MEAT YIELD AND QUALITY: FACTORS AFFECTING VENISON YIELD AND QUALITY

W. M. Robertson, A. L. Schaefer, A. Fortin and S. Landry, AAFC, Lacombe

The utilization of native ungulates in a red meats strategy may provide a viable option for providing a lean, healthy product to today's health conscious consumer. Research was conducted to investigate factors affecting venison yield and quality of white-tail deer. A small initial trial was undertaken using five animals to test the capability of the Lacombe Research Centre slaughter facilities to handle the species and to examine the rudiments of venison yield and quality. While this initial trial demonstrated that farmed white-tail deer produced carcasses with very high proportions of lean meat, under the pre-slaughter management conditions and rapid chilling imposed by a light load in an efficient chilling system produced meat with very high, unacceptable shear values. Subsequently, five trials were conducted over a three-year period using white-tail deer culled from breeding herds from various parts of Alberta. Among the objectives of the research was to collect basic information on carcass composition and venison quality, and to investigate post-mortem carcass management strategies to improve tenderness.

Carcass traits

There was a wide range in live weights (38.0 – 86.9 kg) of the test animals over the five trials with the result that carcass weights also varied widely (Table 1). Carcass yields averaged 57.3% of final (shrunk) live weight. The fourteen percent range in carcass yields observed would primarily be due to the differences in the distances from which the animals were sourced and differences in pre-slaughter management of the animals. In the first two trials, the animals were dispatched immediately upon arrival in the back of the specially designed trailer in which they were transported. In subsequent trials, the holding facilities at the Research Centre had been renovated to accommodate alternative species and the animals were off-loaded and held with access to water prior to slaughter.

Carcass sides were cut out to lean, fat and bone following a 24 or 48 h chill. Lean content of the carcasses averaged 71.8% with a range of approximately 11% (Table 2). Readily dissectable fat averaged 9.6% and ranged as low as an incredible 2.0%. It should be pointed out that as these were cull animals from breeding herds, there was a range in muscling from poor to good, and some had little or no subcutaneous fat cover. In contrast, forty-one typical Canada 1 grade beef carcasses, which were cut out at the Research Centre, had an average lean content of 61.8% and fat content of 21.3%. The range in lean content of the beef carcasses was similar in magnitude to that of the white-tail deer (56 – 67%). Figure 1 shows the low intramuscular or marbling fat content of the rib eye muscle (*longissimus thoracis*) of the study deer, which ranged from 0.2% to 3.4%, compared to that of beef rib eyes of three grades from animals also slaughtered in our facility.

Yield grading

In the later trials various carcass measurements were recorded to determine their value in predicting carcass lean content with a view to the possible establishment of a yield grading system. Carcass measurements included circumference and diameter of the hind leg, width of the chine bone and spinous processes at the 12th rib, and GR measurements of the total tissue depth at various distances from the ventral-lateral end of the rib eye muscle. The GR measurement at 1 cm from the edge of the rib eye along with hot carcass weight gave the greatest accuracy and precision for predicted lean content (r^2 = 0.47). Standard deviation of the difference between estimated and actual lean established by cut out was 1.65%. Width of the chine bone and measurements of the hind leg accounted for only a very small portion of the variation in the lean yield (0 – 6%). It was concluded that a simple physical measurement (GR 1) had potential for yield grading of deer carcasses, but a greater number of carcasses with a wider range in muscling and fatness would be needed to produce a robust equation. The equation would then need to be tested using a different set of carcasses.

Venison quality

The unacceptably high shear values observed for venison chops in the preliminary trial were thought to be due to cold induced toughening. The carcasses were relatively lightly muscled, had very little fat cover to act as insulation, and the small kill represented a very light load on the drip cooler. As a result, the temperature of the rib eye muscle fell below 5°C by 3 h post-mortem, and the temperature of the inside round fell below 5°C by 10 h post-mortem. The generally accepted rule of thumb, established by Bendall in 1972, for beef carcasses has been not to let the muscle temperature fall below 10°C in the first 10 h post-mortem to avoid cold induced toughening. Several experiments were then conducted in which one side of the carcass was chilled conventionally while the opposite side was cooled under various high temperature conditioning regimes.

