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Impact of Castration and Zeranol Implants on Bullocks: II. Organoleptic and Instrument Assessment of Tenderness

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Abstract: The effects of Zeranol and castration on organoleptic and mechanically assessed tenderness were studied using the 193 young beef cattle described in the companion paper (Impact of castration and zeranol implants on bullocks: I. Behavior, growth and carcass traits). Sensory panel evaluations showed that steaks from control and implanted steer carcasses had higher mean scores for tenderness, juiciness, flavor and overall palatability than those from control and implanted bulls. Implanting did not influence juiciness or flavor within the bull or steer groups, but control bulls and steers were significantly (P<.005) more tender and more palatable overall than were implanted bulls and steers. When comparing the mechanical measurements there was considerable variation among the instruments. The Armour tenderometer™ ranked meat from the implanted steers significantly tougher than either the control or implanted bulls. The Warner-Bratzler™ shear, Krammer™ shear and Instron Press™ ranked steaks from steers significantly more tender than those from bulls. Implanted and control groups of animals were similar in tenderness when judged by the mechanical measurements. Behavior and palatability characteristics of implanted and control bulls and steers were also studied. Implantation made bulls and steers more docile. The libido measurements were also lower for the implanted bulls and steers. Within group of implanted bulls and steers those that were least aggressive tended to be more tender than their more aggressive counterparts.

Key words: Beef Cattle, Castration, Implants, Tenderness

Introduction

Lamm *et al.*, 1980, Ford and Gregory *et al.*, 1983 and Vanderwert *et al.*, 1984 reported no difference in sensory evaluation traits between bulls and steers. In contrast, Cross (1982) reported that bull meat palatability was lower and more variable between 6 and 24 mo of age than was meat from steers. Riley *et al.*, 1983a found that steaks from very masculine carcasses were not as tender as steaks from fatter, less masculine carcasses and that fat thickness was more important in predicting palatability than was masculinity. Riley *et al.*, 1983b also showed that young bulls and steers with the same amount of marbling and maturity had lower tenderness values and higher shear values than did steers.

The causes of tenderness problems in young bulls have not been fully documented, but they appear to be related to the state of muscle contraction, or amount and strength of connective tissue and could be affected by the amount of cold shortening the leaner carcasses go through. Palatability or meat tenderness is determined primarily by 1) the state or nature of the contractile or myofibrillar proteins, and 2) the properties and conditions of stromal proteins (Dutson, 1974 and Marsh, 1977). Carmichael and Lawrie (1967) reported that collagen is important in meat tenderness because of its abundance in muscle. Cross *et al.*, 1984b reported that bulls had greater amounts of total collagen than steers at 12 mo of age. Total collagen levels peak at 12 mo with different breeds ranked identically for total collagen and testosterone at 12 mo. This suggests that increases in synthesis of collagen appear to be influenced by testosterone or some other event associated with puberty. Therefore, several factors such as sex, age, nutrition and breed may all contribute to the maturation of collagen and its effect on tenderness.

It is evident that bulls have leaner carcasses than steers but palatability problems do exist. These problems may be associated with lack of marbling and amount and character of the connective tissue.

The objectives of this study were to examine the effect of Zeranol implants on meat tenderness and overall palatability of young bulls and steers and to investigate collagen effects on these same traits of economic importance. Of further interest was the comparison of three mechanical means of assessing beef tenderness and organoleptic evaluation of beef by a 12-member trained taste panel.

Materials and Methods

Carcass Characteristics. The carcasses were placed in a cooler at -2.2 C for 24 hours before each side was ribbed. The quality, yield grade and Armour tenderometer readings were measured at this time. A five rib section from the small end of the rib was removed and shipped to the Brigham Young University Meats Laboratory. The meat was frozen at -32 C for approximately 3 months until organoleptic test could be performed.

Palatability Measures: Steaks from the posterior end of the rib were cut 2.54 cm thick. The first two steaks or 11th and 12th ribs were used in sensory panel (SP) evaluations. The 10th rib was removed for Warner-Bratzler shear (WBS) determinations, and the 9th rib for Krammer Shear press (KSP) evaluations. The Instron Press (IP) as described by Field *et al.*, 1984 was also used to measure tenderness.

