

Mechanical Tenderization of Beef

Robert Maddock, Ph.D.

Tenderness is the most important factor affecting consumer ratings of beef. Beef tenderness is affected by two primary factors called background tenderness and protein (muscle fiber) tenderness. Background tenderness is determined by the amount and type of connective tissue in any given cut. For example, brisket is generally very tough unless cooked properly, whereas tenderloin is almost always very tender. One major difference between brisket and tenderloin is the amount and type of connective tissue in each. Brisket has more and tougher connective tissue and tenderloin has less and more tender connective tissue. Protein or muscle fiber tenderness is affected by the strength of the actual meat fibers, which are affected primarily by aging (holding meat in an unfrozen state). Muscle fibers in meat weaken over time due to the action of enzymes, which break apart the fiber, ultimately improving tenderness. Muscle fibers becoming weaker during aging is why steaks aged 14 days are generally more tender than steaks aged 3 days.⁵

Types of Mechanical Tenderization

There are two major types of mechanical tenderization utilized by the beef industry: 1) needle (blade) tenderization and 2) cubing (maceration).³ Beef tenderness also is improved mechanically during processes such as injection (enhancement) and tumbling.⁷ However, for these processes, mechanical improvement in tenderness is secondary to moisture or flavor addition. Other forms of mechanical tenderization have been investigated experimentally but have not been implemented due to cost or lack of effectiveness.¹⁰

Needle (Blade) Tenderization

Needle tenderization utilizes a set of needles or blades which pierce the meat (Figure 1), cutting through muscle fibers and connective tissue and improving tenderness. Needle tenderization can be performed on wholesale cuts such as whole ribeye rolls or shoulder clods, or on individual steak and roasts. Needle tenderization used on wholesale cuts is referred to as “needled” or “needling.” However, when steaks are needle tenderized, the process is often referred to Jaccarding. Jaccard™ is a company that makes needle tenderization devices commonly used in-home and at restaurants (Figure 2).

Figure 1. Rows of needles or blades in a large mechanical tenderizer.

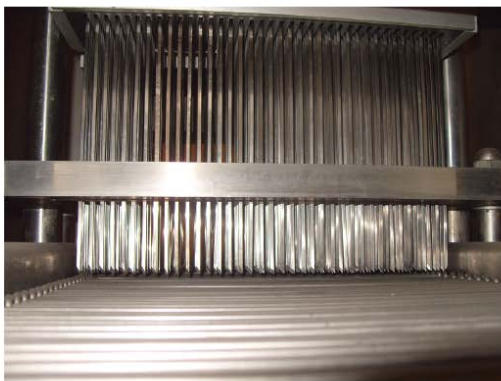


Figure 2. A hand-held tenderizer (Jaccard™).
Photo used by permission.



When beef is mechanically tenderized, desirability ratings for flavor and tenderness of most cuts are greatly improved.^{1, 2,3,5} Without a doubt, needle tenderization can be effectively utilized to reduce the variability and improve the tenderness and palatability of beef cuts. However, like any process, mechanical tenderization must be properly used to ensure the best possible outcome.

Proper use of Needle Tenderization

Needle tenderization of subprimals usually occurs at the processing plant or meat distributor (purveyor) level. The type of equipment used to needle tenderize large cuts is generally large and expensive. Figure 3 shows an example of a needle tenderizing machine. Questions that need be answered about needle tenderization are: 1) What cuts should be needle tenderized; 2) When should a cut be tenderized; 3) What is the proper procedure for mechanically tenderizing beef cuts; and 4) Are there any quality problems that arise from needle tenderization? Each of these questions have been answered through research and industry experience.

Figure 3. A commercial meat tenderizer.



What cuts should be tenderized and how effective is needle tenderization?

Essentially all beef cuts can be needle tenderized, but tougher cuts will have the greatest tenderness improvement. Research has shown needle tenderization improves initial and overall tenderness of the outside round, top sirloin, strip loin, inside round, and chuck tender.^{5,9,12} Needle tenderization decreased the proportion of inside round samples rated tough from 52% to 20%, reduced the

proportion of inside round samples with undesirable flavor from 16% to 0% and reduced the proportion of unpalatable ribeye, inside round, and eye of the round samples from 12% to 0%, 36% to 8% and 80% to 40%, respectively.⁵ Eye of round needle tenderized multiple times was found to have a shear force rating similar to tenderloin.¹² However, taste panels and consumers will not rate mechanically tenderized eye of round steaks as equal to tenderloin. It is apparent that needle tenderization improves tenderness, but inherently tough cuts cannot be made as desirable as tender cuts. Similarly, meat from cow and bull carcasses can be mechanically tenderized with marked improvement in tenderness ratings. However, meat from cow and bull carcasses, even when needle tenderized, may never achieve sensory panel ratings similar to steaks from young heifer and steer carcasses.¹³

When should a cut be tenderized?

