

CANADIAN BEEF TENDERNESS SURVEY 2001-2011

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Abstract – The Canadian beef industry is focused on providing consistently tender beef to the consumer. However, no updated information is available regarding retail beef tenderness in Canada. A large survey across Canada was developed collecting retail beef samples in 2001 (702 steaks) and 2011 (602 steaks). The samples (strip loin, top sirloin, inside round and cross-rib steaks) were evaluated for instrumental tenderness using standard procedures. New equations were also developed in order to compare the results obtained in these studies with consumer thresholds developed in Canada and the U.S. A significant improvement was observed, especially for strip loin and top sirloin steaks. The percentage of strip loin steaks within the “tender” categories increased in 2011 up to 98 and 99% according to the Canadian and U.S. threshold systems, respectively (85 and 94%, respectively, in 2001). Top sirloin steaks also showed a great improvement between 2001 and 2011. The improvement in cross-rib and inside round tenderness values was more limited. Changes in the animal population, production systems, carcass processing and distribution/handling prior to retail display in Canada have led to high levels of consumer satisfaction in the most valuable beef retail cuts. Maintaining this quality and improving tenderness in other cuts are the future challenges.

Key Words – texture, threshold, Warner-Bratzler

I. INTRODUCTION

An ongoing challenge in beef marketing is to provide a consistent and enjoyable eating experience for the consumer [1] and tenderness is the most important component of meat quality taken into account by consumers [2]. National Beef Tenderness Surveys have been regularly conducted in the U.S. since 1990, in order to compile baseline information on the tenderness of beef in the retail case and, since 1998, in foodservice facilities [3]. The results from these surveys reflect an improvement over time and help to identify potential issues to be solved in the future. In Canada, although several studies have

reported some reference values for commercial beef texture [4, 5], current information regarding beef tenderness is not available. In fact, industry is usually working with values from very old studies in which different methodologies were used to measure tenderness [6]. Thus, the common and inaccurate value used to describe Canadian retail beef tenderness is >25% tough.

Over 20 years ago, U.S. scientists [7] developed a threshold system that discriminated tough and tender beef by using two values: 3.90 and 4.60 kg. These values were obtained comparing Warner-Bratzler (1.27 cm cores) and values from a 10-member trained sensory panel. The confidence values used for the development of the threshold values were 50 and 68% for retail and food service, respectively. Using this system, beef can be classified based on “need for tenderness enhancement” (no need, <3.90 kg; slight to moderate need, ≥3.90 and <4.60 kg; significant need, ≥4.60 kg). Canadian scientists also developed a threshold system for beef tenderness between 1995 and 1999 [4, 8]. A different core size, commonly used in Canada, was chosen (1.9 cm) and the results were compared to consumer (3 cities; 1,300 consumers) and trained panel (6 members) values. The system includes four categories: tender (<5.60 kg); probably tender (≥5.60 and <7.85 kg), probably tough (≥7.85 and <9.60 kg) and tough (≥9.60 kg). These values could be mathematically transformed from 1.9 to 1.27 cm. However, the mathematical conversion is not completely accurate and a calibration based on experimental results should be developed. This calibration should also consider the possibility of having to work not only with fresh meat but also with meat frozen for different periods of time, as is common in large surveys.

The objectives of the present study were: 1) to develop accurate conversion equations to be able to transform Canadian threshold into U.S. values, and vice versa, and 2) to study the evolution of Canadian retail beef tenderness during the last

decade using samples collected across Canada in two different years (2001 and 2011).

II. MATERIALS AND METHODS

Validation of U.S. and Canadian thresholds

In order to validate the correlation between Canadian (1.9 cm core diameter) and U.S. (1.27 cm core diameter) cores for Warner-Bratzler shear force (WBSF) evaluation, 144 loins (72 AA and 72 AAA grades) were collected from commercial plants. Controlling by loin location, two sets of paired steaks were cut and assigned to one of two treatments (fresh and 2 months frozen). Paired sets were cooked at the appropriate time. U.S. cores (1.27 cm) were taken from one steak while Canadian cores (1.9 cm) were taken from the other steak within the paired set.

