TENDERNESS RELATIONSHIPS AMONG BEEF MUSCLES DURING AGING

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Abstract – This work was conducted to evaluate the effects of aging period on beef tenderness of the *Longissimus* (LD), *Gluteus medius* (GM) and *Infraspinatus* (IS). Carcasses (n= 120) were selected from the following grades: upper 2/3 Choice, low Choice and Select (40 per grade). Every muscle was cut into 5 steaks, individually identified, packaged and aged for 7, 14, 21, 28 or 35 days; after which these were frozen. Slice shear force was conducted to evaluate tenderness for LD, GM and IS steaks. In general, all the muscles from upper 2/3 Choice carcass were more tender than those from Choice and Select carcasses. Aging period significantly improved tenderness until 28 days. The IS steaks were more tender than LD and GM during all aging periods. The difference between LD and GM steaks was small and was only observed on the upper 2/3 Choice grade. At 14 days of aging, according USDA parameters, 28% of LD steaks were classified as Very Tender (<15.3 kg), 36% were Tender (15.4 – 19.9 kg) and 36% were considered Not Certified (>20.0 kg). According to these results, in order to label all muscles as Very Tender, the IS steaks must be aged for 14 days and the LD and GM steaks would require 28 days of aging.

Key Words – Aging, tenderness, LD, GM, IS

I. INTRODUCTION

On October 26, 2012 the USDA Ag Marketing Service announced a program pertaining to meat tenderness labeling claims (U.S. Department of Agriculture, 2012). Carcasses with ribeyes that meet the criteria established by ASTM International (2012; formerly the International Society of Testing and Materials) for Tender and Very Tender meat may carry a labeling claim for tenderness and therefore would be entitled to have the USDA Certified Tender and USDA Certified Very Tender shields on the label. Tender is defined as meat having a ribeye with a slice shear force (SSF) value below 20.0 kg after 2 or more weeks of aging and Very Tender is defined as having a SSF value below 15.3 kg. The USDA program allows carcasses that meet these SSF standards for the ribeye to also apply the tenderness label to the tri-tip (tensor fascia latae), knuckle center (rectus femoris), knuckle side (Vastus lateralis), tenderloin (Psoas major), flat iron (Infraspinatus), rib cap (Spinalis dorsi), petite tender (Teres major) and the Denver cut (Serratus ventralis), as well as the ribeye and strip loin. That is, if a ribeye can be certified as Very Tender so too can these other cuts. However, a number of economically important muscles that are intermediate in tenderness are not included on the list, including the clod heart (Triceps brachii), top round (Adductor), and sirloin (Gluteus medius). Together these cuts would add about 100 pounds to the list of cuts that could bear a tenderness designation. Because they are not quite as tender as the ribeye (they are close), it would make sense to allow these cuts to carry a label as Certified Tender whenever the ribeye could be certified as Very Tender. Data are needed to verify that this would be an appropriate labeling strategy.

So, the aim of this project was determine the effect of aging period on tenderness of Longissimus, Gluteus Medius and Infraspinatus muscles from different carcass grading and evaluate if selected muscles from carcasses certified as Very Tender could meet the criteria for a Tender marketing claim.

II. MATERIALS AND METHODS

Samples

Carcasses (n= 120) were selected from a single beef packaging plant from the following grades: upper 2/3 Choice, low Choice and Select (40 per grade). Beef tenderness was assessed on three different muscles; *Longissimus* (LD), *Gluteus medius* (GM) and *Infraspinatus* (IS) of each carcass. All 360 muscles were transported under dark vacuum package conditions to the Loeffel Meat Laboratory at the University of Nebraska –

Lincoln. The muscles were trimmed and fabricated on the 7th day post mortem. Every muscle was cut into 5 steaks (2.5 cm thick) with an automatic slicer. Each steak was individually identified, vacuum packaged and aged for 14, 21, 28 or 35 days, after which they were frozen (-28ºC). At the same day of fabrication, the steaks that corresponded to 7 day aging were frozen (-28ºC).

