SLICE SHEAR FORCE OF GRASS- AND GRAIN-FINISHED BEEF STRIP LOIN STEAKS VARYING IN MARBLING LEVEL AND AGING TIME

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I. INTRODUCTION

Beef from grass-finished animals has been known to be tougher than grain-finished finished animals. Grass-fed beef imported from New Zealand or Australia is usually lower in fat content and undergoes an extended wet-aging period during transport compared to domestically produced beef. Therefore, the objective of this study was to evaluate marbling and aging impact on objective tenderness of steaks from grain- and grass-fed beef.

II. MATERIALS AND METHODS

Beef strip loins (n = 200; 20 per marbling level/fed cattle type) representing five marbling levels (slightly abundant and higher, modest 00 to moderate 100, small, slight, and traces) and two fed cattle types (grass-finished and grain-finished) were used in the study. Each carcass was evaluated by trained Texas Tech personnel for beef grading measures such as lean maturity, skeletal maturity, USDA marbling score, MSA marbling score, subcutaneous fat thickness, ribeye area, hot carcass weight, pH and hump height. Strip loins (longissimus lumborum) were collected from commercial beef packing facilities in Nebraska (grain-finished) and New Zealand (grass-finished), equally portioned into thirds, vacuum packaged, and randomly assigned to one of three wet aging periods (7 d, 21 d or 42 d). After aging, all strip loin portions (n = 600) were frozen, then fabricated (while still in the frozen state) into 2.5-cm thick steaks using a band saw, vacuum packaged individually, and stored frozen (-20^{o}C) until subsequent analysis. All samples were thawed at 2 to 4°C for 24 h prior to consumer evaluation, weighed, and were cooked to an internal temperature of 71°C using a clamshell grill (Cuisinart Griddler Deluxe, East Windsor, New Jersey). Steak weights and peak internal temperatures were recorded following cooking for calculation of cook loss and endpoint temperature. Tenderness was evaluated by SSF (Slice Shear Force) as described by Shackelford *et al.* [1] using a G-R Shear Machine (Model GR-152 [Slice Shear Speed], G-R Electric Manufacturing Company LLC, Manhattan, Kansas) with a cross head speed of 500 mm/min with a load cell of 50 kg. Statistical analyses were conducted using the procedures of SAS (Version 9.3; SAS Inst. Inc., Cary, NC). Treatment comparisons were tested for significance using PROC GLIMMIX with $\alpha = 0.05$. Slice shear force and cook loss data were analyzed with a split-plot arrangement of factors, with diet x QG as the main plot factor and age as the sub-plot factor. For carcass data analyses, the Kenward-Roger approximation was used for estimating denominator degrees of freedom. For all analyses, the PDIFF option was used to separate treatment means when the F-test on the main effect or effect interaction was significant ($P < 0.05$).

III. RESULTS AND DISCUSSION

In general, grass-finished carcasses tended to have darker colored lean, less subcutaneous fat, smaller ribeye areas, lighter hot weights and shorter hump sizes than grain-finished cattle. All strip loins selected were from A-maturity, young carcasses with an overall maturity less than 200. Generally, grass-finished treatments had higher lean maturity values with treatment means ranging from 174 to 221 versus grain-fed treatments ranging from 144 to 170. Grass-fed Prime carcasses had the most advanced ($P < 0.05$) skeletal maturity compared to all other treatments. Marbling scores based on USDA standards were similar ($P > 0.05$) between grass and grain for Select, Low Choice and Top Choice treatments. However, grass Prime was higher ($P < 0.05$) than grain Prime, and grass Standard was lower ($P < 0.05$) than grain

Standard for US marbling score. Mostly, grass-fed treatments had less fat at the 12th rib fat thickness (3 to 11 mm) than grain-finished treatments (5 to 14 mm). Grain Prime, Top Choice and Low Choice were fatter ($P < 0.05$) opposite the ribeye than all other treatments. All grain-finished treatments had larger ($P < 0.05$) ribeye areas than grass-finished treatments with means ranging of 86 to 98 cm^2 and 73 to 79 cm^2, respectively. Grain-fed treatment means were generally heavier (353 to 401 kg) than grass-finished treatments (267 to 341 kg). Finally, all treatment means for pH were less than 5.6.

