Customer Satisfaction and National Tenderness Survey

Jason M Scheffler

Department of Animal Sciences

UF IFAS
UNIVERSITY of FLORIDA

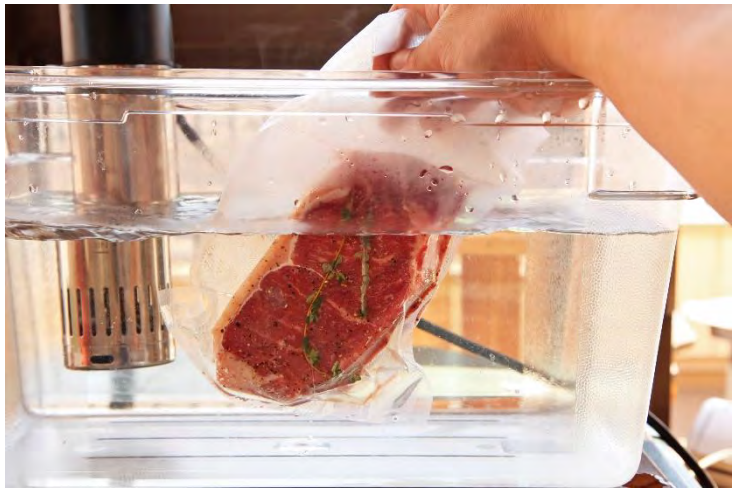
Palatability

- Perceived eating satisfaction influenced by:
  - Flavor 43.4% of variation in overall palatability
  - Juiciness 7.4%
  - Tenderness 49.4%
    - Meta analysis of 11 studies covering 1,500 beef samples and 1,800 customers

O'Quinn et al. 2018. Translational Animal Science 2(1):26–36

Flavor

- Highly complex
  - Degradation of lipids by heat
    - Grass fed
  - Non-enzymatic browning or Maillard reaction
    - Amino acid + Reducing sugar + Dry heat
  - Interaction of lipids and Maillard products



Flavor

- Highly variable acceptability by customer
- Unacceptable flavor more likely to cause steak to be rated unacceptable than tenderness or juiciness (O'Quinn 2018)
- Flavor chemistry is a growing field

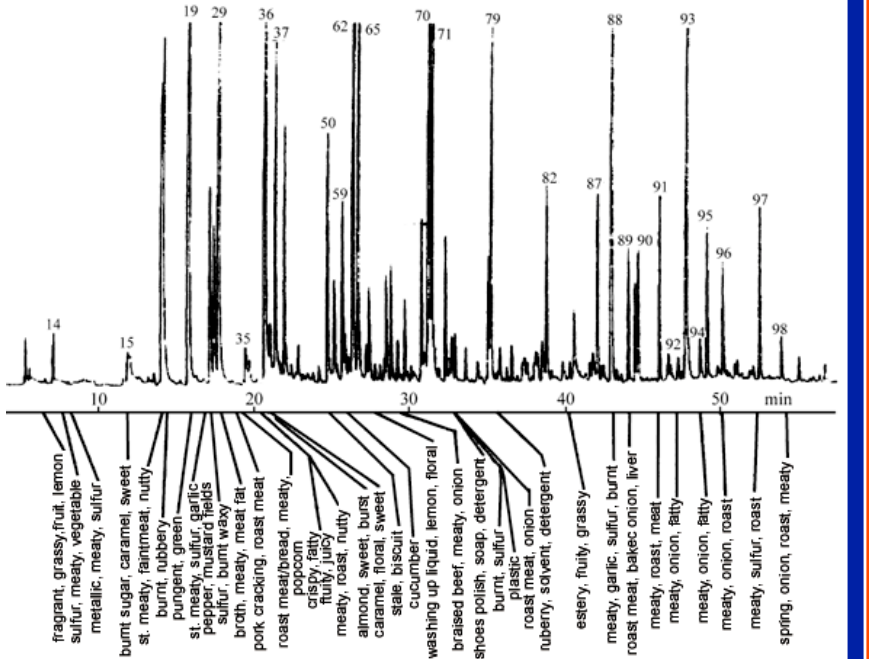


Figure 1. Gas Chromatogram of headspace volatiles collected from 5'-IMP/cysteine model system heated at pH 3.0, showing a summary of the aromas detected in the polar column effluent. Peak numbers related to compounds in Table 1.

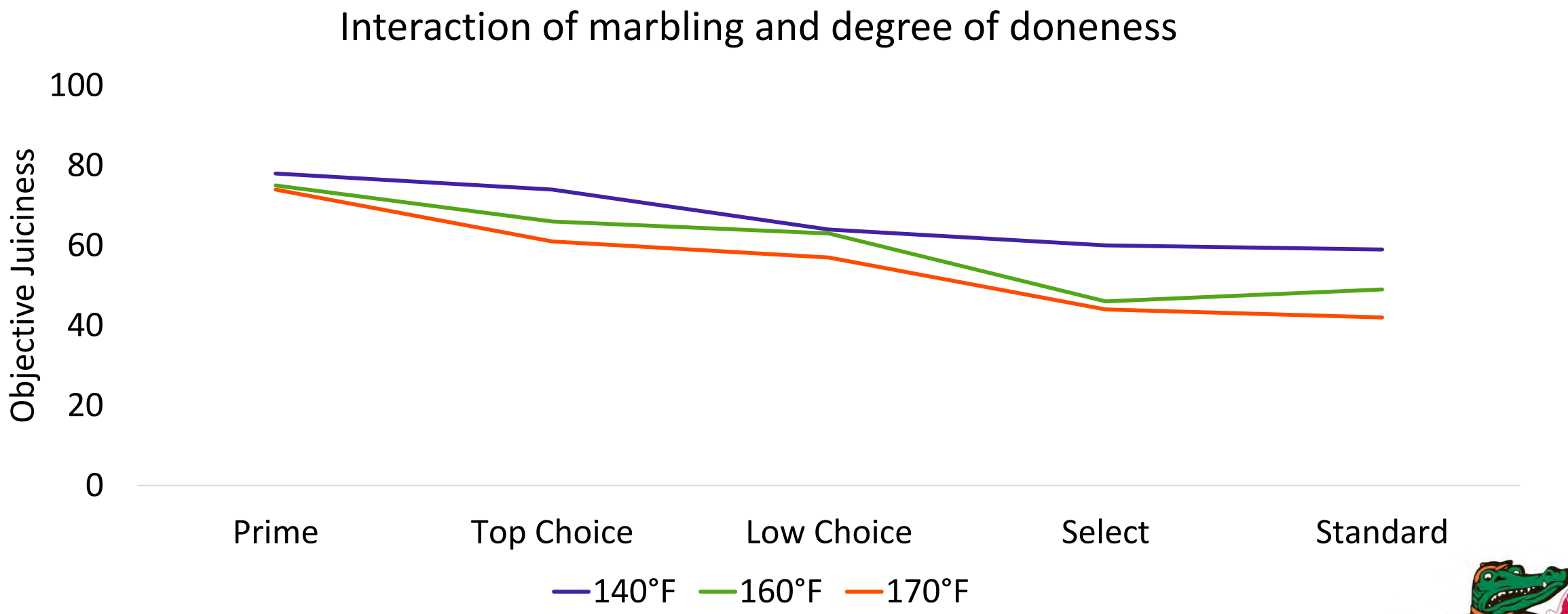
Juiciness

- Marbling
- Endpoint Degree of Doneness

- Perception that marbling provides “insurance”

