Carcass and Meat Quality of Farmed Elk

Part 1: Highlights of Research Conducted at the Lacombe Research Centre, Lacombe, Alberta in 2000 and 2001

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Research Partners:

Agriculture and Agri-Food Canada Research Branch
Alberta Elk Association
Canadian Rocky Mountain Ranch
Saskatchewan Elk Breeders Association

Research Animals:

August, 2000	26 bulls (six 2-yr old, 10 3-yr old, 10 4-yr old)
August, 2001	46 animals (bulls: six 2-yr old, 30 3-yr old, 5 4-yr old plus one 8-yr old bull and four cows aged 8-12 yrs)

Objectives:

1) To establish meat yields in elk carcasses, and the effect of animal age on carcass characteristics including yield of sub-primal cuts and other products.
2) To establish the effect of animal age on meat quality characteristics, including color, muscle pH, water-holding properties and instrumentally-measured tenderness.
3) To determine the effect of endpoint cooking temperature on tenderness of elk steaks.
4) To determine the effect of carcass chilling treatment (conventionally chilled at 1^{o}C or conditioned at 5^{o}C) on meat quality and tenderness.
5) To compare tenderness of elk steaks cooked from fresh product to steaks previously frozen and thawed.

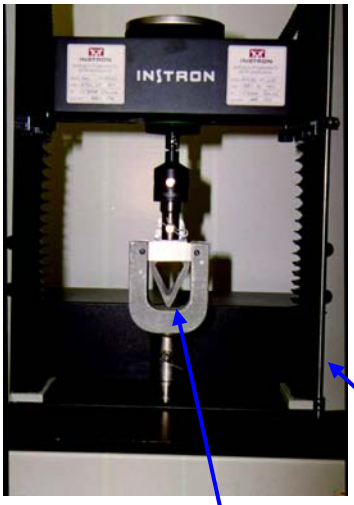
Effect of animal age on carcass characteristics (combined data from both years: 2, 3 and 4 year old bulls only).

	Age of animal (years)		
	2	3	4
n	11	34	15
Final live weight, kg	301.9*b*	327.8*b*	360.7*a*
Hot carcass weight (HCW), kg	177.4*b*	194.6*b*	221.8*a*
HCW, % of final live weight	58.7*b*	59.3*b*	60.3*a*
Rib eye area[1], sq. cm.	59.6*b*	62.9*ab*	66.3*a*
Minimum fat in 4th quadrant[1], mm	1.2*b*	2.5*a*	2.9*a*

ab Least square means accompanied by different letters are significantly different (P<0.05)
[1] Measurements made at the 12th rib, average of both sides of carcass.

Live weight recorded at the abattoir ranged from 239 to 444 kg for these 60 bulls. The range in hot carcass weight was 139 to 263 kg. Carcass yields expressed as a percentage of final, shrunk live weight ranged from 56.2% to 62.4%, averaging 59.4% overall. Minimum fat thickness over the rib eye in the 4th quadrant, measured at the 12th rib ranged from 0 to 11.5 mm. Carcasses were broken down into boneless sub-primals, stew meat and trim. Cut out tables are appended to this document, providing ranges in yields of individual cuts and showing the effect of animal age (for 2 to 4-yr old bulls) on meat yields.

