Meat quality characteristics associated with fatty acid profile differences in beef – phenotypic evaluation

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Introduction

- Beef could be viewed more favorably from a human health standpoint if strategies could be applied to reduce SFA while increasing PUFA.
- Fatty acids can be altered through the diet
  - Pasture feeding can ↑ PUFA, ↓ SFA, ↑ PUFA:SFA, ↑ CLA (French et al., 2000)
  - Forage feeding cattle increased the proportion of C18:0, C18:2, C18:3, C20:4, C20:5, and C22:5, and decreased C14:0, C16:0, and C18:1 (Realini et al., 2004)
  - Forage finishing increased the concentration of C18:2 and C18:3, while decreasing C18:1 in the LD muscle (Faucitano et al., 2008)

Introduction

- Fatty acid composition varies between (Yang et al., 1999; Laborde et al., 2001; and Pitchford et al., 2002) and within breeds (Oka et al., 2002)

Healthfulness Project

- Live animal and carcass data from 3 related populations of Angus cattle
- Longissimus muscle samples obtained for beef palatability, nutrient composition and fatty acid profiles

Estimation of phenotypic correlations between nutrient components of longissimus muscle and beef palatability traits in cattle from different geographic locations

Objective

Assess the influence of certain nutrient profiles (fatty acids and minerals) on tenderness and sensory traits as well as lipid oxidation of beef longissimus to understand how they affect product quality

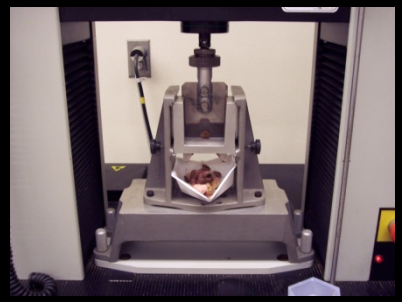
Materials & Methods

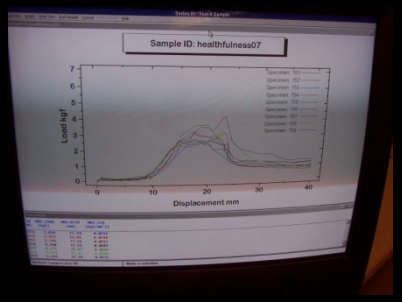
- Animal Resources
  - 3 related Angus herds – Iowa, California, Oklahoma (harvested in CO or TX)
- Harvest and Data Collection
  - Animals harvested October 2007 – May 2008
  - Carcass characteristics

Sample Collection and Preparation

- Iowa, California and Colorado – rib sections
  - Fabricated into 2.54 cm steaks
    - WBS, Sensory, TBARS, Healthfulness
  - Frozen at 14 d postmortem
- Texas– strip loins
  - Fabricated into 2.54 cm steaks
    - WBS, Sensory, TBARS, Healthfulness
  - Frozen at 14 d postmortem

Warner-Bratzler Shear Force (WBS)





- Temper overnight at 4ºC
- Broiled on impingement oven at 200ºC to internal temperature of 68ºC
- Cooled at 4ºC for 18-24 h
- Six 1.27 cm cores removed and sheared
- Average peak load (kg) was analyzed

Sensory Panels

- Cooked similarly to steaks for WBS
- Sessions conducted once or twice per day
- 12 samples served randomly to panelists
- Served to eight member trained panel
- Evaluated juiciness, tenderness, flavor
  - Initial and Sustained Juiciness – 8 point scale (1 = extremely dry and 8 = extremely juicy)
  - Initial and Overall Tenderness – 8 point scale (1 = extremely tough and 8 = extremely tender)
  - Connective Tissue – 8 point scale (1 = abundant and 8 = none)
  - Beef, Painty/Fishy, and Livery/Metallic Flavors – 3 point scale (1 = not detectable, 2 = slightly detectable, and 3 = strong)

Lipid Oxidation

- 10 g sample homogenized with 30 ml cold deionized water
- Centrifuged for 10 min
- Supernatant was extracted and mixed with 4 ml thiobarbituric acid and butylated hydroxyanisol, vortexed and incubated in boiling water bath, followed by cold water bath
- Centrifuged for 10 min
- Absorbance was read at 531 nm

(Modified method of Buege and Aust, 1978)

Nutrient Phenotype

- Healthfulness muscle samples were frozen and ground
- Total Mineral Content
  - 4 g sample dried and microwave digested (AOAC, 2000)
  - Diluted with DI water and analyzed using ICP-OES
  - P, K, Na, Ca, Cu, Fe, Mg, Mn, Zn

Fatty Acid Composition

- Thin-layer chromotography used to separate triglyceride and phospholipid
- Total lipids were esterified and methyl esters were extracted in hexane (Christie, 1972)
- FAMEs analyzed using a gas chromatograph (Sehat et al., 1998)
- Fatty acids identified against a standard and quantified using the peak areas on a percentage basis