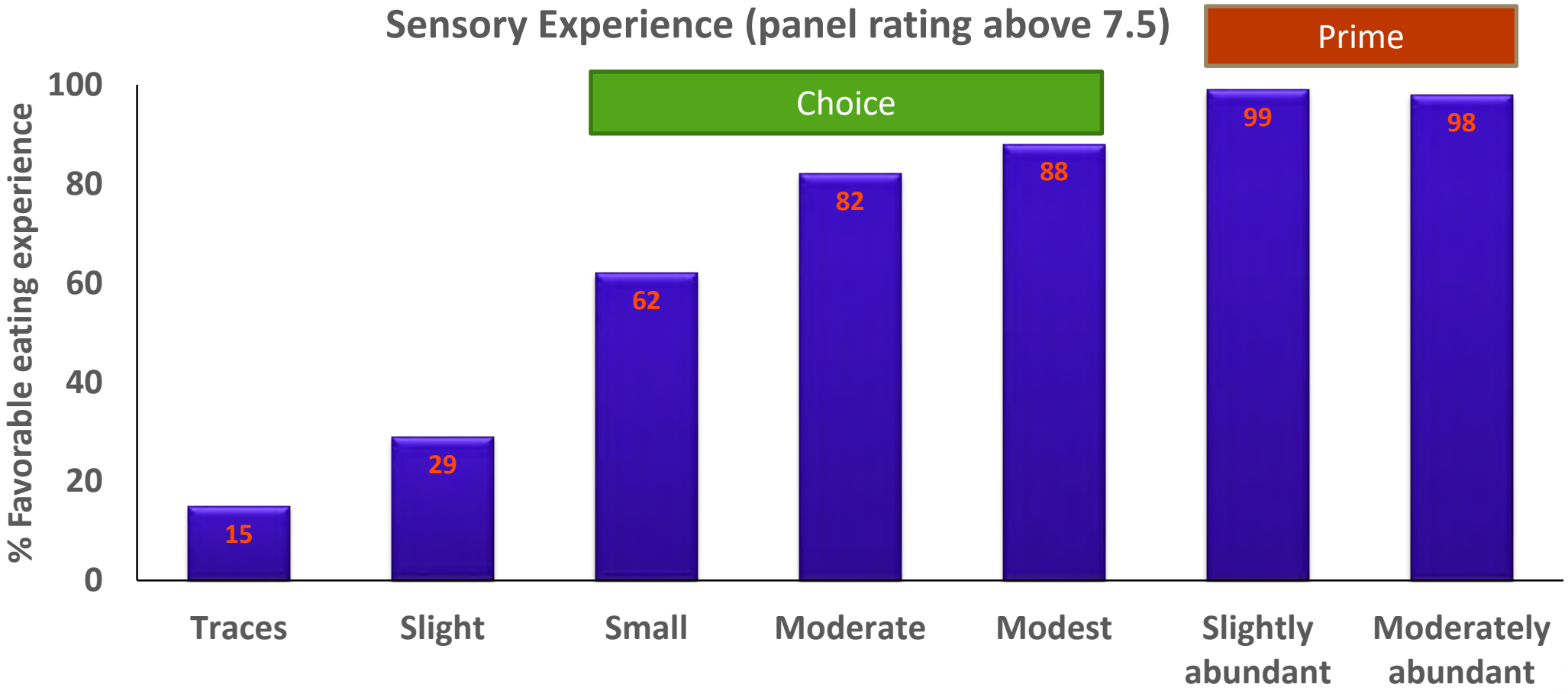
Egbert et al., 1991;
O'Quinn et al., 2012;
Lucherk et al., 2016

Impact of marbling on juiciness



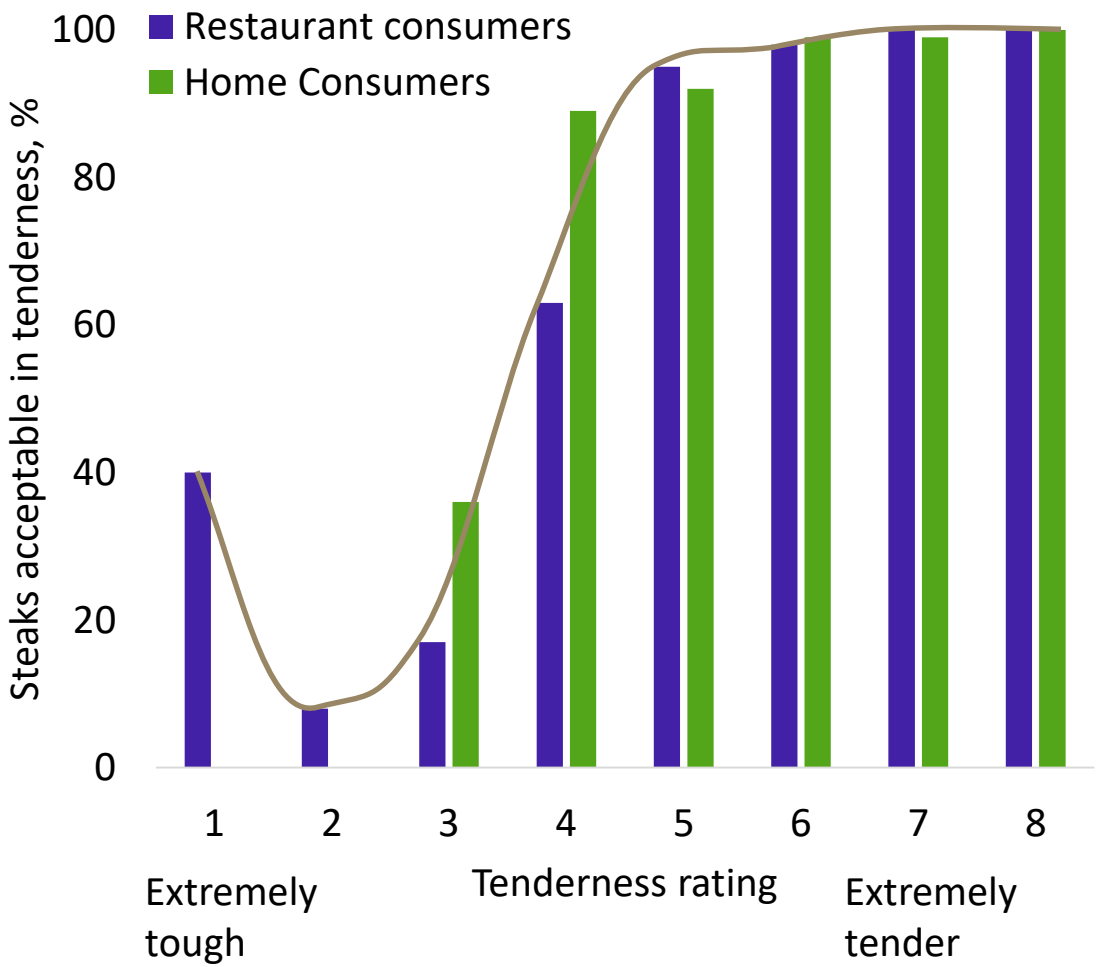
Lucherk et al 2016

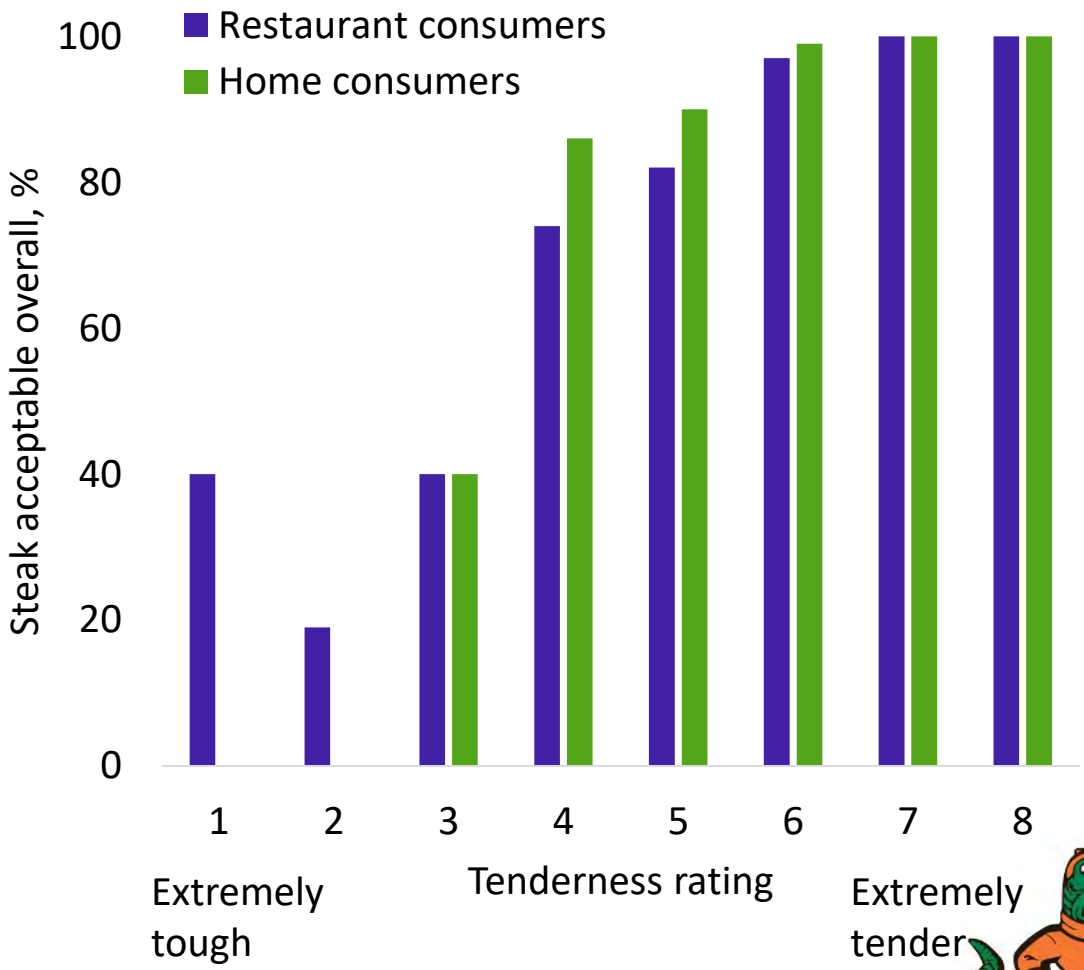
How important is marbling?



