Kansas Agricultural Experiment Station Research Reports

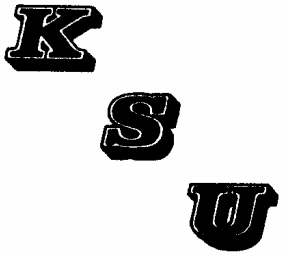
Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 1191

1980

Application and potential of electrical stimulation (1980)

Curtis L. Kastner



Application and Potential of Electrical Stimulation

Curtis L. Kastner

Background

It has been known for years that electrical stimulation will improve tenderness of meat, but the technique only recently has gained considerable interest in the meat industry.

Benjamin Franklin in 1749 observed that killing turkeys electrically made the muscle quite tender. In 1951, Harsham and Deatherage and Rentschler gained separate patents for tenderizing carcasses with electrical stimulation. Tenderness was the most obvious change stemming from electrical stimulation. However, research efforts in New Zealand, England, and the United States have recently attributed other important results to the technique.

Primary Benefits

Besides improving tenderness, electrical stimulation increases lean firmness and color brightness, speeds marbling development, and facilitates hot boning.

Stimulation Methodology

A variety of different methods have been and are being used to stimulate beef and lamb carcasses for research or for industry applications. Both carcass halves and intact carcasses are stimulated. Normally intact carcasses are used commercially, and the electrical stimulus is administered near the hindshank and neck region. Electrical contact may be achieved by inserting probes in the carcass, or with surface contacts. Voltages have ranged from 40 to 3000 volts, and a variety of amperages, frequencies, on-off pulsing techniques, square versus sine waves, AC versus DC current, and stimulation times have been studied. Stimulation times from 1 to 2 minutes normally are used. The optimum combination of these conditions has not been determined. Even so, electrical stimulation has proved more or less effective with most combinations, and best results have been achieved by stimulating within 1 hour after slaughter. Usually the sooner after slaughter, the more dramatic the effects. Not all muscles are affected equally by carcass stimulation. Some muscles may not be stimulated to the same extent as others or are not as responsive to electrical stimuli. Therefore, results based on only a few muscles may not be indicative of how the total carcass responds. The following results should be evaluated with this in mind.

Primary Causes of Benefits

Electrical stimulation speeds the onset of rigor mortis (carcass stiffening) by rapidly depleting the residual energy in the muscle after slaughter. As a result, the acidity of the muscle is rapidly increased compared with nonstimulated muscles. The ultimate acidity is not increased over that of nonstimulated muscle, but acid accumulates faster. It is thought that the relatively rapid onset of rigor mortis, acid accumulation, and intense muscle contraction during stimulation cause the results attributed to electrical stimulation.

Specific Benefits

Tenderness

Rapid chilling of carcasses after slaughter is used to control microorganisms and prepare carcasses for conventional grading and cutting. However, when muscle is chilled too rapidly before the onset of rigor mortis, muscle may be toughened by a condition called cold shortening. It is not uncommon for normal chilling practices to be sufficiently rapid to cause cold shortening, which occurs most frequently in carcasses with little fat cover.

Electrical stimulation speeds rigor onset so cold shortening effects are minimized or eliminated; thus tenderness is improved. The rapid accumulation of acid in stimulated muscle appears to accelerate the aging process and reduce the aging time needed to insure tenderness. For example, strip loins from electrically stimulated carcasses are as tender after 7 days' aging as nonstimulated strip loins are after 21 days. Additionally, severe contraction during stimulation may physically disrupt the muscle and improve tenderness. Connective tissue may be made more susceptible to breakdown upon heating, and the muscle proteins responsible for rigor mortis may be more loosely bound together after electrical stimulation.

Therefore, these proposed mechanisms of tenderization either singularly or collectively account for a 20 to 30% improvement in beef muscle tenderness when compared with that of nonstimulated muscle. Muscle that is already tender is improved very little, but less tender muscle is significantly tenderized. Consequently, wide variation in tenderness (frequently experienced) is reduced.

Most recent research results have been obtained on beef carcasses; however, the effects of electrical stimulation have also been demonstrated with lamb.

