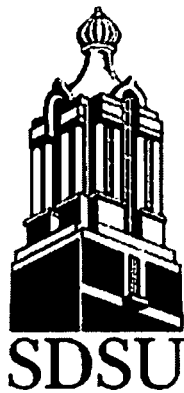


# **Using Impedance to Predict Beef Tenderness – Dumas, TX**

A Report to:  
Nolan Ryan's Guaranteed Tender Meats  
and Swift and Company

Tim Nath and Duane Wulf  
South Dakota State University

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## **Material and Methods**

Four day sample collection at Dumas, TX Swift plant (July 9 to 12).

Impedance testing conducted with both surface and penetrating electrode arrays.

Day one (Monday) impedance testing of 300 head to identify population variation and set selection standards for days two through four.

Day two (Tuesday) 100 head tested with BeefCam, NIR and Impedance and sampled for WB Shear Force.

Day three (Wednesday) 100 new head tested with BeefCam, NIR and Impedance and sampled for WB Shear Force; day one group retested with impedance.

Day four (Thursday) 100 new head tested with BeefCam, NIR and Impedance and sampled for WB Shear Force; day one group retested with impedance.

All meat sampled transported back to SDSU Meat Laboratory under refrigeration, aged in vacuum packages at 35°F until 14 days postmortem, cooked to 160 °F, cooled overnight, and sheared on Warner-Bratzler Shear Machine.

## Results

By themselves, NIR explained 7% of the variation in 14-d shear force, Impedance explained 5% of the variation, and BeefCam explained 3% of the variation (Table 1). When used together, NIR and Impedance explained 12% of the variation. Because they are additive, it appears that NIR and Impedance are measuring two different components of beef tenderness. Impedance measured on steaks at day 14 explained 16% of the variation in 14-d shear force.

**Table 1. R-squares for various prediction models to predict 14-d WB shear force.**

<b>Prediction Model</b>	<b>R-square</b>
SDSU Carcass Data	0.07
Camera Carcass Data	0.06
Camera Color Data	0.05
BeefCam	0.03
NIR	0.07
Impedance	0.05
14-d Impedance	0.16
CamCarc+CamColor	0.11
CamCarc+BeefCam	0.07
CamCarc+NIR	0.13
CamCarc+Impede	0.12
CamColor+BeefCam	0.05
CamColor+NIR	0.09
CamColor+Impede	0.11
BeefCam+NIR	0.10
BeefCam+Impede	0.07
NIR+Impede	0.12
CamCarc+CamColor+BeefCam	0.11
CamCarc+CamColor+NIR	0.15
CamCarc+CamColor+Impede	0.17
CamCarc+BeefCam+NIR	0.14
CamCarc+BeefCam+Impede	0.12
CamCarc+NIR+Impede	0.18
CamColor+BeefCam+NIR	0.11
CamColor+BeefCam+Impede	0.12
CamColor+NIR+Impede	0.16
BeefCam+NIR+Impede	0.15
CamCarc+CamColor+BeefCam+NIR	0.16
CamCarc+CamColor+BeefCam+Impede	0.17
CamCarc+CamColor+NIR+Impede	0.21
CamCarc+BeefCam+NIR+Impede	0.19
CamColor+BeefCam+NIR+Impede	0.17
<b>CamCarc+CamColor+BeefCam+NIR+Impede</b>	<b>0.21</b>

If an instrument is to be used to “eliminate the tough cattle”, it must be able to certify a large percentage of the population while minimizing the percentage tough cattle within the certified group. The 70 to 90% certification rates are highlighted in Table 2 because these would be of the most interest in this “eliminate-the-tough-cattle” scenario. The NIR system was the most effective instrument at eliminating the tough cattle (Table 2). Neither marbling nor Impedance were useful in trying to sort off the tough cattle and certify a large percentage of the population.