Emerson et al. 2011

Importance of beef tenderness

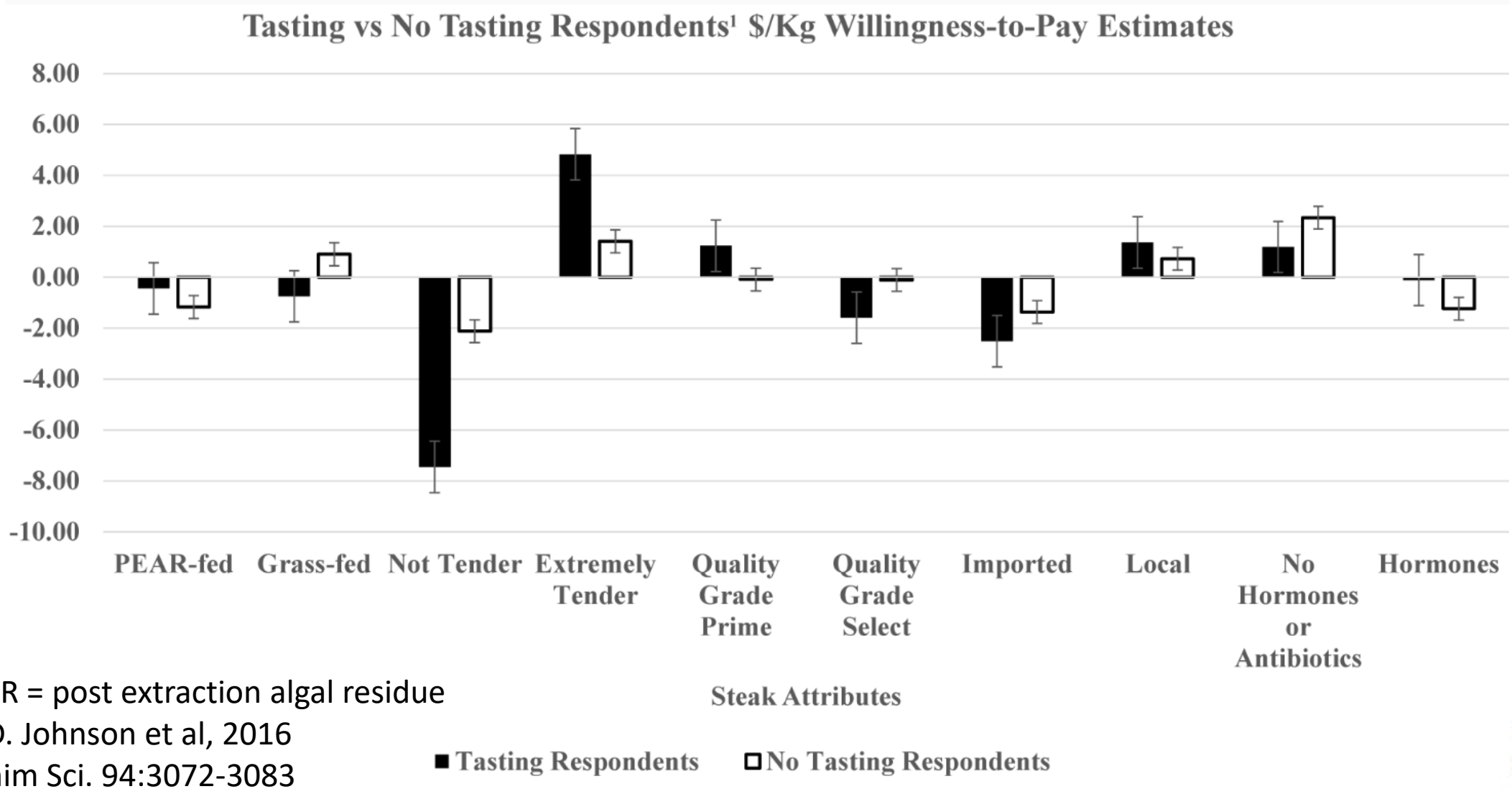




Tenderness had linear relationship with WBSF

Huffman et al. 1996. Journal of Animal Science 74:91-97

Value of tenderness



PEAR = post extraction algal residue

M.D. Johnson et al, 2016

J Anim Sci. 94:3072-3083

Value of tenderness

- Consumers willing to pay $1.23/lb more for steaks after blind taste test (Lusk et al 2001)
- For every 1 lb increase in WBSF, willingness to pay decreased $0.24/lb (Feuz et al 2004)
  - Auction system
    - Increasing # panelists increased bid by $0.29/lb
  - Tenderness was associated with improved juiciness, flavor and overall acceptability

American Journal of Agricultural Economics, 2001, vol. 83, issue 3, 539-550
Journal of Agricultural and Resource Economics Vol. 29, No. 3 (December 2004), pp. 501-516

