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Variation In Shear Tenderness Data

J. J. Guenther, J. D. Gresham and R. D. Morrison

Story in Brief

The inherent variation in shear tenderness data of longissimus dorsi muscle from the right and left sides of the bovine was assessed. Four right and three left L. dorsi muscles from seven, 1100 lb., choice grade steers comprised the experimental material for the study.

Results indicated considerable random variation in steak shear valves both along and across L. dorsi muscles and that shear value varied differently within each side, especially in the lumbar portion of the muscle. Overall, the right L. dorsi muscles averaged 1.6 lbs. greater shear force than did the left muscles. All muscles were more tender nearer the medial side.

Data suggest that the most efficient experimental design, to test the influence of various treatments on beef tenderness, would be the Latin square in which the treatment and control are alternated between muscles from the right and left sides. Results also indicate that to make valid inferences as to treatment influence on beef tenderness, it is neces-

sary to test an entire muscle such as the L. dorsi rather than a small portion of the muscle, such as the 9-10-11th rib, which has been customary procedure in the past.

Introduction

During recent years the beef industry has faced progressively stiffer competition from synthetic protein food products. To meet this competition, the beef industry must undertake measures to assure maximum quality in beef products at the retail level. As tenderness is the most important quality factor, it would be logical to devise chemical and/or physical treatments which would enhance this characteristic in all grades and cuts of retail beef. However, to properly evaluate the efficiency and effectiveness of any imposed tenderizing treatment, it is essential to appraise, first, the extent of variation in tenderness of untreated beef cuts and to identify the factors responsible for such variation.

The objective of this study was to assess the variation in tenderness of a suitable experimental unit, the bovine longissimus dorsi muscle.

Materials and Methods

Experimental material was obtained from four right and three left longissimus dorsi muscles from seven choice grade steers, weighing approximately 1100 lbs. alive. The muscles were removed as whole blocks immediately post-mortem, trimmed of subcutaneous fat, wrapped and stored at 37°F. for 96 hours. The seven muscle blocks (3 right and 4 left) from the contra-lateral sides were treated chemically for another phase of this study. At the appropriate time, each muscle was divided into 15 one-inch steaks (Figure 1). Each core was sheared once, at its center, via the Warner-Bratzler device. Results were expressed as units of resistance to shear. The data were analyzed according to Snedecor & Cochran (1967).

Results

The major objective of this phase of the experiment was to assess the inherent variation that occurred in shear value along and across the longissimus dorsi muscles from the right and left sides of the bovine. It was believed that this information would be pre-requisite to selecting an experimental design for the subsequent evaluation of treatment effects.

One method of appraising the above mentioned variation is by analyzing the shear values on a "by-side" basis and testing the homogeneity of variance in shear value within the right and left longissimus dorsi muscles. The results of these analyses are presented in Table 1. The

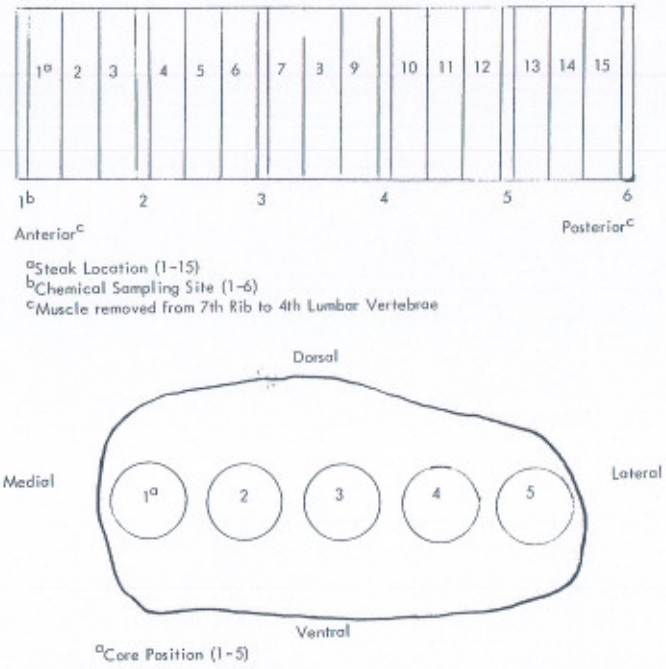

Figure 1. Schematic diagram showing the experimental model with respect to steak location within the L. D. muscle and core position within a particular steak.

only statistically significant source of variation noted in the analyses was that due to animal. As might be expected, this effect was quite large in both the right and left sides. These results also indicate a heterogeneity of variance between the right and left longissimus dorsi muscles for the animal x steak location, steak location x core position and animal x steak location x core position sources of variation.

In figure 2 the mean shear values for each of the fifteen steak locations along the right and left L dorsi muscles are presented. Though the analysis of variance (Table 1) showed no statistically significant difference in shear value due to steak location, these data suggest considerable random variation in steak shear value along the L. dorsi muscles from both sides. Also, the shear values appear to vary differently within each side, especially in the lumbar portion of the muscle. The maximum difference in shear force along the right and left muscle averaged 2.7 and 3.3 lbs., respectively. Overall the right L. dorsi averaged 1.6 lbs. more shear force than did the left. Perhaps if the number of animals were increased, a significant location effect would be obtained.