**Table 2. Percentage of tough carcasses by certification rate and instrument.**  
**Percentage Tough (>5.0 kg) of Certified Carcasses**

Certification Rate, %	Marbling	NIR	BeefCam	Impedance	NIR + Impedance	No System	Perfect System	Impedance d14
10	3.3	0.0	0.0	0.0	0.0	4.3	0.0	0.0
20	3.3	0.0	0.0	0.0	0.0	4.3	0.0	0.0
30	2.2	0.0	2.4	1.1	0.0	4.3	0.0	0.0
40	1.7	0.0	1.8	1.7	0.0	4.3	0.0	1.7
50	4.0	0.7	1.4	2.7	0.7	4.3	0.0	1.3
60	4.4	1.7	1.8	4.4	1.1	4.3	0.0	1.7
70	3.8	2.4	2.5	4.8	1.4	4.3	0.0	1.4
80	4.6	2.1	4.0	4.2	2.1	4.3	0.0	2.9
90	4.8	3.4	3.6	4.4	3.4	4.3	0.0	3.0
100	4.3	4.4	4.6	4.3	4.4	4.3	4.3	4.3
n	300	295	281	300	295	300	300	300

If an instrument is able to “identify the very tender cattle”, it could be used to “cream the crop” and produce a select group of exceptional beef. The 20 to 40% certification rates are highlighted in Table 3 because these would be of the most interest in this “identify-the-very-tender-cattle” scenario. The Impedance system was the most effective instrument at identifying the very tender cattle (Table 3). The NIR system was not useful in trying to sort off the very tender cattle. Therefore, it appears that the reason that NIR and Impedance appeared additive in Table 1 was because NIR is the most effective at identifying the tough cattle while Impedance is not at all effective at identifying tough cattle, whereas Impedance is the most effective at identifying the very tender cattle while NIR is not at all effective at identifying very tender cattle.

**Table 3. Percentage of very tender carcasses by certification rate and instrument.**  
**Percentage Very Tender (<3.0 kg) of Certified Carcasses**

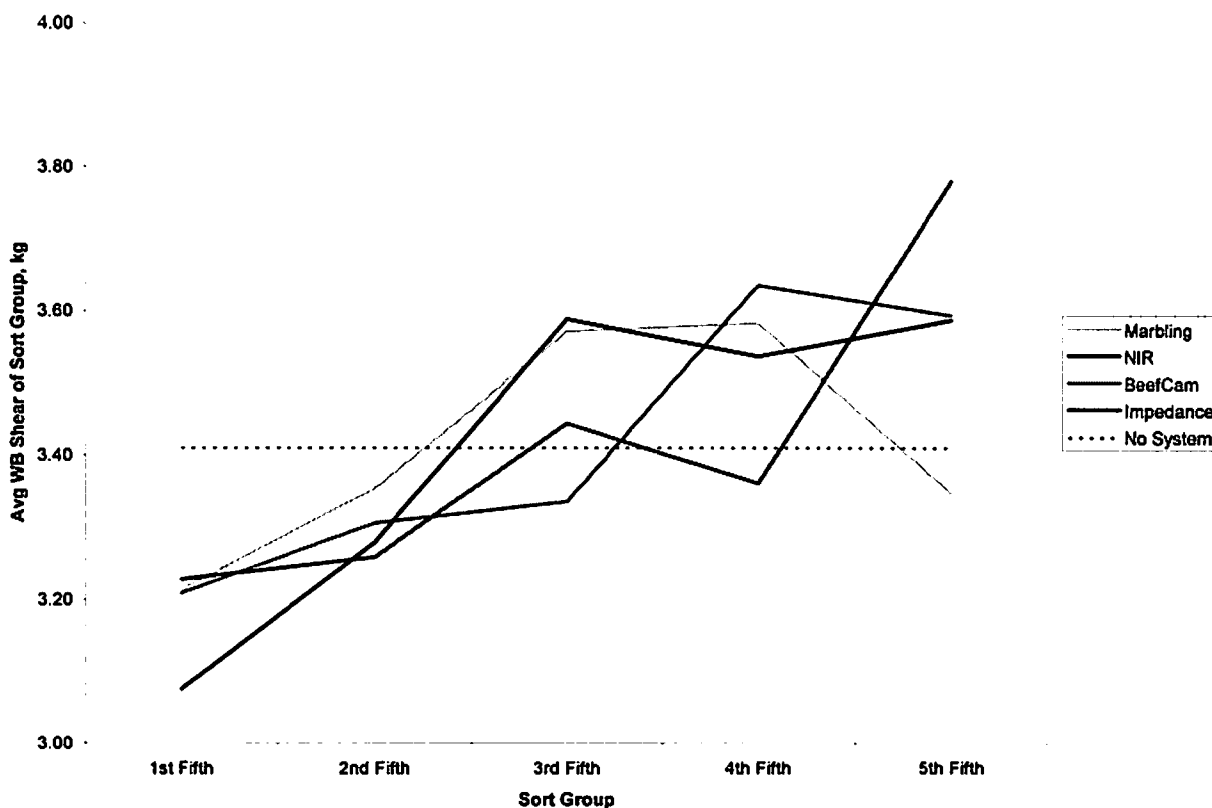
Certification Rate, %	Marbling	NIR	BeefCam	Impedance	NIR + Impedance	No System	Perfect System	Impedance d14
10	46.7	36.7	42.9	46.7	44.8	30.3	100.0	43.3
20	43.3	33.9	46.4	48.3	42.4	30.3	100.0	43.3
30	40.0	33.7	40.5	46.7	46.1	30.3	100.0	37.8
40	37.5	35.6	42.0	45.0	39.0	30.3	75.8	35.0
50	36.7	33.1	38.0	41.3	40.0	30.3	60.7	35.3
60	33.3	33.3	38.5	38.3	37.3	30.3	50.6	35.0
70	33.3	32.9	36.5	35.7	35.3	30.3	43.3	33.3
80	30.8	32.2	34.2	33.3	35.2	30.3	37.9	32.5
90	30.7	31.6	32.8	32.6	32.7	30.3	33.7	33.0
100	30.3	30.5	31.7	30.3	30.5	30.3	30.3	30.3
n	300	295	281	300	295	300	300	300