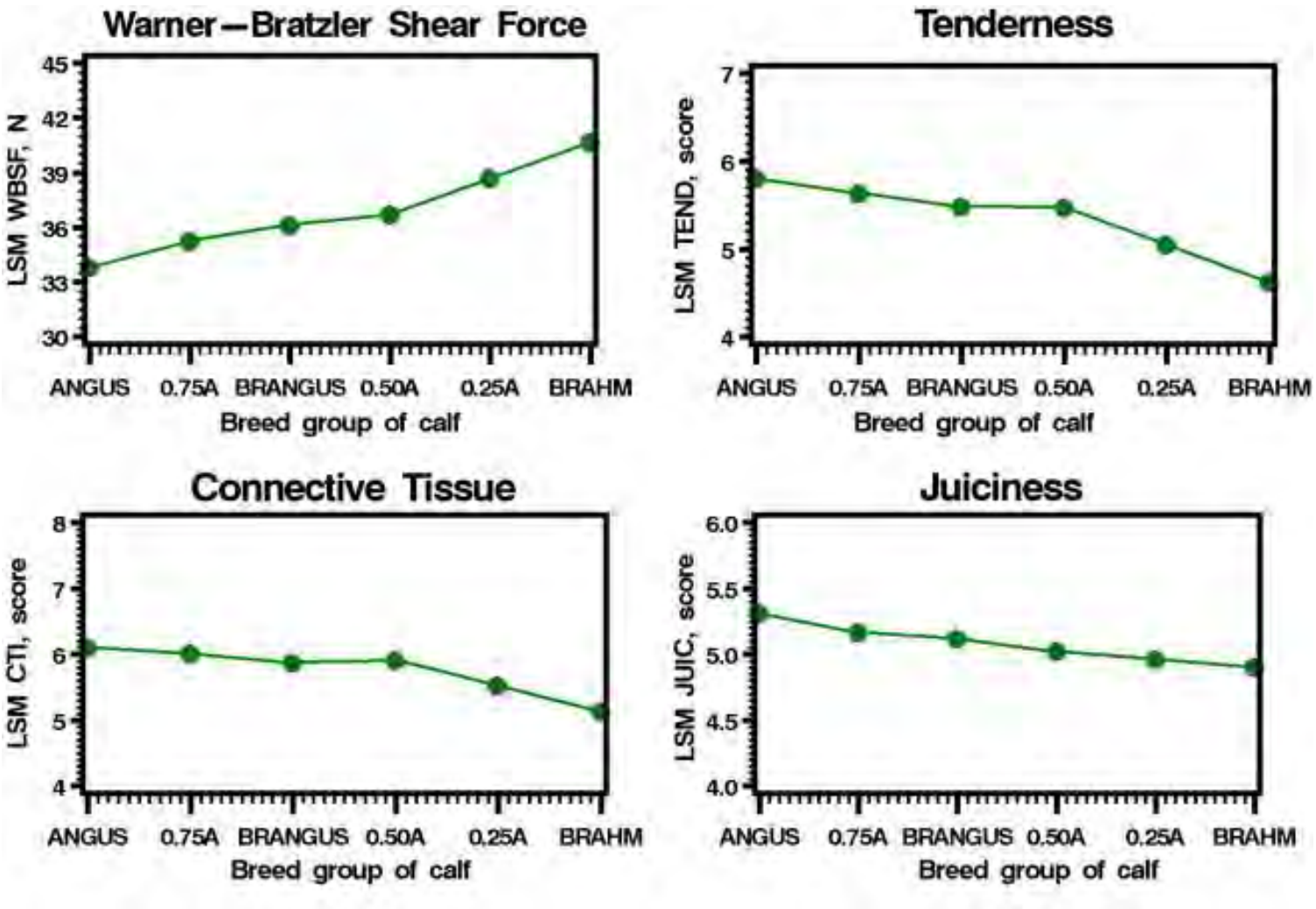
Certified tender

- WBSF <9.7 lbs (4.4 kg)
- Program started in 2014
- Cargill, sold at Harris Teeter in NC
- Success?

https://www.ams.usda.gov/sites/default/files/media/LPSP_Laboratory_Proficiency_Testing_for_Shear_Force%5B1%5D.pdf

Palatability in the UF multibreed herd

- WBSF and tenderness inversely related
- Variation ↑ as Brahman % ↑



Elzo et al 2012.
Meat Science
90(1):87-92

Where tenderness means dollars

- 91 USDA certified beef programs discriminate against carcasses with humps >2”

- Steaks from carcasses with hump height measurements of 7.60 cm (3”) or greater had lower panel tenderness ratings and higher WBS values ($P < .05$) than steaks from carcasses with hump heights less than 6.35 cm (2.5”).

  Sherbeck et al, 1996. J. Anim. Sci. 1996. 74:304–309

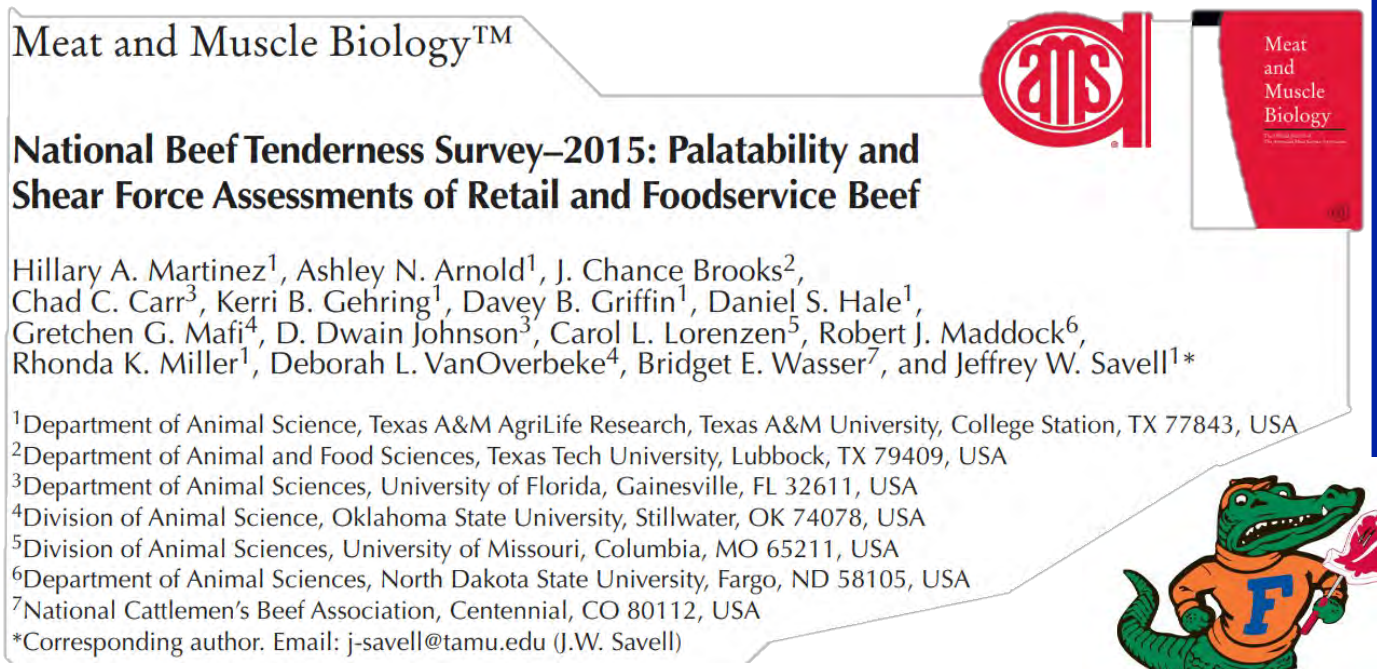
Exceptions

- G5 Swift Chef’s Exclusive EU (JBS)
- G-33 Where Food Comes From Certified Beef Program
- G 38 FM Meat Products Beef
- G 131 Switzerland Export Certified Beef
- G NR Nolan Ryan's Tender Aged Beef

National Beef Tenderness Survey

- Five surveys published 1991, 2000, 2007, 2013, 2015, 2017
- Cross-sectional assessment of retail and food service
- Benchmark tenderness to track progress