Statistical Analysis

- Correlation procedure of SAS
  - Pearson phenotypic correlations
  - Unadjusted means and standard deviations
- Correlations were generated by location
- $\alpha = 0.05$

Results

Carcass Traits (n = 1,747)

Trait	California	Colorado	Iowa	Texas	SEM
HCW, kg	335.5^{bc}	356.7^{a}	312.1^{d}	335.0^{c}	1.880
FT, mm	13.23^{b}	11.58^{c}	11.05^{c}	17.70^{a}	0.236
LM area, cm^2	79.64^{c}	83.66^{a}	76.42^{d}	82.25^{b}	0.436
KPH, %	1.93^{b}	1.95^{b}	2.08^{a}	2.08^{a}	0.021
Calc. YG	3.05^{c}	2.87^{d}	2.86^{d}	3.38^{a}	0.037
Marbling Score[1]	5.95^{b}	5.95^{b}	6.29^{a}	6.29^{a}	0.058

[1]3.0 = traces 0, 4.0 = slight 0, 5.0 = small 0, 6.0 = modest 0

^{abcd} Means within a row without a common superscript differ (P < 0.05)

Garmyn et al., 2011, submitted to J. Anim. Sci., under review

Palatability Traits

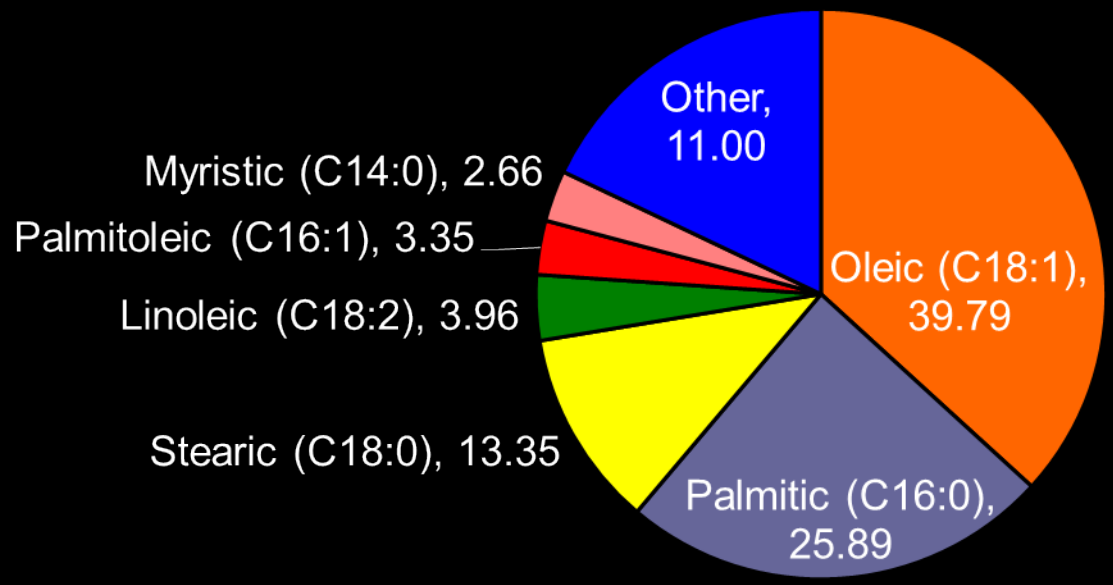
Trait	N	Mean	SD
WBSF, kg	1,718	3.67	0.695
Initial Juiciness[1]	1,715	5.38	0.507
Sustained Juiciness[1]	1,715	5.00	0.495
Initial Tenderness[1]	1,715	5.82	0.581
Overall Tenderness[1]	1,715	5.80	0.590
Connective Tissue[2]	1,715	5.88	0.596
Beef Flavor[3]	1,715	2.50	0.228
Painty/Fishy Flavor[3]	1,715	1.30	0.171
Livery/Metallic Flavor[3]	1,715	1.04	0.123
TBARS, mg/kg	1,715	0.137	0.041

[1] 1 = extremely dry/tough; 8 = extremely juicy/tender
[2] 1 = abundant; 8 = none
[3] 1 = not detectable; 3 = strong
[4] Expressed as mg of malonaldehyde per kg of sample

Minerals

Trait	N	Mean	SD
Calcium, µg	1,746	35.15	20.53
Copper, µg	1,486	0.73	0.70
Iron, µg	1,743	14.46	3.18
Magnesium, µg	1,747	265.41	42.63
Manganese, µg	1,481	0.08	0.04
Phosphorus, µg	1,744	2026.00	274.97
Potassium, µg	1,699	3555.00	461.57
Sodium, µg	1,746	509.48	93.07
Zinc, µg	1,735	38.36	7.39

Fatty Acids (%)


Other, 11.00
Myristic (C14:0), 2.66
Palmitoleic (C16:1), 3.35
Linoleic (C18:2), 3.96
Stearic (C18:0), 13.35
Oleic (C18:1), 39.79
Palmitic (C16:0), 25.89

