lower the water-holding capacity, which may result in excess purge. Therefore, the amount of water may also need adjusting.

Citrus flavors, while popular, can also be tricky due to their acidity. The water-holding capacity of beef proteins is best at a neutral pH. If the pH of a marinade is too low, proteins break down rapidly and beef texture may become soft and mushy.

Achieving a consistent marinade is challenging due to the number of variables involved. Water purity, mixing procedures, temperature, treatment process, packaging and batch size affect marinade success. Even the age, moisture content and specific cut of beef can affect product consistency.

The best approach in process development, therefore, includes thorough testing of each specific formulation and process to meet the desired effect of the marinade. Ingredients and processes that optimize the quality of some products may reduce the performance of others. In the final analysis, perfect marinade depends on the desired final product.

Benefits of Commercially Marinated Beef:

- Enhances juiciness and minimizes consequences of overcooking
- Enhances flavor and tenderness
- Improves consistency
- Provides a vehicle for incorporation of flavors and seasonings
- Can be used to incorporate ingredients that increase shelf life

**Dark-Cutting Beef**

Dark-cutting beef is beef with an abnormally dark lean color (see photograph) that is generally the result of reduced glycogen (muscle “sugar”) content in the muscle at the time the animal is harvested. This causes a higher muscle pH (less acid) after the carcass is chilled. This condition most often occurs as a result of excessive animal stress prior to harvest, although other stressful conditions (such as severe weather changes) may also cause dark-cutters.

The dark color caused by this condition can range from barely evident to very dark. A USDA grader may lower the quality grade up to one full grade because of the dark-cutting condition. Although the incidence in steers and heifers is relatively low (about a 2%), it is estimated that dark cutters cost the beef industry over $5 for every fed steer/heifer marketed.
While the color of raw muscle cuts may be aesthetically unacceptable to the eye of the consumer, the “dark-cutting” condition does not affect the eating quality of the cooked lean. Therefore, dark-cutting beef is considered acceptable for many foodservice applications, because the beef appears the same after cooking as “normal” colored beef.

One caution in utilizing dark-cutting beef, however, is that it does not have a shelf-life as long as other beef when it is held fresh or thawed. Therefore, care should be taken to keep it chilled until ready for cooking, and storage time should be kept to a minimum.

**Meat Color**

The color of fresh meat is related to a specific protein in muscles called “myoglobin.” Myoglobin is a protein very similar to hemoglobin, the oxygen-carrying protein in blood. In fact, myoglobin serves as the protein in muscles that receives oxygen from the hemoglobin blood, and makes this oxygen available to the muscle tissues. Myoglobin and hemoglobin are very similar in that each is an iron-containing protein. However, hemoglobin has four times the iron content as myoglobin, which enhances its ability to transport oxygen in the blood throughout the body.

The amount of myoglobin in the muscles of different animals is what gives various meats their distinctive fresh colors. The following illustrates these differences:

Beef muscle that has not been exposed to air (oxygen) is a purplish red color. The foodservice operator will recognize a color change with vacuum packaged beef cuts. In the vacuum bag the color appears to be purple-red. However, once it has been exposed to the air, the color brightens to a bright, cherry-red.

In both cases, the myoglobin in the muscle picks up oxygen from the air (called “oxygenation”) resulting in the bright cherry-red color. This color change is often referred to as “bloom.” Other color changes can also occur to myoglobin in meat. For instance, when fresh meat is exposed to oxygen in the air for a longer period of time (perhaps several days) the surface may change to a “brownish” color. In this case, a chemical change (called “oxidation”) occurs to the myoglobin resulting in the brown surface color. Since these cuts may have been exposed for several days, they may also be susceptible to the onset of microbial spoilage.

Another familiar color change is that associated with meat cookery. Myoglobin, along with other proteins in meat, “denatures” when cooked. As the myoglobin gradually denatures with increasing temperatures, the red color of the lean progressively changes to a browner cooked meat color. The higher the internal temperature of the meat the less red the cooked meat becomes, reflecting the “degree of doneness” of the cooked meat.

Iridescence in raw and cooked beef is a naturally occurring phenomenon that does not affect quality or palatability. It appears as a blue-green or orange-red color in some raw and cooked beef. It’s associated with the interference of light waves reflected off the meat’s surface. Factors such as the beef’s surface texture and color, and the type, wavelength and angle of the light affect the intensity of the iridescence. Smooth meat surfaces may exhibit iridescence more vividly than rough surfaces.
**Beef Color Dynamics**
Sometimes cooked fresh meat remains red on the surface or retains a red interior despite it being fully cooked. A classic example is meatloaf that remains pink in the center even when fully cooked or the appearance of an outside red ring on smoked or grilled meats. While all of the explanations are not known, some scientifically proven causes for this phenomenon are: (1) traces of nitrates in water supplies (when fresh meat comes in contact with this water the nitrate reacts chemically with the fresh meat pigment and results in the formation of the same pigment as when the food processors intentionally adds nitrates to produce cured meats); (2) traces of nitrites and nitrates in vegetable foods (fresh meats cooked in the presence of celery, turnips and other vegetables could be expected to show some red color depending on the soil in which the vegetables were grown and even lack of freshness in the vegetables – as vegetables deteriorate, the nitrate content lessons and more nitrite is formed); and (3) the use of pepper solution (which may contain a trace of natural nitrate). It has also been suggested that the presence of carbon monoxide in heating gases, exhaust gases and furnaces has led to the red ring on cooked meats.