- The 2017 study was conducted in 2015



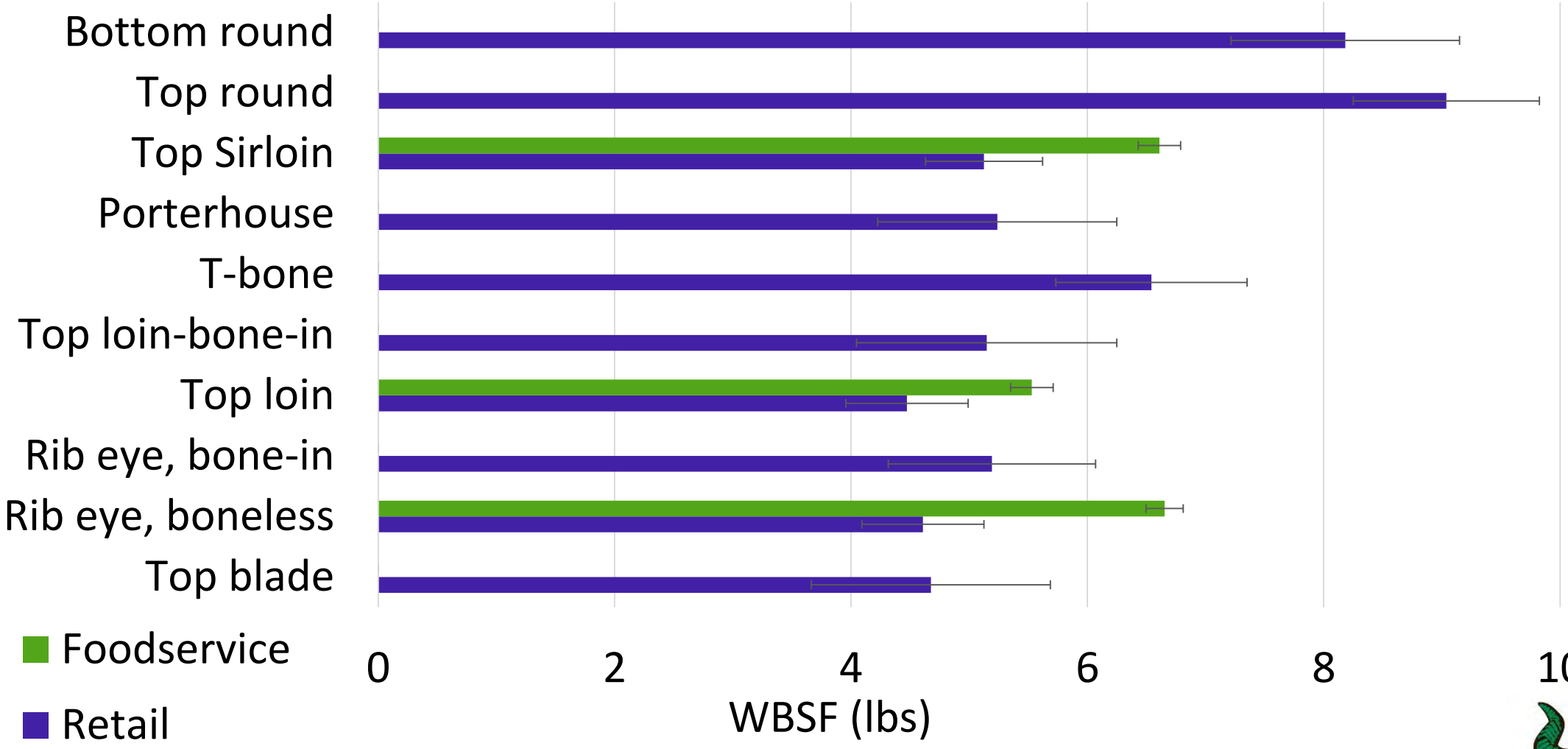
Meat and Muscle Biology™

National Beef Tenderness Survey–2015: Palatability and Shear Force Assessments of Retail and Foodservice Beef

Hillary A. Martinez[1], Ashley N. Arnold[1], J. Chance Brooks[2], Chad C. Carr[3], Kerri B. Gehring[1], Davey B. Griffin[1], Daniel S. Hale[1], Gretchen G. Mafi[4], D. Dwain Johnson[3], Carol L. Lorenzen[5], Robert J. Maddock[6], Rhonda K. Miller[1], Deborah L. VanOverbeke[4], Bridget E. Wasser[7], and Jeffrey W. Savell[1]*

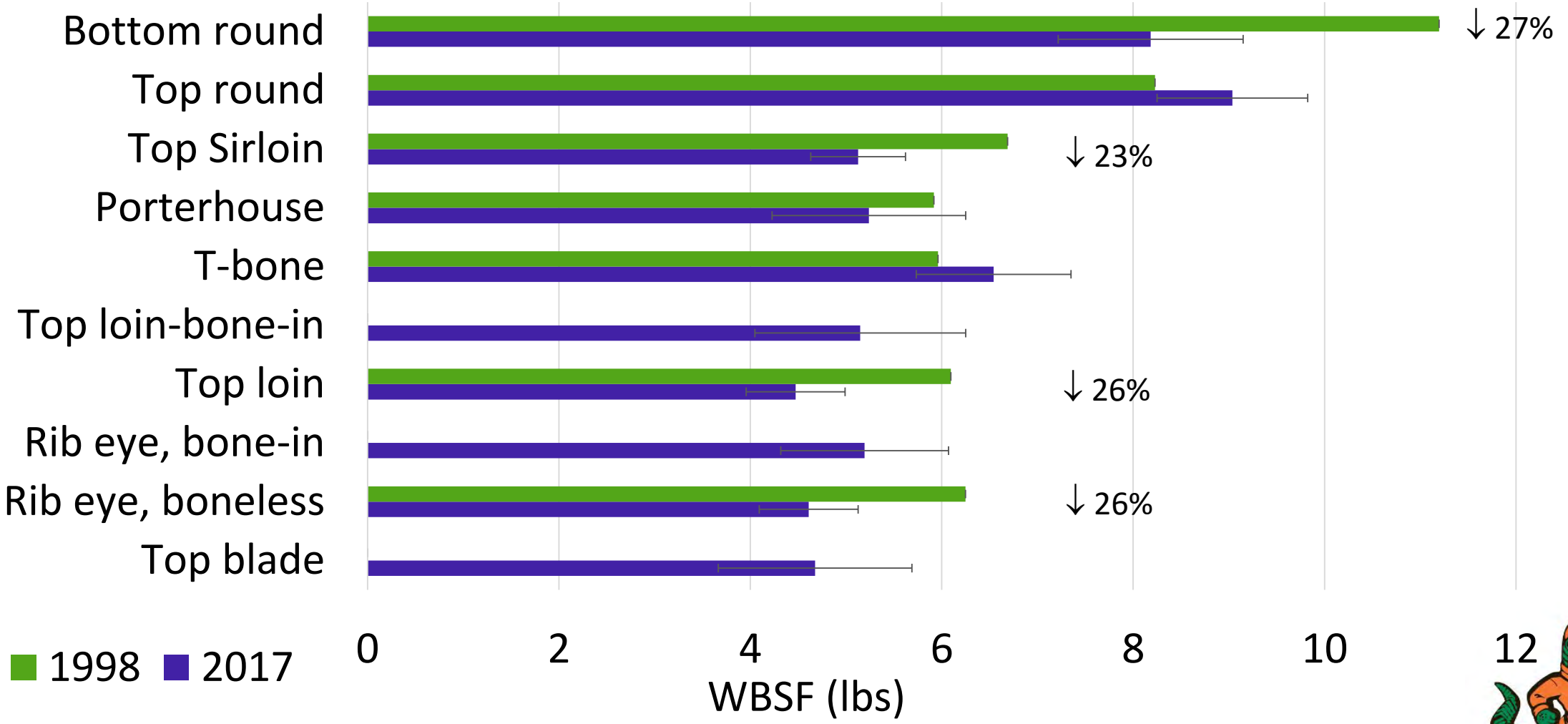
[1]Department of Animal Science, Texas A&M AgriLife Research, Texas A&M University, College Station, TX 77843, USA
[2]Department of Animal and Food Sciences, Texas Tech University, Lubbock, TX 79409, USA
[3]Department of Animal Sciences, University of Florida, Gainesville, FL 32611, USA
[4]Division of Animal Science, Oklahoma State University, Stillwater, OK 74078, USA
[5]Division of Animal Sciences, University of Missouri, Columbia, MO 65211, USA
[6]Department of Animal Sciences, North Dakota State University, Fargo, ND 58105, USA
[7]National Cattlemen's Beef Association, Centennial, CO 80112, USA
*Corresponding author. Email: j-savell@tamu.edu (J.W. Savell)