Correlations between minerals and palatability (n = 1,715)

Mineral	MS	WBSF	I Juic	S Juic	I Tend	O Tend	Conn Tiss	BF Flv	P/F Flv	L/M Flv	TBARS
Calcium	-0.01	**-0.06**	0.03	0.01	0.03	0.04	**0.07**	0.02	-0.04	**0.05**	**-0.08**
Copper	0.02	**-0.06**	**0.14**	**0.11**	**0.06**	0.04	0.03	**0.13**	0.02	**0.09**	**-0.22**
Iron	**0.06**	-0.03	**0.14**	**0.11**	**0.06**	0.04	0.03	**0.13**	0.02	**0.09**	**-0.23**
Magnesium	**-0.05**	**-0.07**	**0.13**	**0.06**	**0.06**	0.01	0.01	**0.11**	**0.09**	**0.09**	**-0.46**
Manganese	**0.13**	**-0.06**	**0.05**	0.04	**0.07**	**0.06**	0.04	**0.05**	0.04	0.01	**-0.16**
Phosphorus	**-0.06**	**-0.09**	**0.09**	0.02	**0.07**	0.03	0.05	**0.10**	0.04	**0.09**	**-0.40**
Potassium	-0.03	**-0.14**	**0.06**	-0.02	0.10	**0.05**	**0.06**	**0.14**	**0.06**	**0.07**	**-0.36**
Sodium	0.04	**-0.14**	**0.15**	**0.06**	**0.16**	**0.12**	**0.10**	**0.13**	**0.07**	**0.13**	**-0.32**
Zinc	-0.03	0.02	**0.08**	0.04	0.02	-0.01	-0.01	**0.07**	0.02	0.04	-0.07

Correlations between fatty acid profile and palatability (n = 1,715)

Mineral	MS	WBSF	I Juic	S Juic	I Tend	O Tend	Conn Tiss	BF Flv	P/F Flv	L/M Flv	TBARS
C14:0	**0.12**	**-0.06**	0.02	-0.02	0.04	**0.07**	**0.07**	**0.06**	**-0.07**	-0.01	0.04
C16:1	**0.15**	**-0.09**	**0.10**	**0.09**	**0.06**	**0.06**	0.04	**0.10**	-0.04	0.00	**-0.05**
C18:0	**-0.15**	**0.09**	**0.08**	**0.06**	**-0.09**	**-0.12**	**-0.17**	0.03	**0.16**	-0.02	**-0.06**
C18:1	**0.10**	**-0.08**	**0.05**	**0.07**	**0.08**	**0.10**	**0.10**	0.04	**-0.11**	0.00	**0.09**
C18:2	**-0.41**	**0.15**	**-0.12**	**-0.15**	**-0.19**	**-0.21**	**-0.20**	**-0.08**	**0.12**	0.01	**-0.05**
C18:3 n-3	0.04	0.03	**-0.11**	**-0.08**	**-0.06**	-0.02	-0.01	-0.01	-0.10	**-0.06**	**0.19**
C18:3 n-6	0.02	-0.03	**-0.16**	**-0.15**	-0.01	0.03	**0.07**	-0.01	**-0.07**	**-0.05**	**0.18**

Correlations between fatty acid profile and palatability (n = 1,715)

Mineral	MS	WBSF	I Juic	S Juic	I Tend	O Tend	Conn Tiss	BF Flv	P/F Flv	L/M Flv	TBARS
SFA	-0.02	0.01	0.03	0.02	**-0.05**	-0.04	**-0.07**	**0.06**	**0.05**	-0.03	0.01
MUFA	**0.16**	**-0.11**	**0.13**	**0.13**	**0.08**	**0.10**	**0.07**	**0.14**	-0.04	0.00	**-0.07**
PUFA	**-0.38**	**0.13**	**-0.18**	**-0.19**	**-0.18**	**-0.18**	**-0.15**	**-0.08**	**-0.05**	0.00	0.01
PUFA:SFA	**-0.34**	**0.11**	**0.15**	**-0.16**	**-0.16**	**-0.15**	**-0.14**	**-0.07**	0.02	0.01	0.00
Σ n-3	**-0.07**	0.02	**-0.12**	**-0.11**	**-0.05**	-0.03	0.00	0.06	**-0.07**	-0.03	**0.07**
Σ n-6	**-0.43**	**0.15**	**-0.15**	**-0.17**	**-0.19**	**-0.21**	**-0.20**	**-0.07**	**0.10**	0.02	-0.03
n-3:n-6 ratio	0.01	0.01	-0.03	-0.02	-0.03	-0.01	0.00	-0.03	-0.04	-0.01	**0.05**

Conclusion

- Specific fatty acids and minerals did not demonstrate strong correlations with beef palatability traits
- Lack of consistency between the locations/populations
- Results indicate tenderness, juiciness, and flavor would not be significantly compromised in cattle with enhanced nutritional composition


QUESTIONS