A trial was conducted in which alternate sides of eight deer carcasses were cooled conventionally at 1°C while the contra-lateral side was held at 10°C for 48 h. Shear values of cooked chops from the high temperature conditioned (HTC) sides were one-half those of the conventionally chilled (CC) sides, which were again unacceptably high (5.14 kg vs. 10.22 kg, respectively; $P<0.05$). While these results were dramatic, the weight losses in the HTC sides over the 48 h period were extremely high at 7.4% compared to 3.4% for the CC sides. Microbial considerations prohibit the use of spray chilling or high humidity environments as means of ameliorating shrinkage losses in carcasses undergoing high temperature conditioning. Therefore, the same experiment was repeated using shorter conditioning times of 10 h and 24 h, using six test animals for each experiment. There were no differences in shear values between HTC and CC sides for the 10 h conditioning treatment (Figure 2); and although there was a substantial difference in shear values for the 24 h conditioning treatment, the difference was not statistically significant.

Twenty animals were used in a repeat of the 48 h conditioning experiment. A significant difference ($P<0.05$) was found in mean shear value between treatments although the results were not as dramatic as in the first experiment largely as a result of the CC sides having lower shear values in the last experiment. Because of the different origins and ages of the animals used in the experiments along with changes in pre-slaughter management over the trials, it is not possible to compare results across the experiments. Even though the difference in mean shear values was only 1.2 kg in the last experiment, the HTC treatment reduced the number of probably tough and tough carcasses and increased the number of tender carcasses (Figure 3).

High voltage electrical stimulation (HVES) has been shown to reduce shear values in beef, particularly for short aging periods of 3 or 6 days. An experiment was conducted using eight animals to test the efficacy of HVES in reducing shear values of venison. Alternating sides were subjected to 470 V, 1.5 amps for 20 pulses over one minute, at 45 min post-mortem while the contra-lateral side served as control. In another trial, seven carcasses were subjected to low voltage electrical stimulation (LVES) during exsanguination and compared to conventionally chilled sides from the high temperature conditioning study. Neither HVES nor LVES had any effect on shear value (data not shown). The lack of response is thought to be due to the physiological condition of the animals at time of slaughter due to transport and pre-slaughter stress with the subsequent reduction in glycolytic potential.

One would hesitate to recommend a 48 h high temperature conditioning regime for white-tail deer carcasses because of the degree of dessication and carcass shrinkage. However it is apparent from our studies that in order to ensure a consistently tender, high quality product, it is necessary to employ pre-slaughter management strategies which minimize stress or attenuate the effects of stress in deer, and post-mortem carcass management strategies which will prevent cold-induced toughening.

Acknowledgements

The research was supported in part by the Alberta White-tail and Mule Deer Association and AAFC Matching Investment Initiative. The excellent work in slaughter and processing of the animals by Don Brereton, Chuck Pimm, Darcy Schatsneider, Mike Vanson and Dale Langevin is greatly appreciated.

Table 1. Carcass yields of white-tail deer (N = 70).

Trait	Mean (SEM)	Range
Live weight, kg	58.1 (9.7)	38.0 – 86.9
Carcass weight, kg	33.3 (6.1)	21.8 – 53.0
Carcass yield, %	57.3 (2.9)	51.0 – 65.3

Table 2. Carcass composition of white-tail deer (N = 70).