Canadian Beef Tenderness Survey 2001 and 2011

In 2001, collaborators sampled four Canadian cities: Calgary, AB, London, ON, Montreal, QC and Toronto, ON. In each city, three or four retail chains, representing at least one third of total market share in their area, were sampled for product in 1-7 stores per chain. A total of 702 steaks were collected (175 cross rib, 176 inside round, 176 top sirloin and 175 strip loin). In 2011, following the same sampling design, a total of 602 steaks (150 cross-rib, 152 inside round, 150 top sirloin and 150 strip loin) were collected for a second phase of the study. Steaks were removed from store packaging, re-packaged and identified individually, frozen immediately and shipped to the AAFC-Lacombe Research Centre, Lacombe, AB. Steaks were then stored frozen for approximately 2 months prior to being analyzed.

Shear force analysis

Steaks were thawed overnight in a cooler at 1°C. Steaks were then placed on a grill (Garland Grill ED30B [Condon Barr Food Equipment Ltd., Edmonton, AB]) preheated to 210°C and grilled to an internal temperature of 35°C, turned and cooked to a final temperature of 71°C. Steaks were placed into polyethylene bags, sealed and immediately immersed in an ice/water bath to prevent further cooking. They were then transferred to a 1°C cooler to allow standing for a 24 h period. Six cores, using a U.S. sized core (1.27 cm in diameter) for the Canadian Beef Tenderness Survey, or both U.S. and Canadian

(1.9 cm in diameter) sized cores for the validation of the thresholds, were removed parallel to the fibre grain. Peak shear force determined on each core perpendicular to the fibre grain using a TA-XT Plus Texture Analyzer equipped with a Warner-Bratzler shear head at a crosshead speed of 20 cm min⁻¹ using a 30 kg load cell and Texture Exponent 32 Software (Texture Technologies Corp., Hamilton, MA, USA). Shear force was reported as the average of the six cores.

Statistical analysis

Statistical analyses were developed using PROC REG and PROC FREQ procedures of SAS [9]. In order to validate the conversion methods to transform shear force values from Canadian cores into values equivalent to those obtained using U.S. cores, the average U.S. shear values were regressed against the corresponding average Canadian shear values for fresh and frozen steaks. Using the equations generated, Canadian threshold limits were transformed into U.S. values. Shear force values from 2001 and 2011 were grouped by threshold class and frequencies were calculated for each year. Two threshold systems were used: U.S. values and Canadian values transformed into U.S. values using the 2-month frozen equation generated through regression analysis. These frequencies from 2001 and 2011 were compared using the χ^2 test.

III. RESULTS AND DISCUSSION

Our results confirm the similarities between the Canadian and the U.S. systems (Table 1). The regression equation for shear force values from 1.9 vs. 1.27 cm cores in fresh meat is completely linear, with an R^2 close to 1 (0.99). Freezing for two months slightly modified the slope and intercept, but the R^2 was still very high (0.96). On the other hand, the mathematical conversion approximates the difference between cores but does not consider structural differences in the meat that might occur when using different core sizes. The number of fibres engaged or the pressure necessary to obtain the core are only two factors that could influence the final shear force value when using different core sizes.

The direct mathematical conversion of Canadian thresholds resulted in values much lower than those from the U.S. system. The closest values were obtained using the equations for fresh and 2-

month frozen meat. However, the lowest value was always lower for the Canadian system (2.8-2.9 kg) compared to the U.S. system (3.2 kg).

Table 1. Regression equations and threshold shear force values to convert from 1.9 to 1.27 cm cores

	1.27 cm	Math.	Fresh	Frozen
Slope	1	0.447	0.417	0.435
Intercept	-	-	0.540	0.351
R²	-	-	0.988	0.957
Thresh.				
<i>High</i>	4.60	4.29	4.54	4.53
<i>Medium</i>	3.90	3.51	3.81	3.77
<i>Low</i>	3.20	2.50	2.88	2.79

In 2001, most strip loins (89%) were classified as “tender” or “no need for tenderness enhancement” (Figure 1). Only 5% of the strip loins needed “significant” intervention. The percentage of top sirloin steaks classified as needing “significant tenderness enhancement” was 8%. Similar values were observed for the cross-rib, but close to 30% of the inside round samples were classified as “tough”. The contemporary U.S. Beef Tenderness Survey [10] reported similar results, with 5.9% of the top loin samples “needing slight to moderate tenderness enhancement”, 0.7% “needing significant intervention”, and up to almost 40% of the inside (top) round needed “slight to moderate” and >15% “significant tenderness enhancement”.