Another way to compare the technologies is to look at their effectiveness to sort into tenderness groups. Table 4 and Figure 5 show average 14-d WB shear force for each fifth of the sample population sorted by predicted tenderness by each instrument. Each fifth contains 56 to 60 head. The 1<sup>st</sup> fifth is predicted to be the most tender and the 5<sup>th</sup> fifth is predicted to be the least tender. Similar to the results in Tables 2 and 3, Impedance was the most effective technology at identifying the most tender cattle, whereas NIR was the most effective technology at identifying the toughest cattle.

**Table 4. Average WB shear force for sort groups (fifths) by instrument.**  
**Average W-B Shear Force (kg) of Each Sort Group**

Sort Group	Marbling	NIR	BeefCam	Impedance	NIR + Impedance	No System	Perfect System	Impedance d14
1st Fifth	3.21	3.23	3.21	3.08	3.14	3.41	2.53	3.14
2nd Fifth	3.35	3.26	3.31	3.28	3.19	3.41	2.97	3.39
3rd Fifth	3.57	3.44	3.34	3.59	3.37	3.41	3.27	3.27
4th Fifth	3.58	3.36	3.64	3.54	3.42	3.41	3.68	3.48
5th Fifth	3.35	3.78	3.59	3.59	3.94	3.41	4.61	3.79
n	300	295	281	300	295	300	300	300

**Figure 5. Average WB shear force for sort groups (fifths) by instrument.**



## Other Results

- For impedance measurements on the carcasses, the two-inch penetration was more accurate at predicting tenderness than the surface electrodes. (All previous results for carcass impedance measurements in this report are using the two-inch penetrating electrodes.)
- For the steak impedance measurements on day 14, the surface electrodes were equal in accuracy to the ½ inch penetrating electrodes. (All previous results for day-14 steak impedance measurements in this report are using the surface electrodes.)
- Impedance measurements on day 1 postmortem were not highly correlated with measurements on days 2 and 3 postmortem (Table 6). Day 2 impedance measurements were highly correlated with day 3 impedance measurements. Tenderness prediction equations developed using day 1 data were not useful when using day 2 or day 3 data. Therefore, tenderness prediction equations using impedance would have to be developed separately for each day postmortem.

**Table 6. Effect of day postmortem on impedance measurements (n = 100).**

		R	Xc	PA	CP
<b>Means</b>	Day 1	47.2	31.1	33.3	31167
	Day 2	46.1	30.6	33.5	31991
	Day 3	42.6	27.1	32.3	33855
<b>Correlations</b>	Day 1&2	0.67	0.56	0.74	0.75
	Day 1&3	0.76	0.59	0.68	0.83
	Day 2&3	0.88	0.86	0.87	0.90
<b>Correlation with WBS</b>	Day 1	-0.20	-0.18	-0.03	0.14
	Day 2	-0.05	0.03	0.09	0.07
	Day 3	-0.08	0.06	0.15	0.12