SINGULAR AND COMBINED METHODS FOR INCREASING TENDERNESS OF BEEF

G.C. Smith, Z.L. Carpenter, T.R. Dutson and R.L. Hostetler

Texas and University College Station, Texas 77843 U.S.A.

Muscles from 42 forage-fed steers were used to determine singular and combined effects of electrical stimulation /ES/, delayed chilling /DC/ and pelvic suspension /PS/ of sides, cooler aging /CA/ of wholesale loins, and blade tenderization /BT/ of wholesale loins and top rounds on palatability and cooking loss of loin and top round steaks. ES or PS /used singularly/ increased /P<.05/ tenderness and decreased /P<.05/ shear force of loin steaks, compared to steaks from untreated /control/ sides or cuts. Maximum tenderization of the longissimus muscle was achieved by either ES or DC of sides, followed by CA and BT of shortloins. None of the initial tenderization treatments /ES; DC; or PS/ used singularly, enhanced the tenderness of the semimembranosus muscle; however, combined treatments--ES, PS; PS, DC; ES, DC, PS--of sides, and use of BT /in combination with PS; ES, PS; PS, DC; or ES, DC, PS/ of the wholesale cut increased /P<.05/ tenderness and decreased /P<.05/ shear force of top round steaks. Maximum tenderization of the semimembranosus muscle was achieved by ES, PS, DC of the side followed by BT of the top round.

Einzelne und Kombinierte Methoden zur Erhöhung der Zartheit von Rindfleisch

G.C Smith, Z.L. Carpenter, T.R. Dutson und R.L. Hostetler

Texas and University College Station, Texas 77843 U.S.A.

Muskeln von 42 stallgejütterten Jungstieren wurden benutzt, um einzelne und kombinierte Effekte von elektrischer Stimulierung /ES/, verzögerter Kühlung /DC/ und Beckenaufhängung /PS/ der Seitenstücke, Kühlerabhängung /CA/ von Grosshandelslendenstücken und Blattzartmachung /BT/ von Grosshandelslenden und Mittelstücken auf die Schmackhaftigkeit und Kochverluste von Lenden- und Rundsteaks zu bestimmen. ES and PS /isoliert angewendet/ erhöhte /P<.05/ die Zartheit und verminderte /P<.05/ die Scherkraft von Lendensteaks, verglichen mit steaks von unbehandelten Seiten oder Stücken /zur Kontrolle/. Eine maximale Zartmachung des longissimus-Muskels wurde erreicht durch ES oder DC von Seitenstücken, gefolgt von CA and BT von Kurzlenden. Keine der anfänglichen Zartmachungsbehandlungen /ES; DC; oder PS/ erhöhte einzeln die Zartheit des semimembranosus- Muskels; kombinierte Behandlung jedoch--ES, PS, DC; ES, DC, PS-- von Steiten und die Benutzung von BT /kombiniert mit PS; ES, PS; PS, DC; oder ES, DC, PS/ des Grosshandelsstückes erhöhte /P<.05/ die Zartheit und verminderte /P<.05/ die Scherkraft von Spitzen-Rundsteaks. Eine maximale Zartheit des semimembranosus -Muskels wurde erreicht durch ES, PS, DC der Seite, gefolgt von BT des Mittelstückes.

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Des Methodes Simples et Combinés pour Augmenter la Tendreté de Boeuf

G.C. Smith, Z.L. Carpenter, T.R. Dutson et R.L. Hostetler

Texas and University College Station, Texas 77843 U.S.A.