Warner-Bratzler Shear Value

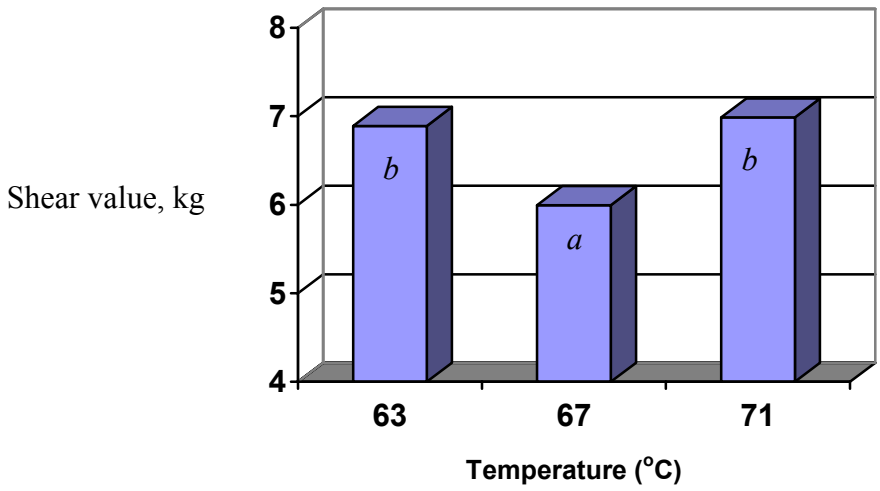


Warner-Bratzler shear values are an objective measurement of tenderness of meat. Cooked cores of a specified diameter of the sample are placed in a V-shaped blade which shears through the core at right angles to the muscle grain. The maximum shear force required to shear through the center of each core is recorded. In these trials, elk rib eyes were aged in vacuum packages to provide 7 d of aging. Two steaks were fabricated from each cut and cooked on a grill. The steaks were cooled, and three cores of 19 mm diameter were removed from each steak. Both the average of the recorded maximum shears and the variation within the steak are important criteria in assessing the tenderness of the samples. A difference of 1 kg in shear value would be readily detected by untrained consumers.

Instron Materials Testing System
(note load cell at top of crosshead)

Warner-Bratzler shear cell
The triangular blade is pulled upwards between two plates, severing the meat sample.

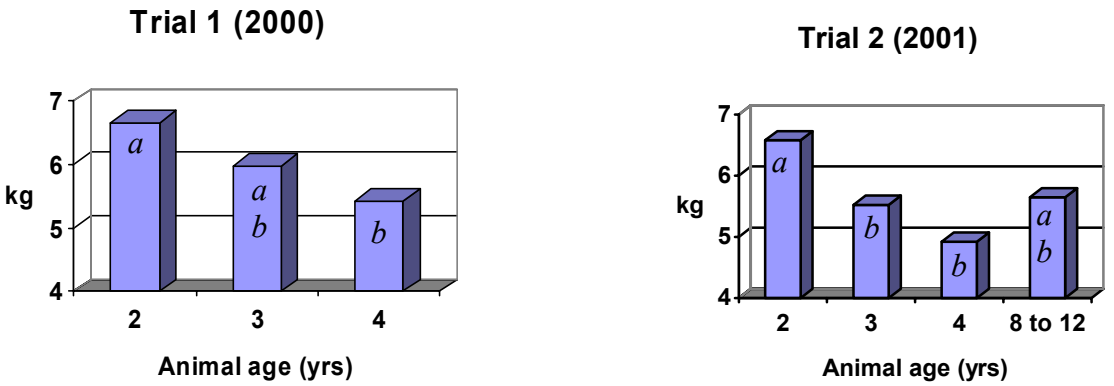
The Effect of Endpoint Cooking Temperature on Tenderness of Elk Rib Eye Steaks



abc LSMeans having different letters are significantly different (P<0.05)

Steaks cooked to 67°C were found to be more tender than those cooked to lower or higher end point temperatures. The steaks cooked to 67°C were visually appraised as rare to medium rare in doneness, and were a full kg lower in average shear compared to steaks cooked to the higher temperature. The within-steak variation of the samples cooked to the intermediate endpoint temperature was also less (27%). It is recommended that elk steaks not be cooked higher than 67 to 69°C to increase the likelihood of a satisfactory tender eating experience.

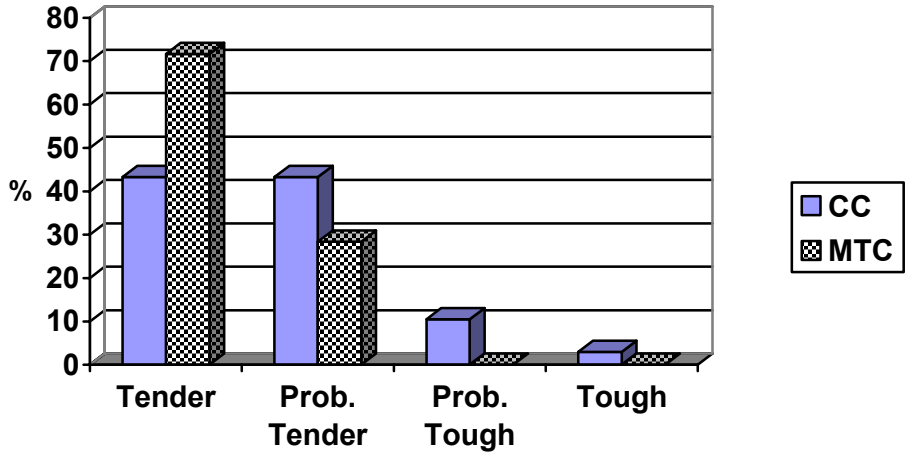
Effect of Animal Age on Shear Values of Elk Rib Eye Steaks[1]



abc LSMeans having different letters are significantly different (P<0.05)
[1]Steaks were previously frozen and thawed prior to cooking.

