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A COMPARISON OF KNIFE TYPE WHEN SAMPLING FOR WARNER-BRATZLER TENDERNESS MEASUREMENTS

Jonatã H. Rezende-de-Souza[1,2], Jenny Lans[1], Karin Wallin[1], Katarina A. Segerkvist[1], Anna Hessle[1], Elin Stenberg[1], Sergio B. Pflanzer[2], Anders H. Karlsson[1*], Johanna Friman[1]

[1] Department of Applied Animal Science and Welfare, Swedish University of Agricultural Sciences, Skara, Sweden.
[2] Department of Engineering and Food Technology, School of Food Engineering, University of Campinas, Campinas, Brazil.
*Corresponding author email: anders.h.karlsson@slu.se

I. INTRODUCTION

Tenderness is one of the most important sensory attributes of beef, directly influencing consumer acceptance. It can be affected by intrinsic factors related to the animal, slaughter and post-slaughter processes, cooking methods, and the analytical methodology used for assessment. Among the intrinsic factors, the finishing feeding regimen plays a crucial role in meat tenderness. In terms of analytical methodologies, the standardization of techniques is essential to ensure reliable and comparable results. Instrumental tenderness evaluation is influenced by several factors, including knife blade thickness, cutting edge, cooking temperature, and muscle fiber orientation [1]. In most cases, texture analysis is conducted on cylindrical samples obtained with a round-blade knife with 1.27 cm diameter. A challenge is to accurately determine muscle fiber orientation and different sampling techniques may yield varying shear force values, potentially affecting the interpretation of results [2,3]. Therefore, this study aims to compare the effects of two core preparation methods, round vs. square, for Warner-Bratzler shear force measurements in beef.

II. MATERIALS AND METHODS

Beef sirloin samples (*Longissimus lumborum*) were collected from three groups of culled Holstein dairy cows, where two groups were finished on one of two diets for 100 days prior to slaughter: grass-clover silage, only, at ad libitum intake (n = 24), or press cake from the same silage ad libitum, complemented with 5.5 kg oats day^{-1} in order to obtain an iso-energetic feed ration (n = 24). A third group of animals (n = 14) was sent to slaughter without finishing. At slaughter, samples were obtained from the 11th rib and extended 10 cm cranially, then frozen at –20 ºC until further analysis. Prior to instrumental tenderness analysis, samples were thawed at 4 ºC for 24 hours, followed by 30-minute at 17 ºC. Samples were sous-vide heated, until a core temperature of 71 ºC, followed by cooling at 4 ºC for 24 hours before sampling. Two sample preparation methods were used to evaluate potential effects on instrumental texture readings. The first method involved using a core cutter with a 1.27 cm diameter to extract cores aligned with the muscle fiber direction (Fig. 1A). The second method involved cutting 1 cm × 1 cm slices along the muscle fiber direction using a knife and a ruler (Fig. 1B). In both methods, six cores per sample (Fig. 1) were collected and analyzed using a TA-XT Stable Micro Systems texture analyzer, set to a pre-test speed of 5 mm/s, equipped with a 1 mm thickness Warner-Bratzler blade. The average of the six cores was used to represent one sample. Data were analyzed using software Statistica (StatSoft, data analysis software system, version 10.0; www.statsoft.com). Outliers within the same sample were identified using the Median Absolute Deviation method [4]. Least squares means and standard errors were calculated and tested by analysis of variance (ANOVA). The model included the fixed effects diet, knife type within animal, and the interaction, and animal as a random effect. The Satterthwaite approximation for degrees of freedom and a significance level of $P < 0.05$ was used. Additionally, tenderness classification using the USDA tenderness classification system with three classes [5] was done (Fig. 2A): Very tender (< 39.2 N), Tender (39.2 to 43.1 N), and Tough (> 43.1 N).



Figure 1. Round (A) and square (B) samples.

III. RESULTS AND DISCUSSION

No interaction was observed between the effects of diet and knife type on shear force values ($P = 0.506$). Samples obtained using a core cutter exhibited significantly higher shear force values compared to those prepared using a knife and ruler ($P = 0.003$; Table 1). One possible explanation for the observed difference could be the variation in cross-sectional area between the two core shapes. The round cores had a larger shear surface area (1.27 cm²)

compared to the square cores (1.00 cm²), which may have negatively impacted instrumental tenderness values by increasing the resistance to shear force. The improved alignment of muscle fibers in square samples may also have contributed to their lower shear force values. Regardless of core shape (round or square), meat samples from the non-finished and grass-clover silage diets had a higher proportion of tough meat compared to those finished on press cake and oats (Fig. 2A). However, square cores yielded lower shear force values than round cores. Conversely, Silva et al. [2,3] reported higher shear force values for square cores in beef and pork samples, suggesting that core shape effects may be species- and muscle-dependent. Despite the lower shear force values observed in square cores, a strong correlation was found between the two sampling methods, with a Pearson's correlation coefficient of $r = 0.84$ ($P < 0.05$) and an R^2 value of 0.7039 (Fig. 2B). This R^2 value is comparable to those reported in previous studies that compared round and square cores in *Longissimus lumborum* samples aged for different periods ($R^2 = 0.77$) [3], as well as in beef ($R^2 = 0.78$) and pork ($R^2 = 0.70$) samples [2], further supporting the robustness of both sampling techniques for shear force assessment.

Table 1 – Factor analysis between diet (GC is grass-clover; PC is press cake) and sample core influencing the instrumental tenderness values of beef sirloin.

	Diet (D)			Sample core (C)		P-value		
	Non-finished	GC silage	PC + oats	Round	Square	D	C	D x C
WBSF (N)	49.74 ± 2.631	52.30 ± 2.455	43.16 ± 2.453	50.01[a] ± 2.230	46.36[b] ± 2.010	0.129	0.003	0.506

[ab] Means (± standard error of the mean) with different letters on the same row differed by the ANOVA ($P < 0.05$).

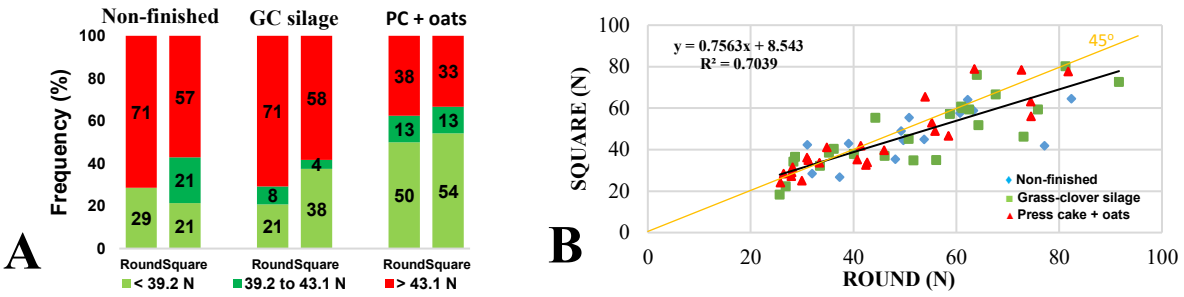


Figure 2. Meat classification according to the required value for instrumental shear force (A), and linear correlation between two different specimen cuts for instrumental texture determination by Warner-Bratzler shear force (B).

IV. CONCLUSION

Square cores exhibited lower shear force values compared to round cores; however, the strong correlation between the two sampling methods suggests that square cores may serve as a viable alternative for tenderness analysis. To further elucidate the impact of core preparation techniques and knife types on shear force outcomes, additional studies across different research centers and meat types are recommended to enhance methodological standardization and comparability.

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