Warner-Bratzler shear force values of retail and food service steaks



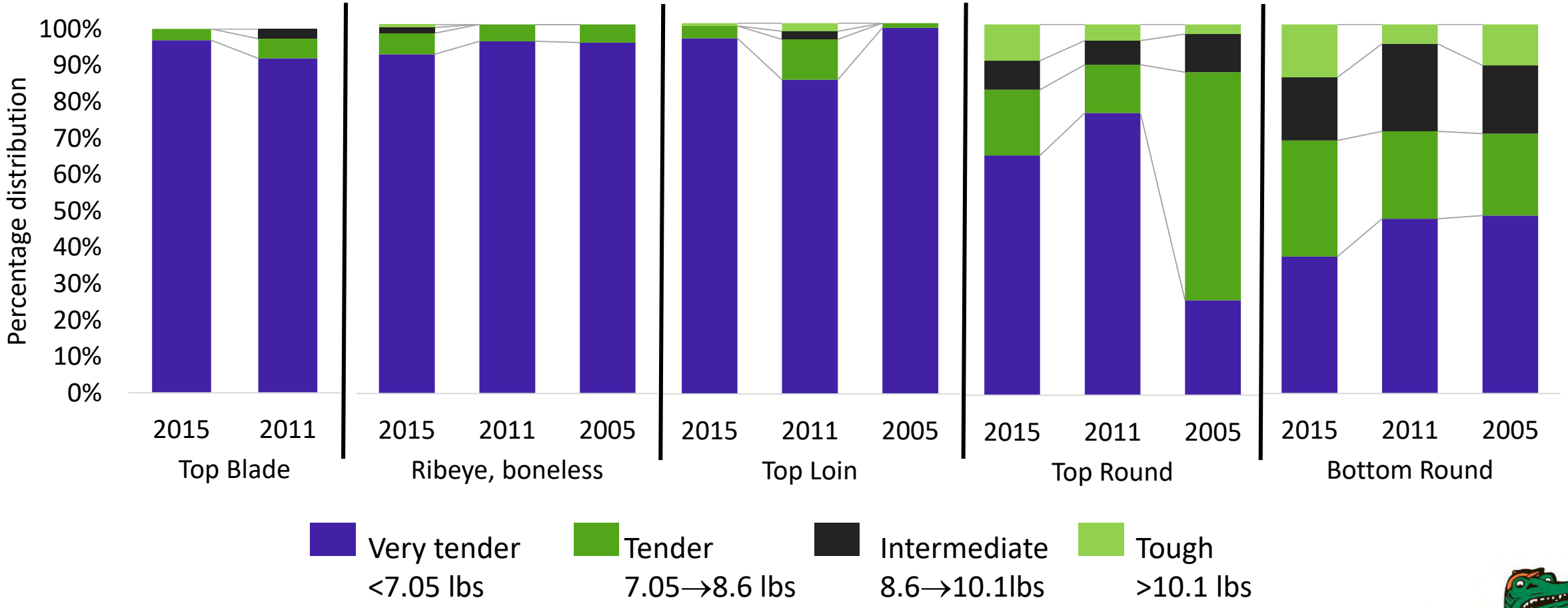
Meat and Muscle Biology 1:138-148

Warner-Bratzler shear force values of retail steaks



Meat and Muscle Biology 1:138-148

Percentage of steaks meeting tenderness thresholds



National Beef Tenderness Survey

- Slow but steady progress
- Need to reduce variation
  - Sorting seems to have pushed less tender product to food service

What influences tenderness?

- Intramuscular fat
- Connective tissue
- Myofibrillar degradation

Tenderness is a byproduct trait

- Most of the known contributing factors to meat tenderness also have functions in the living animal
  - Selection for improved tenderness is often antagonistic to growth and efficiency
- Despite importance, tenderness is a difficult trait to market

When selecting for tenderness

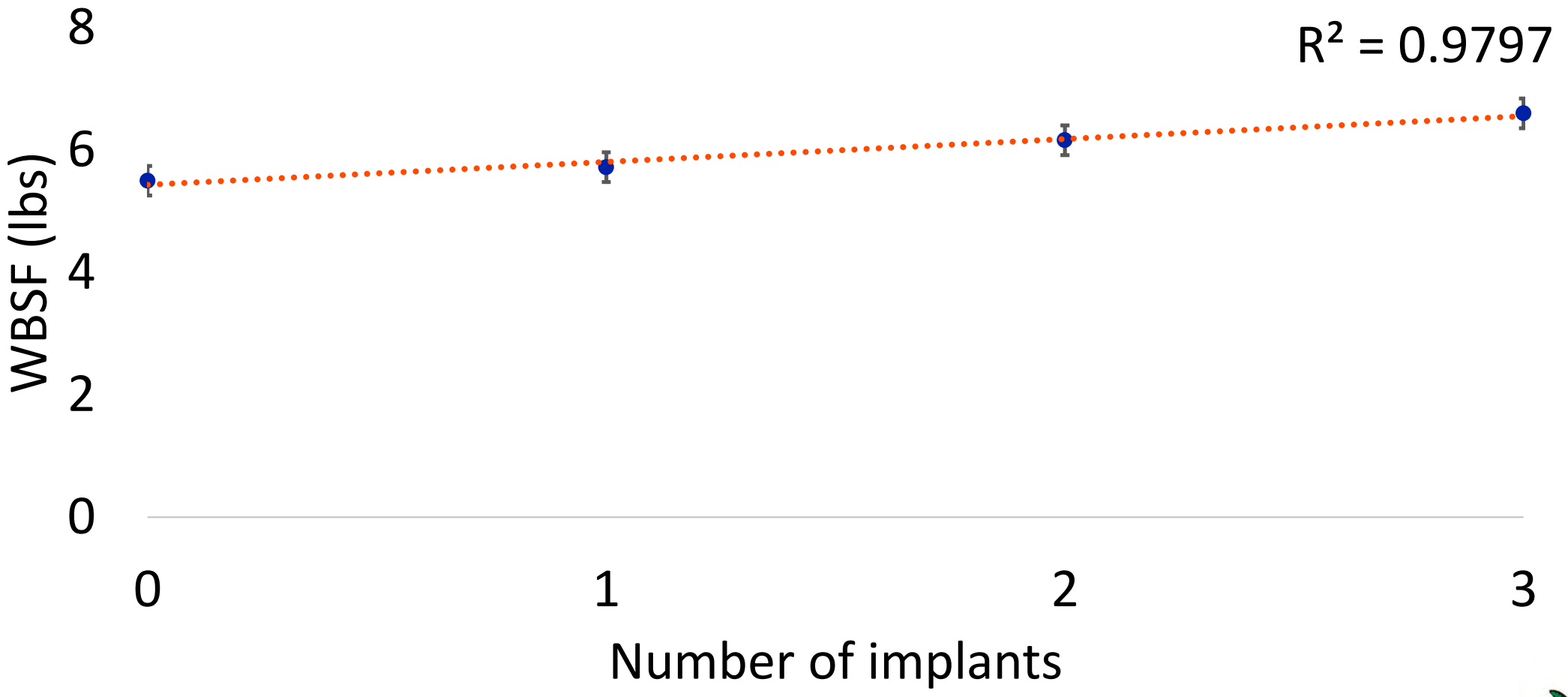
Table 2. Least squares means and standard error for WBSF and the EBV for WBSF of the progeny of tough and tender bulls

	WBSF (lb)		EBV for WBSF (lb)	
Year	Tough	Tender	Tough	Tender
1	$10.71^{a} \pm 0.51$	$8.82^{b} \pm 0.51$	$0.93^{i} \pm 0.20$	$-0.40^{j} \pm 0.20$
2	$7.94^{c} \pm 0.60$	$7.10^{c} \pm 0.66$	$1.12^{k} \pm 0.22$	$-0.93^{i} \pm 0.26$
3	$7.64^{d} \pm 0.66$	$7.54^{d} \pm 0.42$	$0.90^{m} \pm 0.24$	$-0.51^{n} \pm 0.15$
4	$6.28^{e} \pm 0.46$	$5.93^{e} \pm 0.46$	$0.53^{p} \pm 0.18$	$-0.49^{q} \pm 0.18$
5	$7.80^{f} \pm 0.42$	$5.97^{g} \pm 0.49$	$0.82^{r} \pm 0.15$	$-0.57^{s} \pm 0.18$
6	$6.83^{h} \pm 0.49$	$6.17^{h} \pm 0.44$	$0.49^{t} \pm 0.18$	$-0.55^{u} \pm 0.18$

$^{a-u}$Means with the same superscript in the same row are not significantly different at $P<0.05$.