For 2 to 4 year old animals, average shear value tended to decrease with age, i.e. older animals were more tender. Meat from 4-yr old animals was significantly more tender compared to meat from 2-yr old animals in both trials, and the difference in average shear value was greater than 1 kg indicating that untrained consumers would be able to readily detect the difference. Additionally, the amount of variation in shear value within animal for this particular muscle was significantly less in 3 and 4-yr old animals compared to 2-yr old animals. While one might be inclined to interpret these results as meaning meat from older, cull animals is similar in tenderness to that of younger animals, the number of animals was too small to draw valid conclusions. Data collected later on very mature cows (see 2003 update) are contradictory to these earlier results.

Effect of Carcass Chilling Treatment on Frequency of Tender or Tough Rib Eye Steaks



Tenderness categories based on beef values of Aalhus *et al*. (2000)
CC, Conventionally Chilled at 1°C for 24 h
MTC, Modified Temperature Conditioned at 5°C for 24 h

In both trials, slowing the rate of carcass chilling in the first 24 h *post mortem* by increasing the temperature of the hot box from 1°C to 5°C reduced the average shear value by approximately 1 kg. For the combined data, 13.5% of steaks derived from conventionally chilled sides were classified as probably tough or tough, while all of the steaks from the conditioned sides fell into tender or probably tender categories based on their shear values. Instrumentally-measured muscle color was also improved at time of grading by the MTC treatment. Neither carcass weight losses during cooling, nor the amount of drip loss occurring during storage of a rib eye steak in retail packaging over three days was affected by carcass chilling treatment. To ensure safe, continuous chilling of the carcass, and to comply with federal inspection requirements, it is recommended that carcasses subjected to the delayed chilling regime be further chilled, preferably at 1°C, for an additional 24 h prior to cutting.

Effect on shear value of modified temperature conditioning of the carcass and cooking fresh or frozen/thawed steaks.[1]

	Average cooler temperature		
	1°C	5.5°C	P
Cooked from fresh:			
Shear value, kg	9.502	6.700	<0.0001
Within-steak variation[2]	2.265	1.145	0.009
Cooked from frozen/thawed:			
Shear value, kg	6.504	5.335	0.012
Within-steak variation[2]	1.275	0.896	0.010
Difference[3]:			
Shear value, kg	2.998	1.365	0.002

[1] Data subset included 2 to 4 year old bulls from 2001 slaughter only (n = 35).
[2] Standard deviation.
[3] Difference (fresh minus frozen-thawed).

Both average shear value and within-steak variation was greatly reduced when steaks were frozen and thawed prior to cooking compared to their counterparts cooked from the fresh state. For steaks derived from conventionally chilled sides the improvement in average shear value was 3 kg or 32%. A smaller but still very significant improvement of 20% was found for steaks derived from the modified temperature conditioned sides, which were already more tender to start with. The P values (probability) listed in the table indicate the differences between cooler treatments for each trait are highly statistically significant.

Acknowledgements:

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Effect of elk carcass weight on yield of cuts and other carcass components (% of side)

	Warm carcass weight, kg			
	139 - 170	170.1 - 200	200.1 - 230	230.1 - 263
n	11	24	13	12
2 X 3 Boneless rib	2.73	2.93	2.94	2.80
Inside round	4.83*a*	4.50*ab*	4.19*b*	4.39*b*
Outside round	4.34	4.06	4.10	4.00
Eye of round	1.54	1.47	1.48	1.46
Sirloin tip, peeled	5.17*a*	4.67*b*	4.47*bc*	4.34*c*
1 X 0 Strip loin	3.83*a*	3.51*b*	3.55*b*	3.53*b*
Top butt	2.80	2.85	2.84	2.72
Tenderloin, whole	1.55*a*	1.51*ab*	1.43*b*	1.43*b*
Hind shank meat	2.02*a*	1.87*b*	1.78*c*	1.72*c*
Osso buko	2.25*a*	2.15*ab*	2.03*ab*	1.97*b*
Total cuts	31.07*a*	29.53*b*	28.81*bc*	28.37*c*
Middle meats[z]	10.92*a*	10.80*ab*	10.76*ab*	10.48*b*
Stew meat	11.15	9.80	9.86	10.35
85% Lean	33.46	35.08	34.97	36.28
Total meat yield	75.68*a*	74.40*ab*	73.64*b*	75.00*ab*
Readily dissectable fat	6.68*c*	9.50*b*	10.97*a*	10.69*ab*
Bone	17.45*a*	15.91*b*	15.22*b*	14.14*c*