Des muscles de 42 jeunes boeufs élevés au fourrage ont été employés pour déterminer des effets simples et combinés de la stimulation électrique /ES/, d'une réfrigération retardée /DC/ et d'une suspension pelvienne des côtes /PS/, du murissage réfrigéré /CA/ des faux-filets vendus en gros, et de l'adoucissement de lame /BT/ des faux-filets et sous-noix vendus en gros sur le degré du goût et les pertes par la cuisson des steaks de faux-filet et de cous-noix. ES ou PS /employé séparement/ augmentaient /P<.05/ la tendreté et diminuaient /P<.05 la force de coupure de steaks faux-filet, comparé aux steaks pris des côtes ou morceaux non-traites /de contrôle/. Une tendreté maximale du muscle longissimus était accomplie par ES ou DC des côtes, suivie par CA et BT des faux-filets courts. Aucun des premiers traitements d'adoucissement /ES; DC; ou PS/ employés séparement augmentait la tendreté du muscle semimembranosus; par contre, des traitements combines --ES, PS; PS, DC; ES, DC, PS--des côtes et l'emploi de BT /combine avec PS; ES; PS; PS, DC; ou ES, DC, PS/ du morceau vendu en gros augmentait /P<.05/ la tendreté et diminuait /P<.05/ la force de coupure de steaks sous-noix. Une tendreté maximale du muscle semimembranosus était accomplie par ES, PS, DC des côtes suvi par BT du sous-noix.

Единичные и комбинированные методы улучшения обмягчения говядины

Г.Ц.ШМИТ, З.Л.КАРПЕНТЕР, Т.Р.ДУТСОН и Р.Л.ГОСТЕТЛЕР

Техаский А и М Университет, Колледж Стейшен Техас 77843 США

Употребляли мускулы 42 выдержанных на подножном корму быков, чтобы найти единичные и комбинированные эффекты электрической стимуляции (ES), замедленного охлаждения (DC), подвешания тазовых (PS) боков, выдержки в охладителе (CA) и обмягчение клинками (BT) оптовых филейных частей и верхних круглых бифштексов на приятность вкуса и на убыток при их варении. ES или PS употребляемые единично увеличили (P < .05) обмягчение и уменьшили (P < .05) силу среза филейных частей, по сравнению с бифштексами из необработанного мяса. Максимальное обмягчение мускула longissimus было приобретено с ES или с DC боков. Вторым были CA и BT филейных частей. Никакие из первых процессов с целью обмягчения (ES ;DC ; илиPS) употребляемые единично не повысили обмягчения мускула semimembranosus Но, когда комбинировалисьES иPS ; PS и DC ;ES , DC и PS боков, и когда употреблялось BT (вместе с PS ; с ES и PS ; PS и DC ;ES , DC иPS) на оптовых отрезках, тогда обмягчение возросло (P < .05) и уменьшилась (P < .05) сила среза верхних круглых бифштексов. Максимум обмягчения мускула semimembranosusбыло приобретено с ES , PS , DC боков вместе с BT на верхних круглых бифштексов.

SINGULAR AND COMBINED METHODS FOR INCREASING TENDERNESS OF BEEF

G.C.Smith, Z.L.Carpenter, T.R.Dutson and R.I.Hostetler

Texas A M University College Station, Texas 77843 U.S.A.

Wanderstock and Miller /1948/ reported that grass-fed beef was lower in quality, less tender, less fat /externally and internally/ and more yellow in fat color than grain-fed beef. Bowling et al./1977/ reported that grain-fed beef is more tender, more desirable in flavor and more palatable than is forage-fed beef. Tenderization techniques useful for beef include: electrical stimulation /Savell et al.1977/, delayed chilling /Fields et al., 1976/, pelvic suspension /Hostetler et al.,1975/, cooler aging /Smith et al.,1978/ and blade tenderization /Seideman et al.,1977/. The present study determined effects of tenderization techniques on palatability of steaks from forage-fed cattle.

Experimental procedure

One side of 42 forage-fed steer carcasses received 1, 2 or 3 treatments / ES, PS, DC /; the opposite sides served as untreated controls.

Electrical Stimulation. Within 1 hr postmortem, sides were given 50 impulses of 440 volts, 5 amps /50 cycles/sec/ using an "Electro-Sting" stunner for 2 min.

Pelvic Suspension. Sides were suspended via the obturator foramen.