Sensory Evaluation: Eight steaks (two from each treatment group) were thawed for 16 hours at 4 C, and placed in one of three electric ovens and broiled at 232 C until the internal temperature reached 70 C (monitored with thermocouples). After 3 minutes they were weighed and cut using a steak knife. The steak's surface was warm when served to a 12 member trained sensory panel. Panelists were given fifteen training sessions, with all quality grades encountered in the study. They were also given triangle tests where they were asked to choose the samples that were alike. Two steaks were used in sensory evaluations. The first steak was served to panelists 1-7 and the second steak to panelist 8-14. Samples were served on paper plates with panelist number and the reference numbers of the treatments. Evaluations for tenderness, juiciness, flavor intensity, and overall palatability were made using a 0-100 scale with the panel member indicating their evaluation at a point between 0-100 . The range was from very tough to very tender.

Warner-Bratzler Shear (WBS): Steaks used for WBS determinations were cooked to the same internal temperature as those of the sensory panel. Steaks were cooled for 15 minutes before three 1.9 cm diameter cores were obtained parallel to the muscle fibers. Three cores per steak were sheared once through the center.

Krammer Shear Press (KSP): Steaks used for the KSP were cooked the same as the WBS and the steaks were also cooled for 15 minutes then cut into 5.6 cm^2 pieces. Muscle patterns were positioned in the same direction each time. The KSP was washed between each sample.

Instron Press (IP): The steaks were measured at three different stages: raw, cooked to 68 C and to 77 C. The steaks were cut 2.54 cm thick and thawed for 16 hours at 1-2 C before thawed weights were recorded. The raw steaks were then pressed onto tapered needles mounted 2 mm apart around the perimeter of a Plexiglas ring 73 mm in diameter. A 1.27 mm diameter steel ball mounted on the head of an Instron moving at a constant rate of 10 cm/min penetrated the steak. Steaks were also cooked to 68 C or medium degree of doneness, and 77 C or the well done stage. The cooking loss was measured after steaks were placed in a cooler overnight. The internal temperature of the steaks was 1 to 2 C when sheared. Peak break force of the steaks was measured as described by Field *et al.*, 1984.

Heat-Labile Collagen Analysis: Two samples from each steak and each treatment were selected and thawed at 1 to 2 C for 16 hours and pulverized in dry ice for 45 seconds or until the meat sample was pulverized using a Waring™ Blender. Four grams of the pulverized steak were placed into 40 ml centrifuge tubes. Heat-labile collagen was extracted from duplicate samples of 4 g in ¼ strength Ringer's solution heated for 70 minutes to 77 C (Hill, 1966). Following centrifugation and cooling in 6 N HCl for 16 hours in an autoclave. Samples were then cooled and neutralized, and hydroxyproline content was determined in duplicate using spectrophotometric methods. The amount of collagen was calculated by multiplying the hydroxyproline content of the residue by 7.25 (insoluble collagen, IC) and that of the supernatant by 7.52 (soluble collagen, SC). The percent soluble collagen is the soluble collagen divided by the total collagen times 100.

Statistical Analysis: Statistical analysis for the data was made using the Rummage II system of the Statistical Department of Brigham Young University, using 1984 version. Analysis of variance, and Pearson's simple correlation tests were utilized. Factors included in the analysis of variance were: treatment, sex, and pen. The treatment by sex interaction was also included in the model.

Results and Discussion

Sensory tenderness, juiciness, flavor and overall palatability scores are shown in Table 1. Steaks from the steer carcasses, both control and implanted, had higher mean scores for tenderness, juiciness, flavor and overall palatability when compared to those from the bull carcasses. Implanting did not influence flavor or juiciness scores within the bull or steer groups. The control steers were found to be significantly more tender in this study than all treatments and sexes ($P<.05$). Although not significant, the sensory mean values for juiciness were higher for the steaks from the control carcasses.