abc LSMeans with different letters are significantly different (P<0.05)
[z] Middle meats = 2x3 rib eye + 1x0 strip loin + top butt + tenderloin

Data from 60 two to four year old bull elk cut out at Lacombe Research Centre (2000-2001) in a co-operative study by Agriculture and Agri-Food Canada, Alberta Elk Association and Canadian Rocky Mountain Ranch.

Ante mortem Stress Management: Impact on Carcass Yield in Elk

The handling, transport and management to which domestic livestock are exposed prior to slaughter can constitute a significant stressor for the animals. As a result, care must be taken so that animal welfare, carcass yield and meat quality are not significantly degraded. For recently domesticated animals such as elk for example, salivary or plasma cortisol levels (a hormone indicating acute stress level) are often seen to be about twice as high compared to cattle. Research studies at Lacombe Research Centre over the last several years have examined the impact of *ante mortem* stress on venison yield in elk and what means might be available to reduce such losses in marketed animals. In this respect, one method investigated has been the use of amino acid and nutritional therapies offered to the animals pre-slaughter in an attempt to reduce *ante mortem* stress. This method has been seen to be effective in both cattle and swine (Schaefer et al., 2001). As shown in the table below, offering the animals nutritional therapy either in the lairage area pre-slaughter for overnight held animals or pre-transport in their home pens were both seen to be successful in reducing salivary cortisol in treated animals and in reducing the carcass loss. Current efforts are aimed at increasing study numbers and optimizing such strategies.

Table 1. Effect of nutritional therapy on cortisol level and carcass yield in transported elk.

Measurement	Control Elk	Nutritional Therapy Elk	
Trial 1: Salivary Cortisol	14.9 nmol/L	11.8 nmol.L	($P<0.05$)
Collected immediately upon capture. Animals offered nutritional therapy 24 h pre-capture.			
Trial 2: Carcass Yield	61.1%	62.0%	($P<0.05$)
4 h transport and overnight held elk. Approximately 3.6 kg more carcass on a 400 kg animal. Nutritional therapy (0.5 – 1 kg) offered overnight in lairage.			
Trial 3: Carcass Yield	58.3 %	60.8%	($P<0.05$)
2 h transport and direct slaughter. Approximately 2.8 kg more carcass on elk offered nutritional therapy (0.5 – 1 kg) 24h pre-transport.			

Reference:
Schaefer, A.L., P.L. Dubeski, J.L. Aalhus and A.K.W. Tong. 2001. Role of nutrition in reducing *ante mortem* stress and meat quality aberrations. Journal of Animal Science. 79(E Suppl). 1-11.

For further information on the live animal aspects contact Dr. Al Schaefer, Agriculture and Agri-Food Canada, 6000 C & E Trail, Lacombe, Alberta, T4L 1W1, Ph. 403-782-8129, FAX 403-782-6120, schaefera@agr.gc.ca

Part 2: 2003 Research Update

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Research Partners:

Agriculture and Agri-Food Canada Research Branch
Alberta Agriculture, Food and Rural Development
Elk Centre of Excellence
Alberta Elk Commission
University of Alberta

Research Animals:

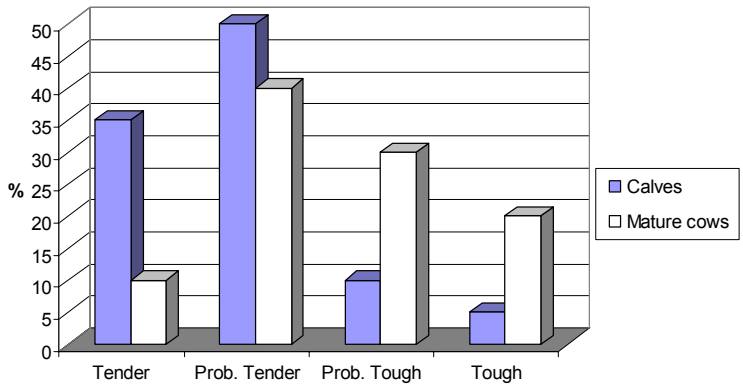
20 Christmas calves (<1 year old)
20 Mature cows (6 to 19 years old, 14 animals > 10 yrs)