Delayed Chilling. Sides were chilled at 21°C for 8 hr postmortem, then placed in a 1°C cooler with the control /untreated/ sides.

Cooler Aging. Unwrapped shortloins were stored at 1°C for 14 days.

Blade Tenderization. Top rounds were tenderized twice, shortloins were tenderized once using a Ross Meat Tenderizer /Model TC-700/.

Carcass Shrinkage. Sides were weighed at 1, 24 and 48 hr postmortem.

pH and Temperature Decline. Temperature and pH of longissimus from every side were monitored at 1, 3, 6, 12, 24 and 48 hr postmortem.

Carcass Evaluation. U.S.D.A. grades were assigned to each side.

Steak and Muscle Samples. Samples were removed /60 hr postmortem/, wrapped in polyethylene-coated freezer paper and frozen-stored at -18°C.

Sensory Panel Evaluation and Warner-Bratzler Shear Values. Thawed /24 hr at 1°C/ steaks were cooked to 70°C in a 177°C oven. A trained sensory panel / 8 members / evaluated palatability; 4 to 6 cores /1.27 cm/ per steak were sheared.

Proximate Analysis and Water Holding Capacity. Longissimus muscle /13th rib/ was frozen /LN_2/ and powdered /Waring Blendor/; moisture /24 hr, 102°C oven-drying/ and fat / 8 hr, ether extraction/ were determined. Longissimus muscle was pressed at 281 kg/sq cm for 5 min to measure water holding capacity.

Sarcomere Lenght. Longissimus muscle was homogenized /10 sec/ in o.25 M sucrose; 10 sarcomeres in each of 25 myofibrils were measured.

Statistical Analyses. Analysis of the data was accomplished using analysis of variance, paired-t analysis and multiple range tests.

RESULTS AND DISCUSSION

There were no /$P < .05$/ differences among the seven initial treatment groups in slaughter weight, dressing percentage, U.S.D.A. yield or quality grades. Control and treated sides did not /$P < .05$/ differ in: /a/ carcass or longissimus quality characteristics, /b/ longissimus moisture or fat, and /c/ with one exception, carcass shrinkage. Sarcomere lenght was increased by ES; PS; DC; ES, PS; ES, DC; PS, DC and ES, PS, DC; results agree with Chrystall /1976/ for ES, Hostetler et al./1975/ for PS, and Fields et al./1976/ for DC, but do not agree with Savell et al. /1977/ for ES or Hostetler et al./1975/ for DC.

Temperature decline was lessened by use of DC; ES, DC; PS, DC; and ES, PS, DC at 3, 5 and 12 hr postmortem, but was not affected by ES; PS; or ES, PS. Temperature of longissimus at 24 or 48 hr postmortem was not affected by treatment. Longissimus pH was lower /P < .05/ than that for control sides in sides treated by ES /1, 3, 6, 12, 24 hr/; DC /3, 6, 48hr/; ES, PS /1, 3, 6 hr/; ES, DC /1, 3, 6, 12 hr/; PS, DC /3, 6, 24 hr/; and ES, PS, DC /1, 3, 6, 12 hr/. Accelerated pH decline has been reported in response to ES /Chrystall, 1976; Smith et al., 1979/ and DC /Fields et al., 1976/.

With one exception, neither flavor nor juiciness ratings for loin steaks and top round steaks were affected /P> .05/ by any of the treatments. Use of tenderization techniques did not increase cooking loss or decrease water holding capacity.

Amount of organoleptically detectable connective tissue /Table 1/ in loin steaks was reduced /P< .05/ when ES; PS; ES, DC; ES, PS; PS, DC; or ES, DC, PS were used alone, with CA, with CA, with BT, or with both CA and BT. ES; DC; and PS did not decrease connective tissue amount in top round steaks /Table 2/, but ES, PS; PS, DC; and ES, DC, PS did/P < .05/ Amount of connective tissue was further decreased /P< .05/ by BT in ES; DC; ES, PS; and PS, DC in round steaks. Savell et al./1977, 1978/, Smith et al./1979/, Hostetler et al. /1975/ and Seideman et al./1977/ have reported that ES; PS; DC; or BT decrease organoleptically detectable connective tissue in cooked beef.

