Project Title: Using Serum Chemistry Profiles to Predict Beef Tenderness for the Purpose of On-line Instrument Grading

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Background

USDA quality grades have been used to assign carcasses into groups of expected eating quality. Quality grades are based primarily on evaluations of carcass maturity and the amount of intramuscular fat (marbling) present in the longissimus muscle. Both of these factors have been shown by numerous researchers to significantly impact beef palatability. Increased maturity has been associated with decreased palatability, however the majority of carcasses within the fed steer and heifer population fall into the "A" maturity group (less than 30 months). The 2000 National Beef Quality Audit reported that 77 percent of all carcasses from the U.S. steer and heifer population had marbling scores of "small" or "slight." Based on these factors, the majority of fed steers and heifers fall in a narrow marbling and maturity range, however substantial palatability differences still occur.

As a result, the beef industry has investigated additional methods to predict palatability, as USDA quality grades do not always effectively segregate carcasses into uniform quality groups. Blood constituents may be a useful method for predicting cooked beef tenderness as many factors shown to influence tenderness are affected, controlled or result in changes in blood or serum chemistry.

Previous research conducted by South Dakota State University (SDSU) researchers substantiated the assumption that blood constituents (minerals, enzymes and hormones) could be used to predict meat tenderness. The objective of this project was to validate using blood chemistry analysis as a means of predicting beef tenderness.

Methodology

Data were collected from 286 head of cattle on five different dates at three different federally inspected facilities. Blood samples were collected immediately following harvest, and analyzed for nineteen compounds (albumin, alkaline phosphatase, amylase, aspartate aminotransferase, β-hydroxy butyric acid, calcium, chloride, creatinine, creatinine phosphokinase, γ-glutamyltransferase, globulin, glucose, magnesium, non-esterified fatty acids, phosphorus, potassium, sodium, total bilirubin, and total protein). Additionally, serum samples were assayed for glucagon and cortisol. These serum profiles were then used to predict how tender the steaks would be from that particular animal.

After a 24-hour chill, experienced evaluators determined USDA yield and quality grades. After an approximately 90-minute bloom time, muscle color measurements on the longissimus at the twelfth and thirteenth rib interface were measured with a HunterLabs MiniScan XE colorimeter (Hunter Associates Laboratory, Inc., Reston, VA).

A one-inch thick steak was removed from the thirteenth rib location from each side of each carcass and analyzed for Warner-Bratzler shear force values.

Findings

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Carcass traits as determined by experienced graders were generally representative of the population sampled in the 2000 National Beef Quality Audit.

Table 1. Means, standard deviations and minimum and maximum values for various carcass traits.

Trait	Mean	Std. Deviation	Minimum	Maximum
Carcass weight (pounds)	799.9	93.7	531	1101
Adjusted fat thickness (inches)	0.51	0.23	0	1.6
Longissimus muscle area	13.9	1.8	10.2	20
Kidney, pelvic, and heart fat	2.4	0.5	1.0	4.5
USDA yield grade	2.8	1.0	0.3	6.7
Marbling score[a]	406.4	77.1	220	820
Skeletal maturity[b]	153	18.2	130	330
Lean maturity[b]	154.2	14.3	120	230
Overall maturity[b]	153.5	14.8	130	300
USDA quality grade[c]	683.2	47.4	407	840
L	39.6	3.2	30.4	49.8
A	24.0	2.7	14.2	49.2
b	20.4	3.1	8.1	34

[a] 300 = Slight^{00}, 400 = Small^{00}, etc.
[b] 100 = A^{00}, 200 = B^{00}, etc.
[c] 600 = Select^{00}, 700 = Choice^{00}, etc.

A threshold value of 20 kilograms (kg) for 14-day shear force was used as a baseline to determine "tender" versus "tough" carcasses. The 20-kilogram threshold was lower than that chosen in similar research (27 kilograms) but was used in this study as the researchers found a relatively small percentage of carcasses with 14-day slice shear force values greater than 27 kilograms.

Least square means for serum chemistry profiles for tender and tough carcasses are shown in Table 2. Tender carcasses had lower aspartate aminotransferase, calcium, non-esterfied fatty acids, phosphorus, potassium, sodium and higher cortisol levels than tough carcasses. Researchers developed a regression analysis that incorporated multiple variables in order to classify carcasses into either a "Certified Tender" or "Not Certified Tender" group. The researchers at SDSU found using serum profiles is a better predictor of tenderness than the current USDA quality grading system, which uses marbling and maturity to predict eating quality.

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Table 2. Least square means for serum chemistry profiles for tender and tough carcasses.

Compound (units vary)	Tender (n = 254)	Tough (n = 32)
Albumin	4.53 +/- 0.04	4.64 +/- 0.11
Alkaline phosphatase	144.74 +/- 3.42	148.53 +/-9.64
Amylase	18.95 +/- 0.44	19.59 +/- 1.23
Aspartate aminotransferase	84.24 +/- 1.58	94.97 +/- 4.43
Calcium	9.51 +/- 0.09	10.09 +/- 0.26
Chloride	103.56 +/- 0.49	106.26 +/- 1.41
Cortisol	6.43 +/- 0.13	5.26 +/- 0.36
Creatine phosphokinase	593.53 +/- 33.01	611.28 +/- 92.82
Creatinine	1.78 +/- 0.03	1.96 +/- 0.10
γ-glutamyltransferase	33.01 +/- 0.92	37.44 +/- 2.59
Globulin	4.24 +/- 0.07	4.66 +/- 0.21
Glucagon	683.22 +/-44.65	761.06 +/- 125.80
Glucose	189.23 +/- 5.56	214.56 +/- 15.66
Magnesium	2.10 +/- 0.02	2.20 +/- 0.06
Non-esterfied fatty acids	0.20 +/- 0.01	0.25 +/- 0.02
Phosphorus	7.35 +/- 0.10	8.02 +/- 0.27
Potassium	7.55 +/- 0.07	8.11 +/- 0.20
Sodium	149.68 +/-0.54	153.33 +/- 1.52
Total bilirubin	0.45 +/- 0.01	0.46 +/- 0.03
Total protein	8.81 +/- 0.10	9.30 +/- 0.27

Results from this study show that using blood chemistry profiles can decrease the potential to incorrectly classify tender beef from 8 percent to 5.3 percent. The ability to correctly certify tender beef improved from 61.5 percent for USDA quality grades to 65.4 percent when using the serum blood chemistry levels.

In conclusion, predicting tenderness using blood chemistry was more accurate than predicting tenderness with USDA quality grades but not as accurate as two-day slice shear force. Predicting tenderness using blood chemistry was similar in accuracy to tenderness prediction using measures of muscle color, but muscle color measurement could probably be applied at a much lower cost.

Implications

Blood chemistry was shown to be more accurate that USDA quality grades as a predictor of beef tenderness, but the cost may not make blood chemistry analysis a practical technology to use in commercial slaughter facilities. It may, however, have application in progeny testing of live cattle for genetic selection to improve tenderness.

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