Objectives:

(1) To evaluate stress levels in two ages of elk subjected to transport, handling and management in novel environments.
(2) To evaluate carcass yield and venison quality in elk of differing ages.
(3) To collect additional information for the creation of a carcass classification system for elk.

Note: As of August, 2003 work continues in the laboratory to evaluate stress parameters from blood samples collected earlier. Carcass composition and meat quality aspects have been completed and selected highlights are reported here.

Effect of age/sex category on frequency of tender or tough rib eye steaks (conventionally chilled)

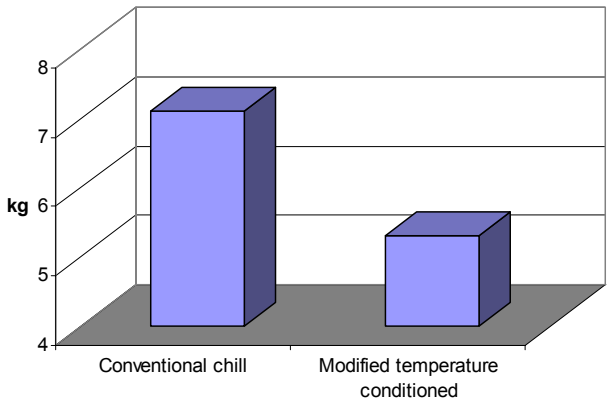


Tenderness categories based on beef values of Aalhus *et al*. (2000)

For this trial carcass sides were chilled conventionally at 1°C. Rib eye muscle samples were aged to provide 7 days of conditioning prior to freezing and on thawing samples were cooked to 67°C, similarly to the earlier trials. Average shear value for Christmas calves aged less than one year was 6.430 kg. Mature cows had an

average shear value of 8.094 kg and fully half of the samples fell into probably tough or tough categories. By comparison, samples from conventionally chilled bulls aged 2 to 4 years had an average shear value of 6.20 kg (2000, 2001 trials). For the second kill of mature cows (10 head), one side of the carcass was conditioned using the modified chill (5°C) since the first kill indicated that very mature cows are prone to produce an unsatisfactorily tough product. The results are illustrated in the figure below. All samples from the conditioned sides fell into the tender or probably tender category, again demonstrating the effectiveness of a slower chill process in increasing tenderness of ranched elk meat. These results also indicate that without intervention strategies, meat from very mature animals will be at best inconsistent in tenderness.

Effect of modified temperature conditioning on average shear value of mature cows (n=10).



Taste panel evaluations of boneless loin steaks from Christmas calves and mature cows.

Boneless loin steaks (1" thick) were fabricated from the 13th rib end of the short loin on the day following slaughter, from sides which had been conventionally chilled at 1°C. The steaks were vacuum packaged and held an additional 10 d for conditioning before freezing. Following thawing, the steaks were cooked on a grill to an internal temperature of 67°C. A trained panel evaluated the steaks. Results are shown in the following table.

	Christmas calves	Mature cows	Probability
Initial tenderness (1= extremely tough, 9=extremely tender)	6.00	5.18	0.01
Juiciness (1=extremely dry, 9=extremely juicy)	6.26	6.51	0.20
Flavor desirability (1=extremely undesirable, 9=extremely desirable)	5.66	5.45	0.19
Flavor intensity (1=extremely bland, 9=extremely intense)	5.89	6.20	0.04
Amount of connective tissue (1=abundant, 9=none perceived)	7.66	7.37	0.0005
Overall tenderness (1=extremely tough, 9=extremely tender)	6.16	5.46	0.04
Overall palatability rating (1=extremely undesirable, 9=extremely. desirable)	5.33	5.09	0.27