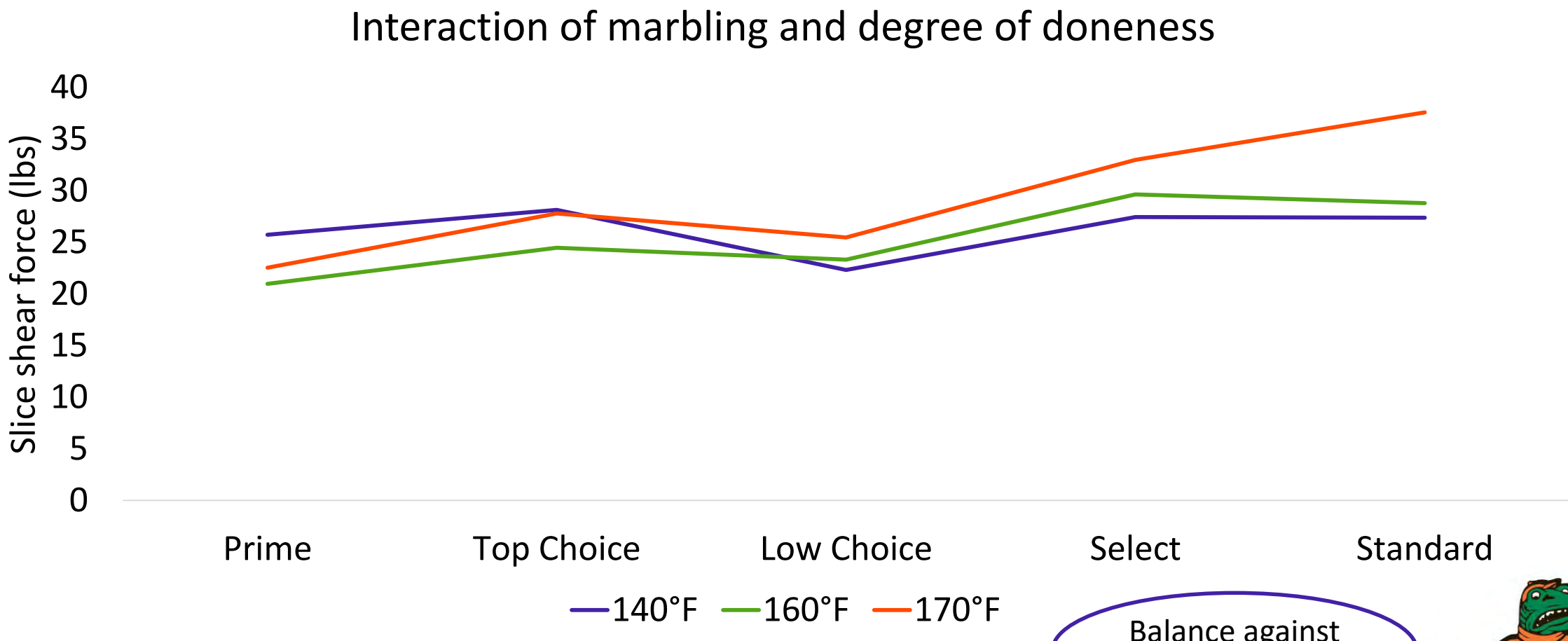
Divergent selection with bulls tested to be tough and tender
Olson, Johnson, and West, 2000
http://ufdcimages.uflib.ufl.edu/AA/00/00/04/12/00001/folsonselmeatten.pdf

Implants reduce tenderness



Scheffler et al. 2003

Marbling and Tenderness



Balance against feed costs?

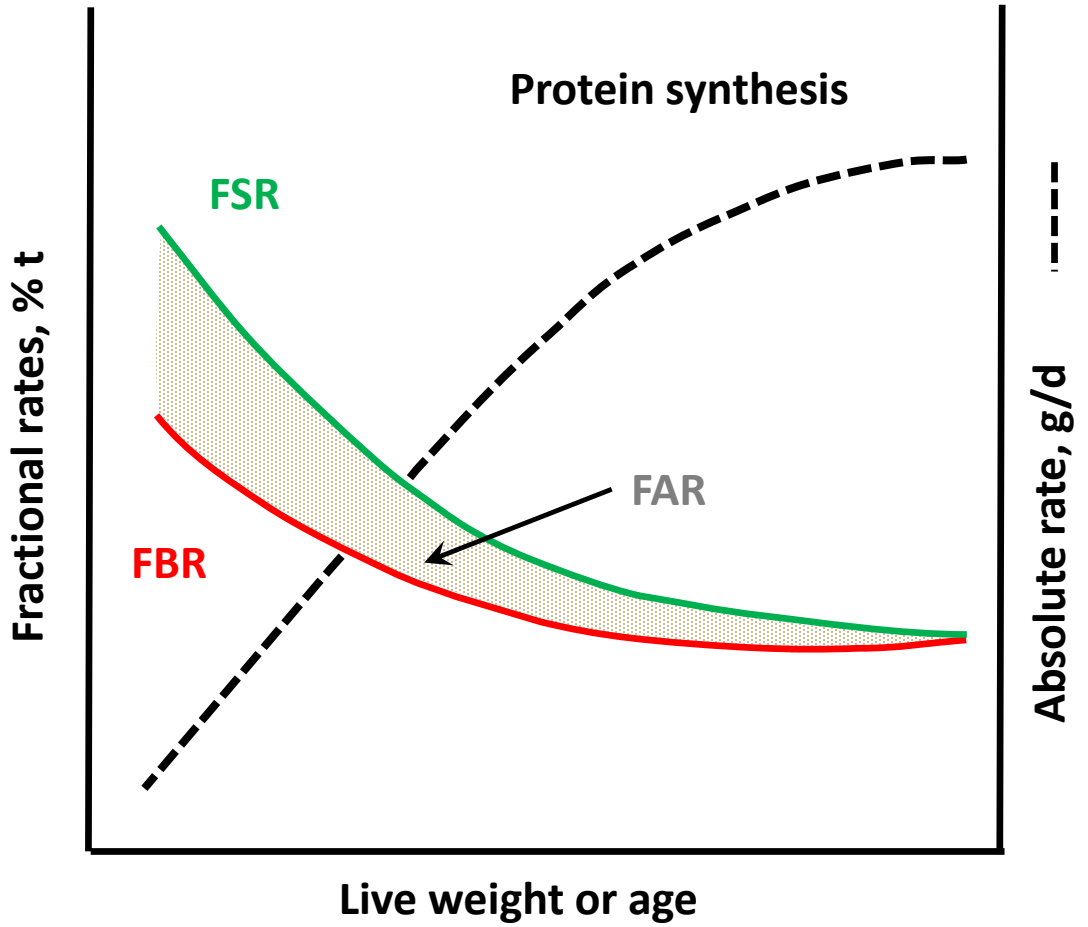
Adapted from Lucherk et al 2016

Protein accumulation

- Fractional rates are highest in young animals
- Difference diminishes as animals approach maturity

- Increasing breakdown to improve tenderness may inadvertently slow down growth

- Challenge
  - How to find the balance between antemortem and postmortem breakdown?



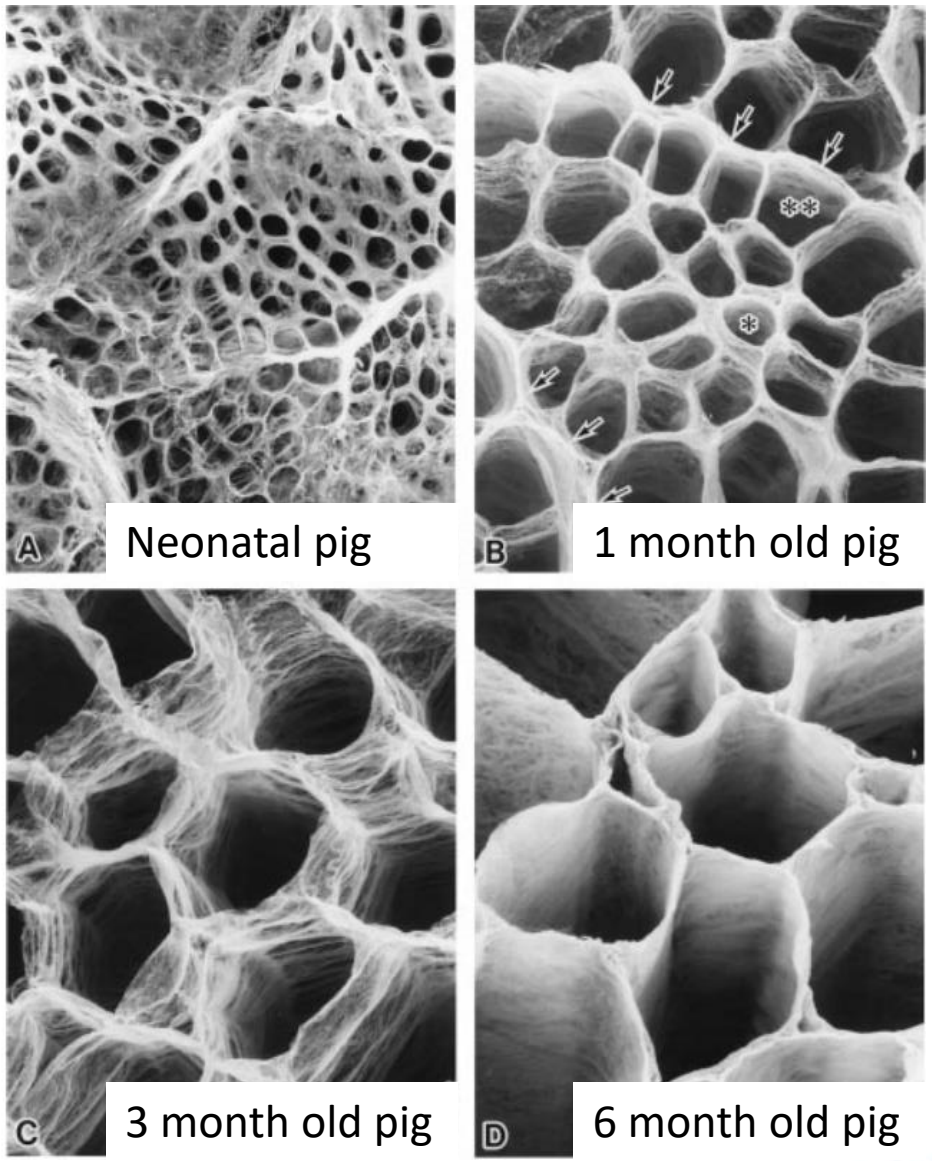
Adapted by T Scheffler

Bergen & Merkel, 1991

Changes in Collagen with growth

- Abundance
- Amount of crosslinking

- Both increase with age
- Both higher in locomotion muscles



Fang et al. J Anim Sci. 77:120

Factors Influencing Tenderness in Steaks From Brahman Cattle

Simple correlations of tenderness traits with other carcass and palatability traits of Brahman cattle