Table 1 Interaction between diet and quality grade ($P < 0.05$) of means for slice shear force and cook loss percentage of beef strip steaks of varying quality treatments (n = 600).

Quality Grade	**Diet**	Slice Shear Force, kg	Cook Loss %
Prime	Grass	11.98^{de}	16.03
	Grain	11.35^{e}	15.82
Top Choice[1]	Grass	12.21^{de}	17.08
	Grain	15.36^{ab}	17.74
Low Choice	Grass	12.65^{de}	17.70
	Grain	13.60^{bcd}	18.68
Select	Grass	13.36^{bcd}	18.31
	Grain	14.89^{abc}	17.96
Standard	Grass	13.22^{cde}	18.75
	Grain	16.72^{ab}	17.96
SEM		0.75	0.45
P-value		0.0147	0.2404

[1]Top Choice: Upper 2/3 Choice
[abcde]Least squares means in the same column without a common superscript differ ($P < 0.05$).

Slice shear force was impacted by the interaction ($P < 0.05$) of diet x quality grade (Table 1). Generally, grass-fed steaks were more tender than grain-fed steaks, and the shear force increased as quality grade decreased, with the exception of grain-fed Top Choice. Grain-fed Standard, Select and Top Choice sheared the highest ($P < 0.05$), but similar to ($P > 0.05$) grain-fed Low Choice and grass-fed Select. Grain-fed Prime samples sheared the most tender ($P < 0.05$), but similar to ($P > 0.05$) grass-fed Prime, Top Choice, Low Choice and Standard.

Table 2 Least squares means for slice shear force and cook loss percentage of grilled beef strip loin steaks of varying quality treatments (n = 600).

Quality Treatment	Slice Shear Force, kg	Cook Loss %
Quality Grade		
Prime	11.67	15.92^{c}
Top Choice[1]	13.78	17.41^{b}
Low Choice	13.13	18.19^{ab}
Select	14.13	18.14^{ab}
Standard	14.97	18.39^{a}
SEM[4]	0.53	0.32
P-value	<0.0001	<0.0001
Age		
7-day	15.02^{a}	17.11^{b}
21-day	13.17^{b}	17.62^{ab}
42-day	12.41^{b}	18.11^{a}
SEM[4]	0.46	0.26
P-value	<0.0001	0.0198
Diet		
Grass	12.68	17.57
Grain	14.39	17.65
SEM[4]	0.43	0.21
P-value	0.0029	0.8078

[1]Top Choice: Upper 2/3 Choice
[abc]Least squares means in the same column without a common superscript differ ($P < 0.05$).

Table 2 consists of least squares means for slice shear force and cook loss percentage. Samples aged for 21 and 42 d were similar ($P > 0.05$) for shear force and more tender ($P < 0.05$) than steaks wet aged 7 d. Cook loss was impacted by quality grade and aging time ($P < 0.05$). Generally, cook loss increased as quality grade decreased. Prime samples lost less ($P < 0.05$) weight during cooking compared to all other treatments. Standard lost the most ($P < 0.05$) weight, but had similar ($P > 0.05$) cook loss to Select and Low Choice.

IV. CONCLUSION

The slice shear force advantages in grass-finished beef could be due to differences in carcass weight along with differences in production practices such as implant and beta agonist use. It is noteworthy all treatments would be considered “Certified Tender”, and most “Certified Very Tender” by the USDA Tenderness Program [2]. There was no improvement in shear force by aging beef longer than 21d, however tenderness improved with increasing marbling levels.

REFERENCES

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2. ASTM. (2011) F 2925-11 Standard Specification for Tenderness Marketing Claims Associated with Meat Cuts Derived from Beef. American Society for Testing Materials International, West Conshohocken, PA.