Tenderness ratings for loin steaks /Table 1/ were improved /P < .05/ when sides were given ES; PS; ES, DC; ES, PS; PS, DC; and ES, DC, PS initial treatments; further tenderness increases /P < .05/ were achived with BT of DC sides and with CA and BT of DC; PS; and ES, PS sides. Tenderness ratings for top round steaks /Table 2/ were improved /P < .05/ when sides were given ES,PS; PS, DC; and ES, DC, PS initial treatments; further tenderness increases /P< .05/ were evident for ES; DC; ES, PS; and PS, DC sides. Loin steaks /Table 1/ from sides given ES; PS; ES, DC; ES, PS; PS, DC; and ES, DC, PS had lower /P< .05/ shear force values than steaks from untreated sides; futher shear force reduction was achieved /P < .05/ by use of both CA and BT with ES; DC; PS; and ES, PS sides. Top round steaks /Table 2/ from ES, PS;PS, DC; and ES, DC, PS sides had lower /P < .05/ shear values than steaks from untreated sides; BT further reduced shear force for PS, DC sides. Hostetler et al./1975/, Fields et al./1976/, Smith et al./1978/, Seideman et al./1977/ and Savell et al./1978/ have reported that ES; PS; DC; CA; and BT increase beef tenderness.

Overall palatability ratings for loin steaks /Table 1/ were improved /P<.05/ by use of PS; ES, DC;ES, PS; PS, DC; or ES, DC, PS; further increases /P < .05/ in overall palatability were achieved by CA and BT of DC sides. Top round steaks /Table 2/ were improved /P< .05/ in overall palatability by use of PS, DC or ES, DC, PS; further increases /P < .05/ attributable to BT were evident for steaks from ES; DC; and ES, DC sides.

Cooking losses for both loin and top round steaks /Table 3/ were decreased /P < .05/ by use of CA; BT; or CA, BT; juiciness ratings did not change /P< .05/ when cuts were CA and/or BT. Cooler aging increased /P< .05/ tenderness and overall palatability and decreased /P< .05/ amount of connective tissue and shear force for loin steaks. Blade tenderization increased /P < .05/ tenderness and overall palatability and decreased/P < .05/ amount of connective tissue and shear values for both loin and top round steaks. For loin steaks, tenderness was improved by about 25% by CA, 22% by BT and 66% by CA plus BT illustrating the additive effects of CA and BT on beef tenderness.

Further analyses of all data /not presented in tabular form/ revealed that maximum tenderization of loin steaks was achieved by use of ES, CA, BT or by use of DC, CA, BT. Maximum tenderization of top round steaks was achieved by use of ES, PS, DC, BT.

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Table 3. Effects of secondary tenderization treatments on cooking loss, shear force and palatability ratings for loin and top round steaks.

Trait	Loin steak[e]				Top round steak[e]	
	Untreated	Secondary treatment			Untreated	Secondary treatment
		CA	BT	CA,BT		BT
Cooking loss, %	24.5[a]	21.9[c]	23.8[bc]	23.6[bc]	31.2[a]	28.5[b]
Flavor rating[d]	5.0[a]	5.0[a]	5.0[a]	5.3[b]	4.4[a]	4.7[b]
Juiciness rating[d]	5.1[a]	5.0[a]	5.0[a]	4.8[a]	4.0[a]	4.2[a]
Tenderness rating[d]	3.5[a]	4.6[b]	4.6[b]	6.4[c]	3.6[a]	4.8[b]
Connective tissue rating[d]	4.6[a]	5.3[b]	5.2[b]	6.6[c]	4.0[a]	4.9[b]
Shear force value, kg	7.0[a]	5.0[b]	5.4[b]	3.0[c]	5.5[a]	4.1[b]
Overall palatability rating[d]	3.9[a]	4.5[b]	4.5[b]	5.4[c]	3.6[a]	4.5[b]

[abc]Means in the same row and for the same kind of steak, bearing a common superscript letter do not differ (P>.05).