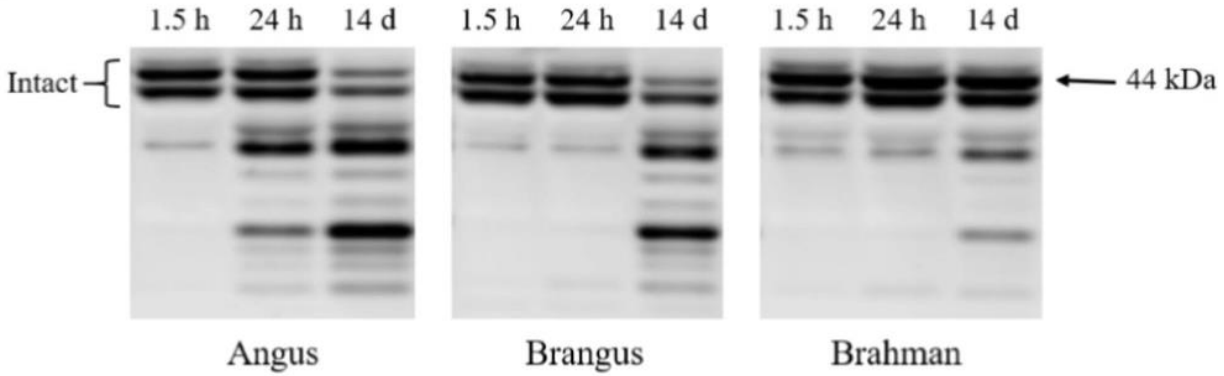
Days of aging	WBSF		
	7	14	21
Carcass weight, kg	**−0.21**	**−0.21**	**−0.15**
12th rib fat thickness, mm	**−0.29**	**−0.25**	**−0.27**
Ribeye area, cm^2	**−0.18**	**−0.22**	**−0.10**
Lean maturity	0.07	**0.10**	**0.15**
Skeletal maturity	**−0.28**	**−0.26**	**−0.24**
Lean color	**−0.30**	**−0.18**	**−0.25**
Lean texture	**0.19**	**0.18**	**0.20**
Lean firmness	**−0.12**	**−0.12**	**−0.13**
Marbling score	**−0.13**	**−0.18**	**−0.13**
Hump height, cm	**0.52**	**0.44**	**0.43**
Raw lipids, %	**−0.20**	**−0.12**	**−0.16**
Collagen, mg per g muscle			
Total	**0.66**	**0.56**	**0.82**
Insoluble	**0.66**	**0.57**	**0.83**
Calpastatin, units/g muscle	**−0.12**	−0.05	−0.06
Sarcomere length, μm	−0.02	−0.07	**−0.08**

Riley et al. 2005. Meat Science 70 :347–356

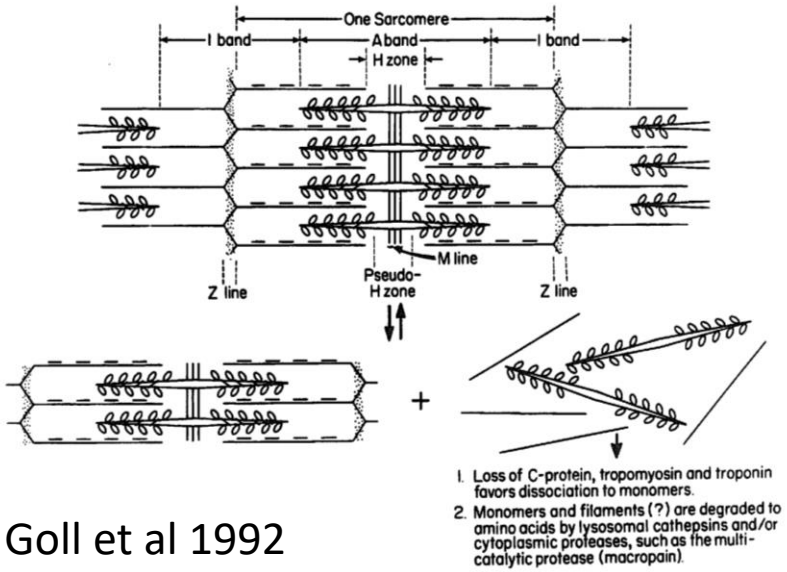
Calpain

- Calcium-activated protease (μ and m)
- Inhibited by calpastatin

- Important for muscle growth/ protein turnover



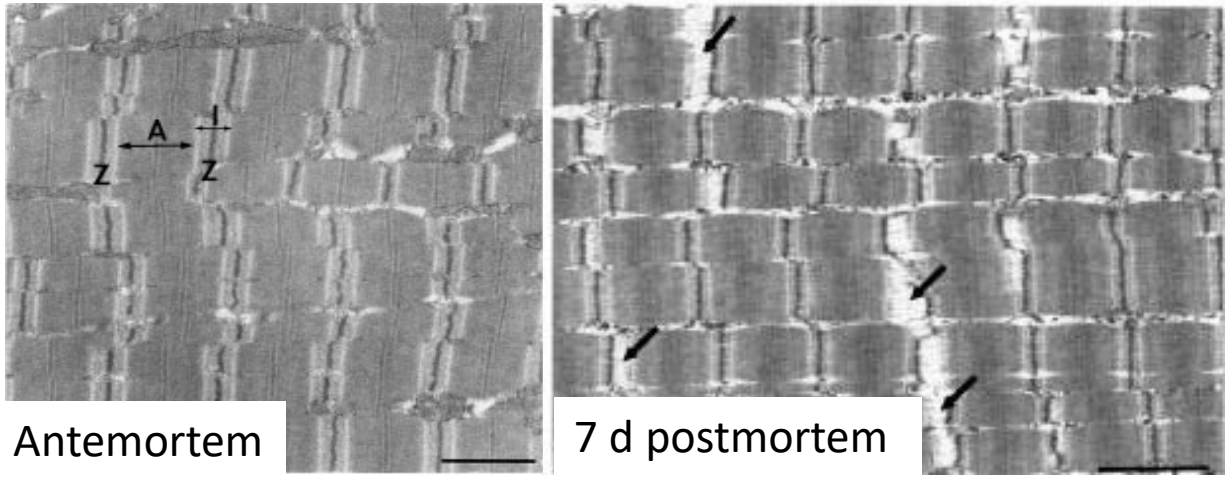
Troponin degradation by calpain; Wright et al 2018



Goll et al 1992

Other enzymes possibly involved in protein degradation

- Caspases?
- Cathepsins?
- Lysosomal proteases (cathepsins)?
- Ubiquitin proteasome?



Antemortem

7 d postmortem

Do their targets degrade post mortem?

Are they active post mortem?

Are they located near targets?

Inhibitors present, activators required?

Summary

- Consumer satisfaction is a function of flavor, juiciness, and tenderness
  - Beef isn't going to out price other proteins, it needs to be more satisfying
- Need to improve meat quality and/or better sort product
  - As sorting gets better, how will that impact the valuation of your cattle?
- Tenderness needs to improve, but not at the detriment of other economically important traits

Thank you

jmscheff@ufl.edu

@UFloridaBrahman

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