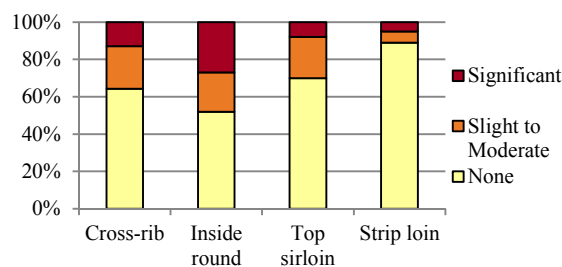


Figure 1. Frequencies of steaks based on U.S. Threshold Cut-offs in 2001

Using the Canadian four-category system and the regression equation for meat frozen for 2 months (Figure 2), strip loins and top sirloins classified as “tender” or “probably tender” were still >80 and >60%, respectively. However, ~5 and 10% of the strip loins and top sirloins, respectively, were classified as “tough”.

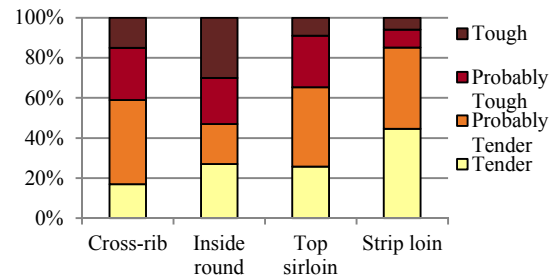


Figure 2. Frequencies of steaks based on Canadian Threshold Cut-offs in 2001

Ten years later (2011), according to the U.S. threshold system, only 1% of the analyzed strip loins were classified as requiring “slight to moderate tenderness enhancement” ($\chi^2 < 0.001$). Among the top sirloins, 8% would require “slight to moderate” and 5% “significant” intervention ($\chi^2 < 0.001$). The trend in the reduction in cross-rib samples requiring tenderness enhancement ($\chi^2 = 0.098$) resulted in 24% needing “slight to moderate” or “significant” intervention. The inside round resulted in still almost 40% of the samples requiring some kind of tenderness enhancement ($\chi^2 = 0.006$).

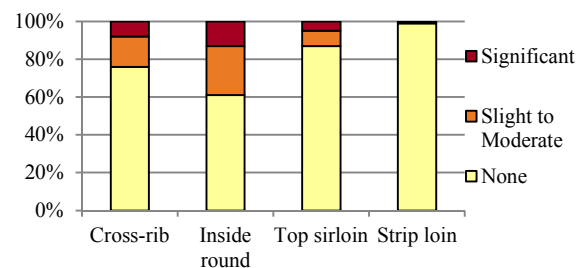


Figure 3. Frequencies of steaks based on U.S. Threshold Cut-offs in 2011

In 2011, using the Canadian system (Figure 4) none of the strip loins was classified as “tough” and only 3% were classified as “probably tough” ($\chi^2 < 0.001$). The percentage of samples within the “tender” class increased up to 78%. The percentage of “tough” and “probably tough” top sirloins also decreased (15 and 8%, respectively) ($\chi^2 = 0.001$). Both the cross-rib and inside round showed significant but smaller decreases in the % “tough” ($\chi^2 = 0.031$ and 0.012 , respectively) and roughly an overall 10% increase in the percentage of muscles classified as either “tender” or “probably tender”.

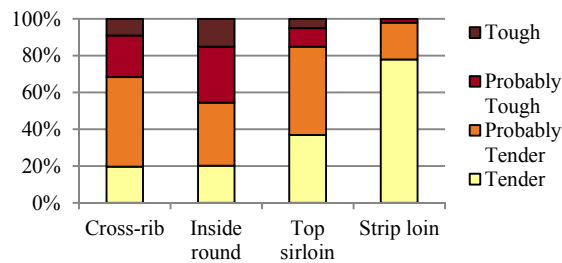


Figure 4. Frequencies of steaks based on Canadian Threshold Cut-offs in 2011

These results suggest that the strategies implemented by the Canadian beef industry to improve beef tenderness during the last decade have been successful in the most valuable middle cuts, such as strip loin and top sirloin. Nevertheless, tenderness values of other cuts, such as cross-rib and inside round, still have room for improvement despite an overall 10% improvement since 2001.

IV. CONCLUSION

Changes in the animal population, production systems and carcass processing in Canada during the last decade have led to high levels of consumer satisfaction in the most valuable beef retail cuts. Maintaining this quality and improving tenderness in other cuts are the new challenges.

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