Table 2 shows means for behavior and palatability characteristics of Zeranol implanted and control bulls and steers. Values for the seven more aggressive and the seven least aggressive animals for which we had complete behavior and palatability data are listed for the four groups. The most aggressive animals were more than twice as active as the less aggressive animals for behavioral attributes. Scores for libido showed the implanted bulls and steers to be less aggressive. The libido mean scores for the control steers were about equal to the implanted bulls. Tenderness values for the cooked steaks showed that implanting made the least aggressive animal more acceptable. Implanting also improved tenderness for the most aggressive animals. However, the control steers were the most acceptable. Juiciness and flavor were lower for the less aggressive bulls than in other treatment groups. The least aggressive control bulls were the lowest in acceptability to the trained sensory panel for juiciness and flavor. The Armour tenderometer readings made on the intact carcass were lowest for the most aggressive implanted bulls and control steers, while the Warner-Bratzler Shear values indicated that the least aggressive implanted bulls and steers to be more tender and the most aggressive bulls and steers in the control group were more tender. The Krammer Shear showed the least aggressive animals to be the most tender except for the control steers which showed the most aggressive steers to be more tender. Table 3 lists simple correlations between aggressive behavior and the various palatability traits studied. All correlations except four explained less than nine percent of variation existing in a particular trait which could be attributed to behavior. The highest correlations was found between the aggressive behavior of the non-implanted steers and the Krammer shear press ($r=-45$). However, it is noted that most of the simple correlations between measures of tenderness and juiciness and behavior for the bulls were positively related whereas those same correlations for the steers generally showed inverse relationships.

Simple correlations between libido and measurements of meat palatability are listed in Table 4. Correlations are generally higher than those for behavior. Libido was associated with variation in palatability as measured by the taste panel and by objective measures of tenderness. With the exception of the implanted steers libido was related to overall palatability. Although significant correlations were present, no consistent trend was found for steaks from the implanted versus the non-implanted animals. As expected, simple correlations between libido and the various measures for meat palatability were higher for bulls than steers. Since most correlations showed a negative sign, as libido increased there was a tendency for tenderness to decrease.

Treatment means for the various mechanical measurements of tenderness generally favored the steers (Table 5). There was variation among the various instruments for measuring tenderness. The Armour tenderometer ranked meat from the implanted steers significantly tougher than meat from the bulls. However, the Warner-Bratzler shear, the Krammer Shear press and Instron values ranked steaks from

Table 1: Means of Sensory Evaluation of Zeranol Implanted

	Bulls		Steers			Bull vs	Imp vs	Trt x
Item	Impl	Con	Imp	Con	SD[a]	Steer	Con	Sex
Number	14	14	14	14				
Tenderness[b]	64.2	66.4	70.4	74.8	14.24	*	*	*
Juiciness[b]	64.6	65.0	67.2	69.9	12.51	*	NS	NS
Flavor[b]	67.6	66.6	69.1	69.9	9.98	*	NS	NS
Overall[b]	64.7	66.6	69.4	72.3	11.94	*	*	NS

a) Pooled Standard Deviation of the Observation b) Higher values are more acceptable

* Differences between bulls vs. Steers; implanted animal svs. Control animal sor the treatment x sex interaction are significant at the P<0.05 level.

Table 2: Means for Behavior and Palatability Characteristics of Zeranol Implanted and Control Bulls and Steers

