Dark, Firm, and Dry Meat

Ben Borher, Ph.D.
The Ohio State University

Dark, firm, and dry (DFD) meat, or commonly referred to as dark-cutting in beef, refers to a type of meat that has abnormal characteristics in terms of its appearance, texture, and moisture retention properties. This condition is characterized by an above-normal pH (pH above 6.0).

Appearance, Texture, and Moisture Retention

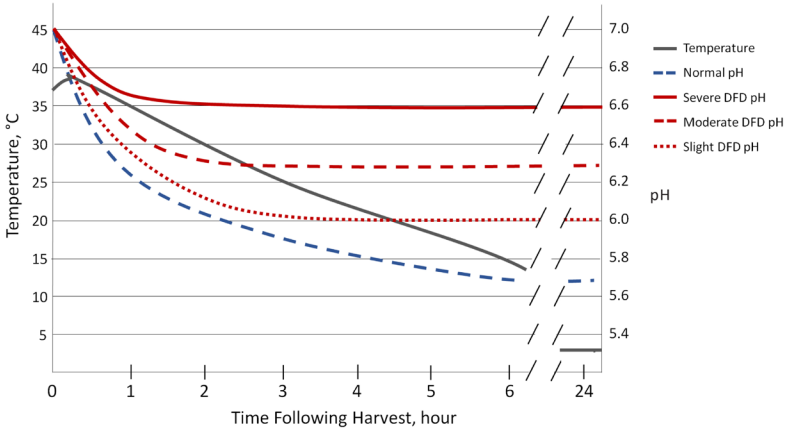
DFD meat appears darker in color than normal meat. For beef, the color is dark red or even purplish rather than the typical bright cherry red. The texture of DFD meat may feel firm and dry. DFD meat has very high water-holding capacity resulting in very little to no purge or drip loss.

Sensory Properties

Sensory properties (tenderness, juiciness, and flavor) of DFD meat are dependent on the severity of DFD, and particularly the pH value. In general, sensory attributes between DFD meat and normal meat are minor and not as significant of a concern as appearance.

Events Leading to DFD Meat

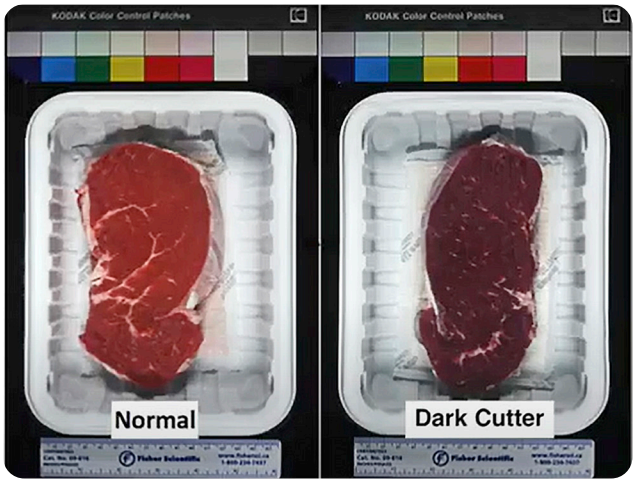
The depletion of muscle glycogen prior to slaughter can be caused by a variety of stressful preslaughter events including moving animals to a new location prior to slaughter, mixing animals with unfamiliar animals prior to slaughter, prolonged withholding of feed and/or water prior to slaughter, transport exhaustion, aggressive or prolonged periods of handling, and climatic stress (and particularly large fluctuations in weather patterns). The replacement of glycogen stores may take several days following a stressful event.



Theoretical post-mortem temperature (gray line) and pH decline of DFD beef longissimus muscle (red lines) compared with normal beef longissimus muscle (blue line).

Shelf Life

DFD meat has greater spoilage potential compared with normal meat due to its high pH (less acidic environment), greater levels of waterholding capacity, and greater levels of surface moisture. DFD meat requires proper handling, refrigeration, and controlled humidity to maintain shelf life.



Representation of DFD beef compared with normal beef. Source: Beef Cattle Research Council of Canada (BCRC) 2017 National Beef Quality Audit Results.

Causes of DFD Meat

Ultimately, DFD meat is caused by less available glycogen (energy reservoirs in the body) at the time of slaughter and less accumulation of hydrogen ions during post-mortem metabolism. Lactic acid is a primary by-product of glycogen utilization in muscle. The buildup of lactic acid in post-mortem muscle is responsible for normal pH decline resulting in pH values of approximately 5.7.

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College of Food, Agricultural, and Environmental Sciences

American Meat Science Association

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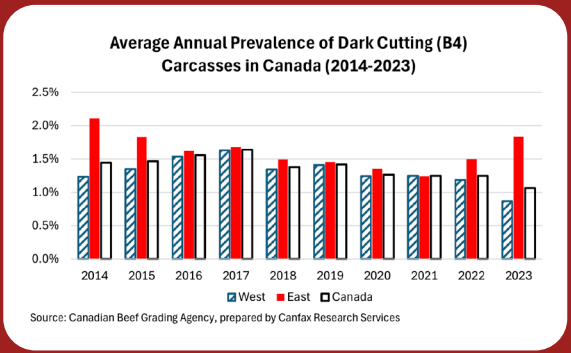
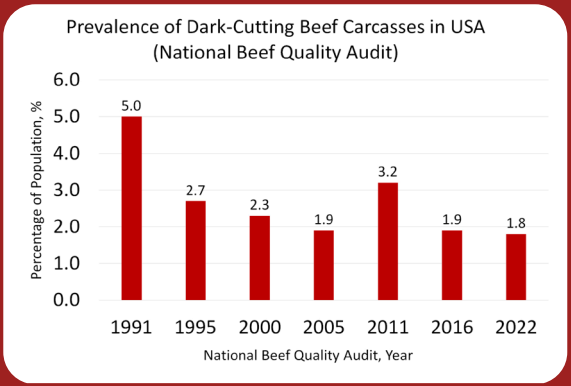
Emerging Research on DFD Meat

Research on DFD meat has focused on a variety of topics throughout the production chain, from farm to consumer. In recent years, notable research from multiple different groups of meat scientists have investigated the interplay between glycolytic and mitochondrial pathways using multi-omic approaches and have concluded that mitochondrial oxygen consumption rate and anaerobic metabolism affecting pH are clearly linked. In addition, applied research investigating strategies to add value to DFD meat such as packaging, storage, and ingredient interventions have been explored.

Despite the known economic implications to the beef industry (estimated at over $200 million to the US beef industry and over $10 million to the Canadian beef industry), the prevalence of dark cutting beef has remained at similar levels over the past several decades, and is consistenly one of the most common meat quality defects affecting the beef industry.



Average annual prevalence of dark-cutting beef carcasses in Canada. Source: Beef Cattle Research Council of Canada.



Prevalence of dark-cutting beef carcasses in USA. Source: National Beef Quality Audit - 1991, 1995, 2000, 2005, 2011, 2016, 2022.

Perspectives from the industry:

Globally, the beef industry manages with theoccurence of dark cutting beef in a variety of different ways. For instance, quality grading systems in the USA discount dark-cutting beef carcasses based on severity [typically ranging from one-third of a quality grade in less-severe instances to a full quality grade in more-severe instances].

According to the National Beef Quality Audit - 2022, 1.8% of steers and heifers were dark-cutters and of those carcasses - 35.4% received a one-third grade discount, 12.4% received a one-half grade discount, 34.3% received a two-third grade discount, and 18.0% received a full-grade discount.

Quality grading systems in Canada have a specific designation for dark-cutting beef (Canada Grade B4) that does not designate severity.

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