Slice Shear Force

Steaks were thawed for 24 hours (2ºC) before cooking. To avoid any random effect of cooking, all the 5 steaks from each carcass/muscle were cooked together. Before cooking, the steaks were weighed and the internal temperature was measured with a hand-thermometer (OAKTON, mod. 10 J). Steaks were cooked on a Belt Grill (TBG60 – V3 MagiGrill, MagiKitch'n Inc., Quakertown, PA). The Belt Grill settings were the same of Wheeler et el. (2007), where the top heat = 163°C, bottom heat = 163°C, preheat = 149°C, cook time = 5.5 min. Slice shear force was conducted according to Wheeler et al. (2007) for LD, GM and IS steaks. Immediately after cooking, the temperature was monitored and maximum temperature was recorded (target of 71°C) and the steaks were weighted again. Slice shear force was measured using a Food Texture Analyzer (TMS-PRO, Food Technology Crop., Sterling, VA) within 2 min of recording cooked temperature. Data were collected from a total of 1800 steaks.

Statistical Analysis

Data were analyzed using the GLIMMIX procedures of SAS (Version 9.2, Cary, N.C., 2002 – 2008). Mean separation was done with the TUKEY adjustment with an alpha of 0.05. Correlations as well as regression analysis were also used to determine relationships between muscles and their response to aging.

The LD values at 14 d of aging were classified according USDA categories for meat tenderness: Very Tender (SSF < 15.3 kg), Tender (SSF = 15.4 – 19.9 kg) and Not Certified (SSF > 20.0 kg).

III. RESULTS AND DISCUSSION

There were differences for slice shear force (SSF) values among muscles, carcass grades and aging periods (Table 1). The Longissimus steaks from the upper 2/3 Choice grade were more tender than those from Choice and Select during all aging time points. Steaks from the low Choice grade were more tender than Select until 14 days of aging, after which time there were no differences between these carcass grades. Aging period affected tenderness just until 28 days for all grades (Table 1).

Table 1. Effect of carcass grading and aging time (7, 14, 21, 28, and 35 days) on Slice Shear Force Means and Standard Errors of *Longissimus* (LD), *Gluteus Medius* (GM) and *Infraspintaus* (IS) muscles.

	Upper 2/3 Choice		*Low Choice*		*Select*	
	Mean (kg)	S.E	Mean (kg)	S.E	Mean (kg)	S.E
LD						
7	17.9 ^{Ac}	0.54	22.6^{Ab}	0.54	24.7 ^{Aa}	0.54
14	16.3 ^{Bc}	0.54	19.4^{Bb}	0.54	21.1 ^{Ba}	0.54
21	14.6 ^{Cb}	0.54	17.5 ^{Ca}	0.54	18.8 ^{Ca}	0.54
28	13.2^{Db}	0.54	15.6 ^{Da}	0.54	16.3 ^{Da}	0.54
35	13.1^{Db}	0.54	15.3 ^{Da}	0.54	15.9 ^{Da}	0.54
GM						
7	20.5^{Aab}	0.54	19.3^{Ab}	0.54	21.9^{Aa}	0.54
14	18.9^{Ba}	0.54	17.1^{Bb}	0.54	19.9^{Ba}	0.54
21	18.1 ^{Ba}	0.54	16.3^{Bb}	0.54	19.1^{Ba}	0.54
28	16.3^{Cab}	0.54	16.0^{Bb}	0.54	17.6^{Ca}	0.54
35	14.40^{b}	0.54	14.1^{Cb}	0.54	15.9^{Da}	0.54
IS						
7	16.2^{Aa}	0.54	16.2^{Aa}	0.54	15.7^{Aa}	0.54
14	15.3^{Aa}	0.54	15.8^{Aa}	0.54	15.1^{Aa}	0.54
21	13.5^{Ba}	0.54	14.3^{Ba}	0.54	13.5^{Ba}	0.54
28	12.4^{Ba}	0.54	12.7^{Ca}	0.54	12.3^{Bca}	0.54
35	12.3^{Ba}	0.54	12.2^{Ca}	0.54	11.9^{Ca}	0.54