	Bulls		Steers	
Item	Implant	Control	Implant	Control
Behavior[a]				
7 Most Aggressive	17.6	39.7	6.9	18.4
7 Least Aggressive	4.6	16.6	2.6	6.9
Libido[b]				
7 Most Aggressive	8.7	10.6	1.0	2.7
7 Least Aggressive	5.4	12.6	3.9	2.4
Tenderness[c]				
7 Most Aggressive	64.3	69.3	66.2	72.7
7 Least Aggressive	66.3	60.9	74.4	72.2
Juiciness[c]				
7 Most Aggressive	67.1	70.8	65.1	67.9
7 Least Aggressive	65.5	61.1	71.9	69.1
Flavor[c]				
7 Most Aggressive	68.0	66.9	68.4	67.2
7 Least Aggressive	65.8	66.3	69.4	69.5
Overall Palatability[c]				
7 Most Aggressive	66.4	68.7	66.3	70.0
7 Least Aggressive	67.1	62.7	74.9	70.9
Armnour Tenderometer[d]				
7 Most Aggressive	12.9	15.5	12.9	12.3
7 Least Aggressive	13.9	14.4	12.9	12.5
Warner-Bratzler Shear[d]				
7 Most Aggressive	28.6	21.6	23.6	21.7
7 Least Aggressive	23.8	23.6	21.9	21.8
Krammer Sheard[d]				
7 Most Aggressive	55.0	48.1	47.7	40.3
7 Least Aggressive	47.4	44.1	40.6	45.4

a) Average for mount, bunts, fights per animal during Observation of 30 min per wk for the total 19 wk the animals were on feed.

b) Averages of total flehmens, mounts, attempts and services per animal during observation of 10 min. Observation s were made on one occasion 2 wk before slaughter.

c) Organoleptic results of a 12 member trained panel on a 100mm scale the higher the number of more appealing to the panelists.

d) Objective measures to evaluate tenderness. Measured in lbs. of pressure to shear through sample. The lower the score the more tender the samples was.

Table 3: Correlations Between Aggressive Behavior of Animals and Palatability Traits of the Meat (N=14a)

	Bulls		Steers	
Item	Implant	Control	Implant	Control
Tenderness	0.07	0.00	-0.06	0.04
Juiciness	0.11	0.35	-0.16	-0.04
Flavor	0.06	0.18	0.15	-0.19
Overall Palatability	0.06	0.02	-0.18	-0.00
Armour	-0.28	0.36	0.26	-0.03
WBS	-0.26	-0.22	-0.03	-0.07
KSP	0.18	0.33	-0.09	-0.45

a) Correlations greater than 0.47 are significant at the P<0.05 level

Table 4: Correlations between Libido of Animals and Palatability of the Meat (N=14a)

	Bulls		Steers	
Item	Implant	Control	Implant	Control
Tenderness	-0.48	-0.42	-0.06	-0.36
Juiciness	-0.41	-0.02	0.08	-0.52
Flavor	-0.49	-0.09	-0.13	-0.36
Overall Pal.	-0.54	-0.33	0.17	-0.48
Armour	-0.05	-0.27	-0.06	0.32
WBS	0.16	0.25	-0.04	0.12
KSP	0.12	0.61	-0.22	0.14

a) Correlations greater than 0.47 are significant at the P<0.05 level

Table 5: Means for Mechanical Measurements (lb) of Tenderness in Zeranol Implanted and Control Bulls and Steers

	Bulls		Steers			Bull vs	Imp vs	Trt x
Item	Impl	Con	Imp	Con	SD[a]	Steer	Con	Sex
Number	14	14	14	14				
Armour Tndr	13.1	12.7	14.3	12.2	1.88	*	NS	*
Warner-Bratzler	23.7	23.5	22.4	21.0	0.84	*	NS	NS
Krammer shear	47.8	47.3	43.1	41.1	2.15	*	NS	NS
Instron Press	33.9	32.8	28.8	27.4	2.17	*	NS	NS

a) Pooled standard deviation of the observation

* Differences between bulls vs steers; implanted animals vs control animals or the treatment x sex interaction are significant at the P<0.05 level

Table 6: Instron values (lb) for rib steaks 2.54 cm thick

	Bulls		Steers	
Item	Implant	Control	Implant	Control
Number	5	5	5	5
Raw	10.6	8.4	10.9	8.9
Cooked to 68 C	14.5	15.3	15.5	13.9
Cooked to 77 C	17.3	14.2	19.2	14.2

Table 7: Heat-Labile Collagen Properties of Longissimus Muscle from Zeranol Implanted and Control Bulls and Steers

