TENDERNESS VARIATION AMONG LOIN STEAKS FROM HEIFERS

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INTRODUCTION: Cattle approximately 9 to 30, 30 to 42, or 42 to 60 mo of age normally produce A, B or C maturity carcasses, respectively (USDA, 1995). As chronological age increases, tenderness of beef decreases and it is for this reason that A, B, C, D and E maturity categories are part of the beef grading system (USDA, 1989). The maturity categories are based to a large extent on degree of bone calcification in the vertebral column. The A and B categories are reserved for prime, choice, select and standard grade carcasses. The highest grade a carcass possessing C maturity characteristics can obtain is commercial and as such is sold for much less per kg than those from A or B maturity. Two-yr-old heifers that have calved produce a higher percentage of C maturity carcasses than open heifers, and open heifers a higher percentage than ovariectomized heifers. Nevertheless, within open, ovariectomized and single-calf heifers, A, B and C maturity categories are present. The purpose of this research was to study factors related to tenderness of loin steaks from A and C maturity carcasses of heifers similar in chronological age.

MATERIALS AND METHODS: Fifty-two Angus/Gelbvieh rotationally crossed open, ovariectomized or single-calf heifers were slaughtered after 100 d on a high concentrate diet. Heifers from each treatment were approximately 31 to 35 mo of age and they produced 31 A, 5 B and 16 C maturity carcasses. The B maturity carcasses were not included in this study because the number was too small to furnish meaningful information.

Carcasses were evaluated for quality and yield grade characteristics by a representative from the USDA Livestock and Meat Standardization Branch approximately 48 h postmortem. He assigned percentage scores for bone maturity (e.g., A^{80}) and these scores, along with lean maturity, were used in determining overall carcass maturity (USDA, 1989). Roasts 10 cm thick were removed posterior to the 12th rib from each carcass after 14 d aging at 4°C. The roasts were frozen and stored at -30°C for 2 to 6 mo until biochemical, sensory and Warner-Bratzler (WB) shear analysis could be completed.

Bone dust from sawing the metacarpal shaft cortex, and a thin transverse slice of the longissimus muscle minus all epimysial tissue were dried in an oven at 100°C for 2 d. The dried muscle was ground using a mortar and pestle. Dried muscle and bone were hydrolyzed and used for determination of hydroxyproline. Hydroxyproline concentration was determined in bone and muscle tissue hydrolyzates colorimetrically (Woessner, 1961). Collagen concentration was calculated assuming that collagen weighed 7.25 times the measured weight of hydroxyproline. Hydroxylysylpyridinoline (HP) and lysylpyridinoline (LP) crosslink concentrations for bone, and HP concentration for intramuscular collagen were determined using a modification of the high pressure liquid chromatography procedure developed by Eyre et al., (1984).

For WB shear force determination, 2.5 cm thick steaks were cut from the roasts, thawed overnight at 4°C, and roasted at 177°C in a convection oven to an internal temperature of 74°C. Cooked steaks were then cooled, wrapped in freezer paper and held at 4°C before WB shear values were obtained on three 2.54 cm diameter cores cut parallel to the muscle fibers. Each core was sheared three times. The average of nine shear values was used for subsequent analysis. Thirteenth rib roasts for sensory analysis were thawed at 4°C for 24 h and then roasted to an internal temperature of 74°C in a 177°C convection oven. The internal temperature was monitored by thermocouples and a relay scanner. Samples were served warm to an eight-member, experienced sensory panel. Panelists evaluated tenderness using a 12 cm continuous scale (0 = extremely tough; 12 = extremely tender). Evaluations were made on six steaks per session. The steaks were selected at random.

All data were analyzed by one-way ANOVA employing GLM procedures of SAS (1985). Differences between means were tested using Fisher's protected lsd test ($P<.05$).

RESULTS AND DISCUSSION: Number of A or C maturity carcasses within each slaughter age group are found in Table 1. As age increased over the 31 to 35 mo range, number of A maturity carcasses decreased and number of C maturity carcasses increased. Therefore, Angus/Gelbvieh rotationally- crossed heifers should be slaughtered at 31 mo of age or younger to avoid price discounts that come with C maturity carcasses.