Color and Marbling

Electrical stimulation causes the desirable color of beef muscle to develop more rapidly and be brighter at 48 hours after slaughter compared with nonstimulated muscle. This minimizes the regrading of beef carcasses that may have to be held additional time to allow desirable color development. Rapid color development and increased muscle firmness due to stimu-

lation appear to make muscle marbling more apparent sooner after slaughter, which reduces time required between slaughter and grading.

Color and apparent marbling differences between stimulated and non-stimulated beef muscle may be minimized as the time after slaughter increases (exceeding 48 hours). But a processor who wants to grade beef carcasses before 48 hours may obtain a higher percentage (up to 14 percent in one study) of higher grading carcasses by using electrical stimulation.

Hot Boning

Recent studies here in conjunction with the Departments of Agricultural Economics and Agricultural Engineering showed hot boning beef carcasses to be an economically advantageous process when energy, labor, and other resources are considered. Savings due to hot processing amounted to $2.75 per carcass (energy 34¢, materials and supplies 3¢, labor $1.67, interest on fixed capital 49¢, and interest on inventory 21¢ per head). These savings would contribute significantly to the overall profit picture of processors.

Hot boning, or cutting the carcass before chilling, has proved successful when certain precautions are observed. But, cutting carcasses prior to the onset of rigor mortis can result in a less tender product. So, early successful hot-boning involved holding the carcass 5 to 8 hours postmortem to allow rigor onset before cutting, or aging cuts removed at 1 to 2 hours postmortem for 8 days at refrigeration temperatures or for 24 to 48 hours at 60 F to minimize tenderness problems associated with pre-rigor cutting. Such practices do not necessarily facilitate the continuous flow of product, so electrical stimulation can be used to speed rigor mortis onset and allow carcasses to be hot boned without holding and aging periods.

We are continuing to evaluate electrical stimulation as a complement to hot boning. Our research shows that all beef muscles do not respond equally to our electrical stimulation and hot boning methodology when compared to conventionally treated carcasses. However, none of our samples were rated as unacceptable. We hope to determine the electrical stimulation methods needed to optimize hot-boned beef quality.

Industry Applications and Considerations

An estimated 15,000 beef carcasses are electrically stimulated daily in the United States with products being marketed under various brand names as: Good and Tender, Electro Tenderaged, Trueth Tender, Electrolit, and Electro Tender. Companies like Le Fiell, Britton Manufacturing, Koch, Cervin Manufacturing, and Omeco St. John Company produce commercial stimulators ranging from $10,000 to $40,000 per unit that will handle up to 250 beef carcasses per hour, so the practice likely will increase.

Cost of operation is approximately 0.3 cent per carcass; however, other costs must be considered. Operator labor, cost of the stimulator, sanitation, and space are other cost factors. The units are relatively simple to maintain, and some of the more expensive ones are automated, requiring no operator.

Because of increased industry use of electrical stimulation, USDA has established guidelines to insure employee safety and product wholesomeness. Extreme caution should be used, especially when high voltages and amperages are being used.

Summary

Electrical stimulation offers several potential benefits to the meat processor. The technique can be easily adapted to operations where only a few cattle per day or per week are slaughtered.

With electrical stimulation, the occasional less tender carcass may be avoided, tenderness is more uniform, aging time to insure tenderness may be significantly decreased, and the time between slaughter and grading and cutting can be significantly reduced yet product quality maintained. In addition, electrical stimulation may be used to insure the tenderness of beef from carcasses with little exterior fat cover. Producers may be interested in feeding cattle for shorter periods of time or producing cattle that reach desirable slaughter weights yet have minimum fat cover. Electrical stimulation can be used to maximize product tenderness for beef resulting from these production practices. Therefore, electrical stimulation can give the producer greater latitude in using alternative management systems and cattle types.

Electrical Stimulation of Beef Carcasses

When beef carcasses are electrically stimulated soon after slaughter, the resulting muscle contractions cause some of the chemical energy in the muscle to be used up. Rigor occurs much faster; tenderness, color, firmness, and quality grade are improved; and aging time decreases. Largest improvements are in lower grading carcasses with less fat cover or in carcasses that are "hot boned" without conventional chilling. Nationally, about 15,000 carcasses per day are stimulated, and the practice will probably increase.