	Bulls		Steers			Bull vs	Imp vs	Trt x
Item	Impl	Con	Imp	Con	SD[a]	Steer	Con	Sex
Number	5	5	5	5				
Residue Collagen mg/g	0.72	0.59	0.37	0.40	0.22	*	*	NS
Supernatant Collagen mg/g	0.13	0.11	0.13	0.11	0.00	*	*	NS
total Collagen Resid. +Super.	0.85	0.70	0.50	0.51	0.26	*	*	NS
Sol. Collagen/total %	15.29	15.71	26.00	21.57	0.00	*	*	NS

b) Pooled standard deviation of the observation

* Differences between bulls vs. steers; implanted animals vs. control animals or the treatment x sex interaction are significant at the P<0.05 level

steers significantly more tender than those from bulls. Differences in shear and press values between implanted and control groups were not significant (P<.05). Table 6 compares means for raw rib steaks cooked to 68 C and steaks cooked to 77 C. The LSD test was used to make all possible pairwise comparisons. The pairwise comparison for treatment vs sex was not significant, but the other combinations of treatment, sex, with meat raw or cooked to either 68 or 77 C were significant at P<.05. This was done to test the between sample variability relative to the within sample variability. Differences between means of meat samples were large making the raw, treatment, and sex variables significant. Table 7 shows collagen properties of longissimus muscle from Zeranol implanted and control bulls and steers. The residue or insoluble collagen was higher in the implanted bulls, when compared to the other treatment groups. Supernatant or soluble collagen was higher in the implanted bulls and steers. The total collagen was higher in the bulls, while the percent soluble collagen was higher in the steers.

The finding in the present study that steers were always more tender than bulls is different from Greathouse (1983) who found flavor intensity greater in the implanted bulls. Cross (1982) reported that bulls were less juicy and flavorful than steers. Cross (1984a), Unruh *et al.*, 1986 found that bulls and steers were similar in tenderness at 12 mo; at 15 mo bulls were more tender than steers, but by 18 mo steers were more tender than bulls. Barham *et al.*, 2003 reported that control cattle were significantly more tender than control cattle. A trained taste panel as well as post-graduates could distinguish between implant and control for flavor, juiciness and tenderness while consumers could not. In contrast, Morgan *et al.*, 1993 reported sensory panelists were unable to detect differences in tenderness or other sensory traits between bulls and steers. Tenderness is due to the contractile state of the myofibrillar proteins, and the properties and conditions of the stromal proteins (Cross *et al.*, 1973; Dutson, 1974 and Marsh, 1977). Tanzer (1973), and Marsh (1977) reported that collagen is important in meat tenderness because of its abundance in muscle. Cross *et al.* (1973) suggested that the concentration and percent of heat-liable collagen was related to tenderness. Bailey (1972) reported that collagen was responsible for the age-related changes in tenderness since metabolic turnover time for contractile elements of actin and myosin was about 12 d and therefore in older animals actin and myosin is not old. However, collagen has a very long turnover time. The amount of heat-liable collagen in bovine skeletal muscle decreases during maturation and this is responsible for the age associated toughening of beef. Bailey (1985) showed collagen types IV and V are synthesized first in the embryo then types I and III later. There is no direct relationship between collagen content and toughness, but a difference can be explained by the nature and extent of cross-links with increasing age. Collagen fibers are initially stabilized by intramolecular and intermolecular cross-links. Therefore it is the quality rather than the quantity of collagen that determines the texture. Sensory panelists rated meat from steers higher ($P<.05$) than that for bulls in tenderness, juiciness, flavor and overall palatability. Mechanical measurements showed a sex difference in all four objective measures of tenderness. Bull steaks contained more collagen than those of steers and implanted bulls and steers contained more soluble collagen than control bulls and steers. Implanting young bulls and steers with Zeranol from branding through to slaughter may improve performance and behavior. Implants have minimal effects on carcass characteristics and palatability characteristics when compared to non-implanted animals. However, within the groups of implanted bulls and steers those animals that were least aggressive tended to be more tender than their more aggressive counterparts.

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