[d]Means based on 8-point rating scales, 8 = extremely desirable, extremely juicy, extremely tender, none and extremely desirable for flavor, juiciness, tenderness, amount of connective tissue and overall palatability, respectively.

[e]CA = cooler aging, BT = blade tenderization.

Table 1. Effects of tenderization techniques on palatability traits of loin steaks

Trait	Treatment[e]	Loin steak[f]				
		Untreated	Initial treatment alone	Initial treatment plus CA[g]	Initial treatment plus BT[g]	Initial treatment plus CA,BT[g]
Connective tissue rating	ES	4.1[a]	5.3[bc]	5.9[cd]	5.8[bcd]	6.7[d]
Connective tissue rating	DC	4.7[a]	4.5[a]	5.1[ab]	5.6[bc]	6.2[c]
Connective tissue rating	PS	4.7[a]	6.0[b]	6.5[b]	6.4[b]	7.0[b]
Connective tissue rating	ES, DC	4.4[a]	6.1[b]	6.4[b]	6.5[b]	6.7[b]
Connective tissue rating	ES, PS	4.9[a]	5.8[bc]	6.6[dc]	6.4[bcd]	6.9[d]
Connective tissue rating	PS, DC	5.2[a]	6.1[b]	6.3[b]	6.2[b]	6.4[b]
Connective tissue rating	ES, DC, PS	4.5[a]	6.2[b]	6.4[b]	6.3[b]	6.6[b]
Tenderness rating	ES	3.1[a]	4.8[b]	5.4[b]	5.3[b]	6.5[b]
Tenderness rating	DC	3.6[a]	4.0[a]	4.5[ab]	5.0[b]	6.1[c]
Tenderness rating	PS	3.8[a]	5.6[bc]	6.3[dc]	5.9[bc]	7.1[d]
Tenderness rating	ES, DC	3.5[a]	5.7[b]	5.8[b]	6.4[b]	6.6[b]
Tenderness rating	ES, PS	3.7[a]	5.5[bc]	6.2[dc]	5.8[bc]	6.9[d]
Tenderness rating	PS, DC	4.2[a]	5.5[b]	6.1[b]	6.1[b]	6.2[b]
Tenderness rating	ES, DC, PS	2.9[a]	5.6[b]	6.2[b]	5.9[b]	6.3[b]
Shear force, kg	ES	7.8[a]	4.6[c]	3.6[bc]	4.4[b]	2.3[c]
Shear force, kg	DC	7.9[a]	6.6[ab]	5.4[b]	5.0[b]	2.9[c]
Shear force, kg	PS	6.2[a]	4.5[b]	3.8[b]	3.8[b]	2.6[c]
Shear force, kg	ES, DC	7.0[a]	4.1[b]	3.6[b]	3.0[b]	2.7[b]
Shear force, kg	ES, PS	6.9[a]	4.1[b]	3.4[bc]	3.5[bc]	2.4[c]
Shear force, kg	PS, DC	5.9[a]	4.3[b]	4.4[b]	3.8[b]	3.5[b]
Shear force, kg	ES, DC, PS	7.5[a]	4.6[b]	4.2[b]	3.8[b]	3.3[b]
Palatability rating	ES	3.7[a]	4.5[ab]	4.7[ab]	5.0[b]	5.0[b]
Palatability rating	DC	4.0[a]	4.3[ab]	4.5[abc]	5.0[bc]	5.3[c]
Palatability rating	PS	4.0[a]	5.4[b]	5.4[b]	5.3[b]	6.1[b]
Palatability rating	ES, DC	3.9[a]	5.4[b]	5.1[b]	5.5[b]	5.1[b]
Palatability rating	ES, PS	4.1[a]	5.4[b]	5.5[b]	5.3[b]	5.5[b]
Palatability raring	PS, DC	4.3[a]	5.2[b]	5.2[b]	5.3[b]	5.4[b]
Palatability rating	ES, DC, PS	3.4[a]	5.0[b]	5.2[b]	5.5[b]	5.2[b]