Needle tenderization is used on raw product, generally after rigor.⁶ Primal and subprimal cuts can be needle tenderized before or after packaging and aging with equal effectiveness.^{2,9} However, some research has shown that strip loins blade tenderized prior to aging had greater purge

loss, but time of blade tenderization (before or after aging) did not affect retail display life or palatability traits. Blade tenderization increases tenderness above that achieved by aging alone but did not otherwise affect other palatability traits such as flavor or juiciness. Individual steaks can be blade tenderized immediately prior to cooking as there is an instantaneous improvement in tenderness.

Needle tenderization is commonly used to improve the tenderness of beef roasts cooked at a processing plant and intended for restaurant sales.⁷ Blade tenderization prior to injection generally has been found to be beneficial for textural characteristics and improve cook yield, but not influence other properties. Cuts can also be needle tenderized prior to tumbling. Blade tenderization decreased shear values by 15-20% for roasts tumbled for 0 or 2 hours compared to roasts that were not tenderized.⁷

What is the proper procedure for needle tenderizing beef cuts?

Some of the factors that can be controlled during needle tenderization include the number of times a cut is tenderized and the number of times the blade enters the meat. Conveyor speed can be controlled to increase or decrease the number of times needles enter a cut. Slow versus fast conveyor speeds did not affect shear force values of inside round as tenderness improvement was similar between conveyor speeds.¹¹ The number of times that a cut is tenderized is also not especially important. One pass through a blade tenderizer improved tenderness ratings of cooked steaks from the eye of round and tenderloin.¹² Increasing the number of passes through the tenderizer does improve tenderness, but, improvements are marginal and likely not worth the addition time and cost. It appears that one pass through a needle tenderizer at medium to fast conveyor speed is adequate to improve tenderness of most cuts.⁸ A second or third pass through the tenderizer may further improve tenderness but is not generally required.

Are there any quality problems associated with needle tenderization?

Fortunately, needle tenderization has been shown to cause very few problems with quality. Several researchers have evaluated purge loss during packaging, cooking loss, and display life of needle tenderized cuts and have found only small differences.^{2,3,7} In fact, some studies have found improved cooking yields of needle tenderized inside round. There may be a slight increase in purge loss due to needle tenderization, however, the differences are small (< 1%). Display life is also not generally affected by needle tenderization, with minimal differences found in fresh color during display.

Cubing (Maceration) and Pounding

Cubing and pounding are very effective methods of improving the tenderness of beef steaks. Cubing utilizes small blades on rollers and results in the surface of the steak being completely macerated, causing a complete change in the look and texture of the steak. Cubing is only useful for steaks because the type of equipment used for cubing can only process steaks. Cubing of beef is often done to very tough cuts such as inside round steak, but it is also used for knuckle steaks, chuck tender steaks and others. Cubing is often done at retail as the disruption of the surface results in a diminished display life. Small meat shops may cube round steaks and then freeze them. Cubing is used when making products such as Swiss steak or chicken-fried steak. Cubing is not appropriate for tender cuts such as ribeyes, tenderloins, and many value cuts. Pounding accomplishes the same result as cubing but is usually only done at home using a meat hammer.

Safety of Mechanically Tenderized Beef

Steaks and roasts are considered to have fewer food safety concerns than ground beef because contamination is on the surface and will be destroyed during cooking. However, mechanically tenderized beef changes that dynamic as it is possible bacterial contamination on the surface can be introduced into the center of the cut.⁴ Therefore, it is important to consider food safety issues when mechanically tenderizing beef because there have been disease outbreaks associated with mechanically tenderized beef. In May 2005, USDA-Food Safety Inspecting Service required that processors who produce mechanically tenderized beef reevaluate their HACCP plans for *Escherichia coli* O157:H7.

Thankfully, many researchers have investigated the impact of mechanical tenderization on beef safety. The Beef Industry Food Safety Council has developed best practice guidelines to limit possible bacterial contamination (<http://www.bifsc.org>).

Key points of focus when producing non-intact products include raw material control, sanitation, cold chain management and packaging. A summary report of the Non-intact Product Processing Workshop, funded by The Beef Checkoff, is available at <http://www.bifsc.org/Meetings.aspx>. The meeting brought together researchers, industry and government representatives to discuss research, regulation and risks associated with producing non-intact beef products. This document summarizes the group discussion and outlines research gaps identified during the meeting. Enhancing the safety of beef products is a priority for the U.S. beef industry and resources will be directed to improving the systems used to produce non-intact beef products.

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