Capital letters in the same column having different superscripts are different at $P \leq 0.05$. Lower case letters in the same row having different superscripts are different at $P \leq 0.05$

The GM steaks for all carcass grades had a significant tenderization all through 35 days of aging. Until day 21, the GM steaks from the low Choice group were more tender than the other grades. At 28 and 35 days, the GM steaks from

upper 2/3 Choice and low Choice group were more tender than the Select carcasses. There were no differences on SSF values from IS steaks among carcass grades. Also, there were meaningful effects of aging time until 21 days (Table 1).

The Longissimus steaks were classified according USDA categories at 14 d of aging and 28% (n= 34) of LD steaks were classified as Very Tender (<15.3 kg), 36% (n=43) were Tender (15.4 – 19.9 kg) and 36% (n=43) were considered Not Certified (>20.0kg). Also, were calculated the aging response during each post mortem aging period and the total of aging response too (Table 2).

Table 2. Total aging response and rate of change in Slice Shear Force (SSF; kg instantaneous unit of time) on each post mortem aging periods, according USDA tenderness classification.

	Time post mortem (days)					
USDA Class*	7d	Aging Respon-se (kg)	14	21	28	35
Very Tender (< 15.3 kg)						
LD	16.1	-3.68	-3.12	0.30	-0.82	-0.05
GM	19.8	-5.46	-2.16	-0.74	-1.18	-1.37
IS	16.2	-4.14	-0.83	-1.53	-1.62	-0.15
Tender (15.4 – 19.9 kg)						
LD	20.8	-6.40	-3.17	-1.56	-1.31	-0.36
GM	20.2	-6.46	-2.43	-0.71	-0.89	-2.43
IS	15.9	-4.01	-0.65	-1.89	-0.96	-0.52
Not Certified (SSF > 20.0 kg)						
LD	27.2	-7.97	-2.23	-1.84	-5.65	-0.48
GM	21.6	-3.98	-1.28	-0.98	-1.6	-1.41
IS	16.0	-3.21	-0.41	-1.43	-1.57	-0.21

* By muscle; LD = *Longissimus*; GM = *Gluteus medius*; IS = *Infraspinatus*

In general, the LD tenderness from Very tender group, decreased more rapidly from 7 to 14 days postmortem than from the Tender and Very Tender group. The GM tenderness was slower than LD and decreased during all post mortem period for all carcass grading and the IS tenderness was intermediate and the effect of aging was higher until 21 days.

To characterize the extent and the rate of change in shear force that occurred during post mortem storage, regression models were fitted and the results showed quadratic effect for LD and linear effect for GM and IS muscles (Table 3).

Table 3. Coefficients of parameter estimates for models fitted to Upper 2/3 Choice(UP), Low Choice (LC) or Select (SE) beef muscles.

		Parameter estimate*		
		b_0	b_1	b_2
Longissimus§	UP	20.55	-0.387	0.0048
Longissimus§	LC	26.45	-0.614	0.0084
Longissimus§	SE	29.15	-0.699	0.0090
*Gluteus Medius*Ŧ	UP	22.08	-0.211	-
*Gluteus Medius*Ŧ	LC	20.01	-0.163	-
*Gluteus Medius*Ŧ	SE	23.22	-0.205	-
*Infraspinatus*Ŧ	UP	17.15	-0.152	-
*Infraspinatus*Ŧ	LC	17.60	-0.160	-
*Infraspinatus*Ŧ	SE	16.87	-0.150	-

* Parameters estimates correspond to the following regression nonlinear§ ($SSF= b_0+ b_1x+ b_2x^2$) or linearŦ model ($SSF = b_0+ b_1x$), where x = d of aging.

IV. CONCLUSION

It seems that sorting carcasses based on the USDA tenderness categories of LD at 14 d of aging does not clearly provide a guide for aging strategies in other muscles.

The effect of aging time is different for different muscles and each one has a specific period before it might be considered USDA Tender or Very Tender.

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