[abcd] Means in the same row, and for the same trait, bearing a common superscript letter do not differ /P > .05/

[e] ES= electrical stimulation, DC= delayed chilling, PS= pelvic suspension

[f] Mean values based on 8-point scales /8=none, extremely tender and extremely desirable for connective tissue, tenderness and palatability, respectively; mean values for shear force are kg required to shear 1.27 cm cores

[g] CA= cooler aging, BT = blade tenderization.

Table 2. Effects of tenderization techniques on palatability traits of top round steaks

Trait	Treatment[d]	Top round steak[f]		
		Untreated	Initial treatment alone	Initial treatment plus BT[g]
Connective tissue rating	ES	4.0[a]	4.3[a]	5.2[b]
Connective tissue rating	DC	3.5[a]	3.9[a]	5.1[b]
Connective tissue rating	PS	4.4[a]	4.9[a]	5.5[a]
Connective tissue rating	ES,DC	4.2[a]	4.6[a]	6.1[a]
Connective tissue rating	ES,PS	4.1[a]	5.0[b]	5.8[c]
Connectiva tissue rating	PS, DC	4.1[a]	5.2[b]	6.2[c]
Connective tissue rating	ES,DC,PS	4.1[a]	5.2[b]	5.6[b]
Tenderness rating	ES,	3.5[a]	3.7[a]	5.2[b]
Tenderness rating	DC	3.1[a]	3.3[a]	4.8[b]
Tenderness rating	PS	3.8[a]	4.8[ab]	5.6[b]
Tenderness rating	ES,DC	3.9[a]	4.0[a]	4.8[a]
Tenderness rating	ES,PS	3.7[a]	4.7[b]	5.5[c]
Tenderness rating	PS,DC	3.6[a]	4.9[b]	6.0[c]
Tenderness rating	ES,DC,PS	3.4[a]	5.0[b]	5.6[b]
Shear force, kg	ES	5.6[a]	4.7[a]	4.0[a]
Shear force, kg	DC	5.6[a]	5.3[a]	4.6[a]
Shear force, kg	PS	5.3[a]	4.7[ab]	3.5[b]
Shear force, kg	ES,DC	5.1[a]	5.2[a]	4.3[a]
Shear force, kg	ES, PS	5.4[a]	4.2[b]	3.3[b]
Shear force, kg	PS,DC	4.9[a]	4.2[b]	3.2[c]
Shear force, kg	ES,DC,PS	6.9[a]	4.5[b]	3.7[b]
Palatability rating	ES	3.6[a]	3.7[a]	4.7[b]
Palatability rating	DC	3.2[a]	3.4[a]	4.4[b]
Palatability rating	PS	3.5[a]	4.2[a]	4.6[a]
Palatability rating	ES,DC	4.0[a]	3.8[a]	4.5[b]
Palatability rating	ES,PS	3.7[a]	4.2[ab]	4.7[b]
Palatability rating	PS,DC	3.7[a]	4.5[b]	5.0[b]
Palatability rating	ES,DC,PS	3.5[a]	4.5[b]	4.9[b]

[abc] Means in the same row, and for the same trait, bearing a common superscript letter do not differ /P<.05/.

[d] ES = electrical stimulation, DC = delayed chilling, PS = pelvic suspension.

[e] Mean values based on 8-point scales /8= none, extremely tender and extremely desirable for connective tissue, tenderness and palatability, respectively/; mean values for shear force are kg required to shear 1.27 cm cores.

[f] BT = blade tenderization.