Heifers producing C maturity carcasses averaged 32 d older ($P<.01$) than those producing A maturity carcasses (Table 2). Initial feedlot weight, slaughter weight and hot carcass weight tended to be heavier for C maturity animals but neither differences in weight nor differences in weight gain during the 100 d feeding period were significant ($P>.05$). Greater adjusted fat depths for C maturity carcasses when compared to A maturity carcasses ($P<.01$) indicate that fat deposition and bone maturation in animals of similar chronological age may occur simultaneously. Percentage kidney, heart and pelvic fat, and marbling followed the same trends as those for fat depth. However, lean scores were almost identical for A and C maturity carcasses. Metacarpal bone weights and lengths were not different ($P>.05$) by maturity groups.

Collagen characteristics of bone and muscle from A and C maturity carcasses are found in Table 3. Lack of differences in collagen percentage and in HP and LP crosslinks from bone and muscle show that these characteristics are independent of the bone maturation process. Ash and moisture percentages in bone cortex also were similar for A and C maturity carcasses.

Panel tenderness scores tended to be lower and WB shear values higher when loin steaks from C maturity carcasses were compared to those from A maturity carcasses but these differences were not significant ($P>.05$). Shackelford et al. (1995) found longissimus muscle from yearling heifers was similar in shear force to that from 2-yr-old cows but mean panel tenderness scores were slightly lower for the 2-yr-old cows. In contrast, Waggoner et al. (1990) reported longissimus muscle from 2-yr-old open heifers was similar in panel tenderness to that from 2-yr-old cows but open heifers had slightly lower shear force values. We compared longissimus muscle from A and C maturity carcasses where open, single-calf and ovariectomized heifers were included in each maturity group. Under these conditions neither bone maturity nor collagen characteristics were related to panel tenderness or shear values. Apparently tenderness of meat is more closely related to chronological age than it is to bone maturity.

CONCLUSIONS: Because heifers of a narrow age range produced carcasses ranging from A to C maturity, we concluded that in this population, chronological age was not closely related to changes in bone characteristics. In addition, differences in bone maturity were not related to collagen percentage, HP crosslinks, panel tenderness or WB shear values as they are in animals over a broad age range.

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Table 1. Number of carcasses of A or C maturity within each slaughter age group.

Carcass maturity	Slaughter age in mo		
	31	33	35
A	13	11	7
C	3	6	7

Table 2. Means for growth and carcass characteristics of heifers by maturity group.

Item[a]	Overall maturity		P
	A	C	Value
Number	31	16	
Slaughter age, d	984	1016	0.01
Initial feedlot wt, kg	533	568	0.06
Slaughter wt, kg	665	689	0.21
Total wt gain, kg	132	121	0.39
Hot carcass wt, kg	415	430	0.20
Dressing %	62.4	62.6	0.88
Adj. fat depth, cm	1.06	1.41	0.01
Longissimus area, cm^2	98.3	102.7	0.21
KPH, %	2.09	2.25	0.35
Marbling[a]	3.79	4.0	0.40
Lean maturity[b]	1.56	1.57	0.75
Overall bone maturity[b]	1.86	3.47	0.01
Metacarpal wt, g	506	476	0.09
Metacarpal length, cm	21.74	21.62	0.70

[a]3.79 = slight^{79}, 4.0 = small^{0}. The superscript after degree of marbling is the percentage increase in marbling above the minimum.
[b]1.56 = A^{56} maturity, and 3.47 = C^{47} maturity. The superscript after the degree of maturity is the percentage increase in maturity above the minimum.

Table 3. Means for bone and muscle characteristics of heifers by maturity group.

Item[a]	Overall maturity		P
	A	C	Value
Number	31	16	-
Bone			
Collagen[a], %	21.16	20.75	0.38
Hydroxylysylpyridinium[b]	0.25	0.27	0.24
Lysylpyridinium[b]	0.03	0.03	0.95
Bone cortex moisture, %	12.0	11.6	0.56
Bone cortex ash[a], %	69.8	69.7	0.99
Muscle			
Collagen[a] %	1.89	1.85	0.64
Hydroxylysylpyridinium[b]	0.26	0.26	0.81
Panel tenderness[c]	6.43	5.97	0.32
WB shear, kg	9.02	9.82	0.11

[a]Expressed on a dry weight basis.
[b]Moles of hydroxylysylpyridinium or lysylpyridinium per mol of collagen.
[c]Evaluated by an experienced sensory panel using a 12 cm continuous scale: 0 = extremely tough; 12 = extremely tender.