Probability values less than 0.05 indicate the difference between Christmas calves and mature cows for that trait is statistically significant. From the table it can be seen that mature cows on average are less tender, have higher amounts of perceptible connective tissue and more intense flavor compared to Christmas calves. Juiciness and flavor desirability was similar for both age classes, as was the taste panelists overall impression of the samples. Four of the twenty samples (20%) obtained from mature cows and three of twenty Christmas calf samples (15%) were rated unacceptable by the panelists. All non-conforming samples were the result of lack of tenderness; flavor desirability did not appear to be an issue even for these very mature cows. With the information obtained from shear values and taste panel ratings, it is clear that, while meat from mature cows can be quite tender, there is considerable variation in tenderness which increases the risk of an unsatisfactory eating experience. Modified temperature conditioning has been shown to reduce that variation, and would subsequently lessen the risk. Certainly in the absence of intervention strategies it can hardly be recommended to introduce meat from very mature animals into the high end markets. It should also be noted that we have used a single muscle (the main muscle of the rib and loin, or longissimus) to evaluate the effect of treatments or sex and age class on muscle quality attributes including tenderness. This muscle was specifically selected because it is prone to cold-induced toughening and cold shortening. Extrapolation to other muscles in the carcass would be imprudent.

Effect of age/sex class on carcass characteristics of ranched elk.

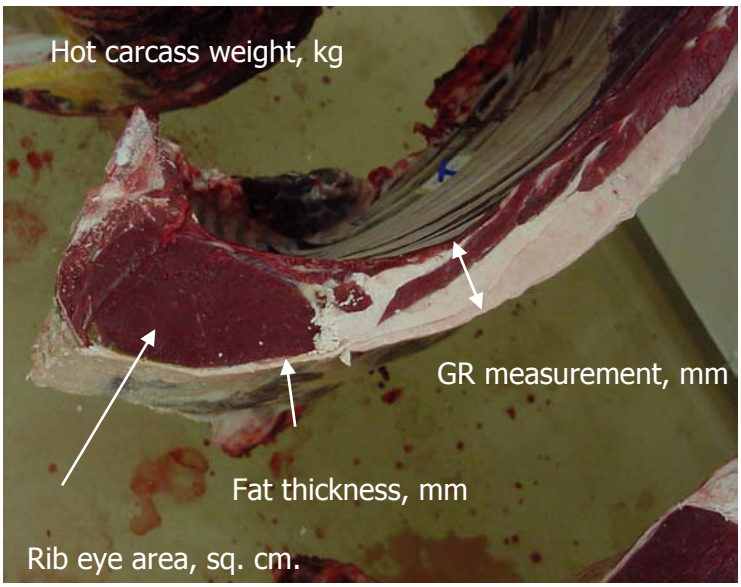
Data from the 2000, 2001 and 2003 trials was combined to demonstrate the effect of age/sex class on carcass characteristics.

	Christmas calves	2-4 year old bulls	Mature cows
n	20	58	24
Hot carcass wt., kg	84	197	156
HCW, % of live wt.[1]	62.8	59.4	59.0
Rib eye area, sq. cm.	37	63	52
Middle cuts, %[2]	12.9	10.8	13.0
Total cuts, %	36.5	29.5	34.0
Total meat yield[3], %	76.1	74.6	76.5

[1]Hot carcass yield expressed as a percentage of final (shrunk) live weight at the abattoir.
[2]Middle cuts = boneless rib + strip loin + top butt + tenderloin
[3]Total meat yield = total cuts + stew meat + lean trim

Carcass Classification System

The combined trials now have produced a data base of 102 elk carcasses with complete cut out and grading information. Simply obtained carcass measurements were recorded to determine which measurement, or combination of measurements, would be useful in the development of a grading equation to predict salable yield in elk carcasses. A grading equation to predict carcass yield could be used for settlement purposes between buyer and producer. The carcass measurements are illustrated in the figure below. Rib eye area was measured using a plastic grid ruled in one cm squares. The GR measurement is the total tissue depth through the rib cage measured at a point 7 cm past the rib eye muscle. Hot carcass weight and the GR measurement made using a simple ruler appear to be sufficient to provide an accurate ($R^2 = 0.67$) and precise (residual error = 1.23%) estimate of total meat yield expressed as a percentage of carcass weight. Relative to beef and pork yield grading equations, this degree of accuracy and precision is very acceptable, with the proviso that 102 carcasses is a small data base for development of grading equations and, ideally, the equations should be verified against a separate group of carcasses. The single equation appears to be suitable for all three age/sex classes: 2 to 4 year old bulls, Christmas calves and mature cows.



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