Tissue, %	Mean (SEM)	Range
Lean	71.8 (2.6)	66.9 – 77.6
Fat	9.6 (3.6)	2.0 – 17.5
Bone	18.6 (1.9)	15.7 – 25.1

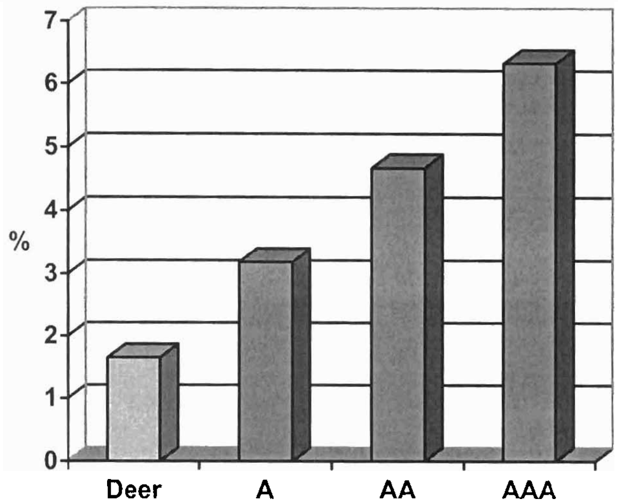

Figure 1. Comparison of marbling fat in white-tail deer with beef grades.

(n: deer = 72, A = 69, AA = 149, AAA = 69)

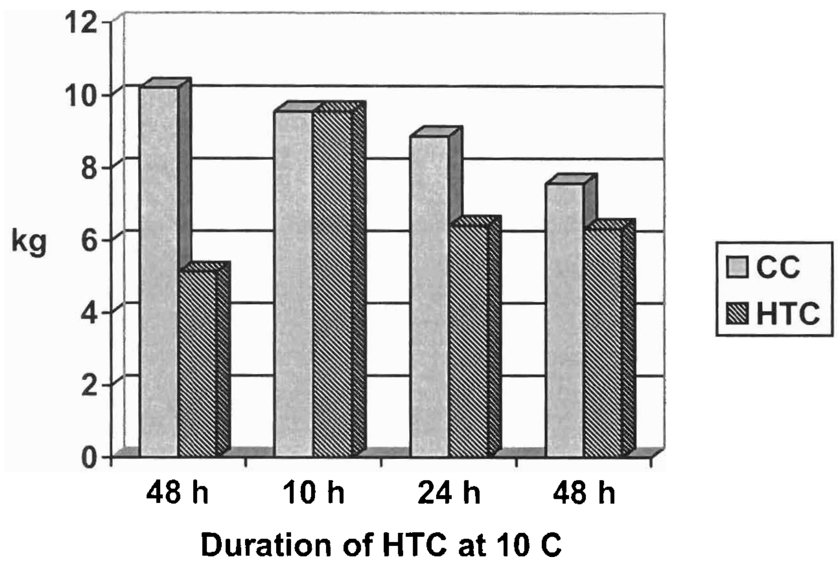

Figure 2. Effect of high temperature conditioning on shear values of cooked venison chops.

CC = conventionally chilled
HTC = high temperature conditioned

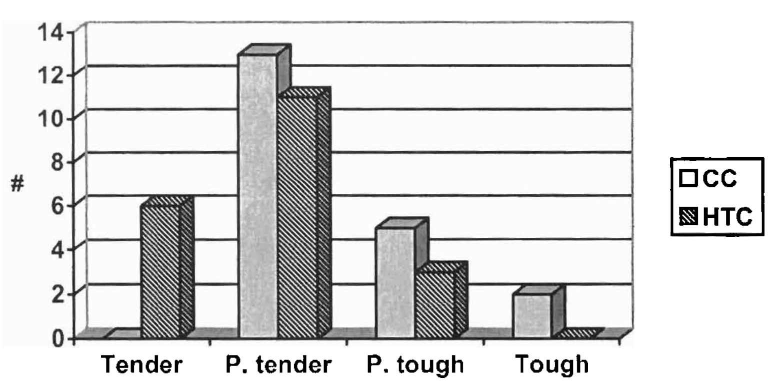

Figure 3. Effect of HTC on frequency of tender, probably tender, probably tough and tough venison chops for last experiment (10 C for 48 h).