Table 1. Analysis of Variance For Shear Force By - Side

Source	d.f.	M.S.
Total	523	
Left Side	224	
Right Side	299	
Animal - in - left	2	944.8[1]
Animal - in - right	3	1817.8[1]
Steak location in left	14	14.6
Steak in right	14	17.9
Animal x steak location in left[2]	28	11.6[a]
Animal x steak location in right[3]	42	24.8[a]
Core position in left	4	12.8
Core position in right	4	36.0
Animal x position in left [4]	8	5.5
Animal x position in right[5]	12	13.2
Steak location x position in left	56	4.1[b]
Steak location x position in right	56	10.2[b]
Animal x steak location x position in left[6]	112	3.8[c]
Animal x steak location x position in right[7]	168	11.1[c]

[1] Significant ($P < 0.005$) difference in shear force among animals.
2, 4, 6 Error term for left side.
3, 5, 7 Error term for right side.
a, b, c Common superscript indicates unequality of variance.

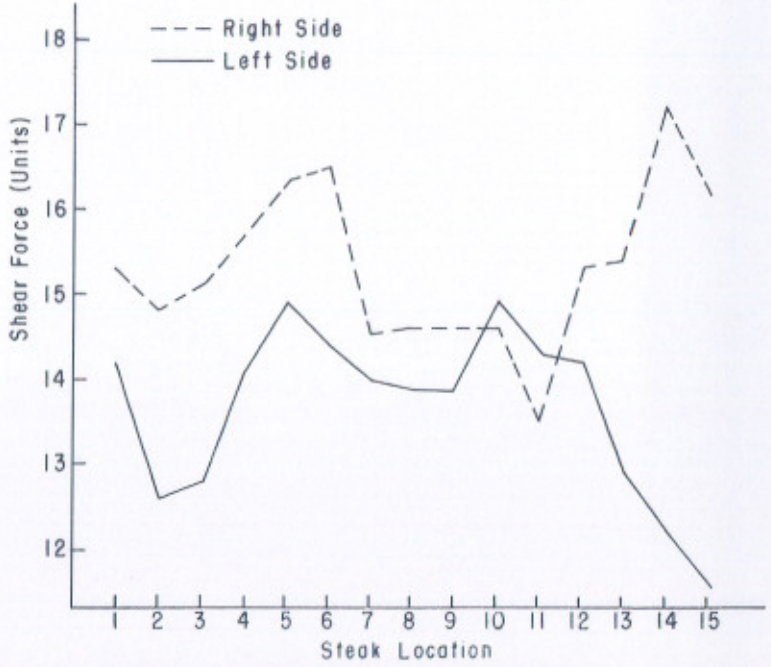

Figure 2. Mean shear values plotted by steak location along the right and left longissimus dorsi muscles.

Figure 3 portrays the average shear values plotted by core position within each steak from the right and left muscles. As indicated by these data, both right and left L. dorsi muscle seem to be more tender nearer the medial side, with the right side muscles having the higher shear values. The maximum difference in shear force between the two sides, 2.1 lbs., occurred at the lateral - most position. Again, the shear values tended to vary differently with side.

Discussion

As stated earlier, this study was conducted to determine the most efficient experimental design to test the influence of various chemical treatments on beef tenderness. The most frequently used experimental design in studies of this nature is a split - plot technique in which a portion of the longissimus dorsi muscle from one side of the animal is treated and the contra - lateral muscle portion is used as the "untreated control". The basic assumption in this technique is that there are no inherent differences between the right and left sides in the variable (such as tenderness) under investigation. This type of design, however, could lead to an unintentional confounding of the results with any side differences. For the results of the present study suggest that tenderness may vary not only between sides but also it may vary in different directions along and across the right and left longissimus dorsi muscles. Also, the

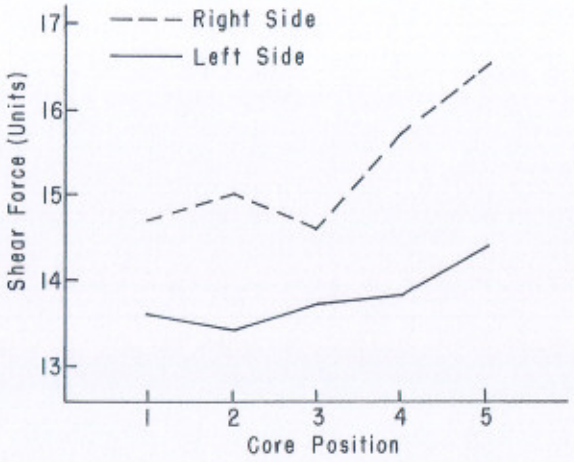

Figure 3. Mean shear values plotted by core position within steaks from the right and left longissimus dorsi muscles.

contra - lateral technique would require large numbers of animals to assess treatment effects.

The present results indicate that a more efficient design would be the Latin Square in which the treatment is assigned alternately to a particular side, and an even number of animals are added to the test. In this procedure the control side is also alternated between right and left. Moreover, the Latin Square design would require a minimum number of animals to assess animal, side and treatment effects.

The current data also suggest that if inferences are to be made to the effect of a particular treatment on beef tenderness in general, if would be wise to test an entire muscle such as the longissimus dorsi rather than a small portion of the muscle, such as the 9-10-11th rib, which has been the customary procedure in the past.

The Influence Of P-Chloromercuribenzoate On The Tenderness, pH, Adenosine Triphosphatase Activity And Protein Solubility Of Bovine Longissimus Muscle

J. D. Gresham, J. J. Guenther and R. D. Morrison

Story in Brief

This experiment was conducted to study the effect of a particular level of p-chloromercuribenzoate on the tenderness and certain biochemical attributes of beef muscle. Results showed that PCMB, as used in this test, had no statistically significant effect on the shear force, calcium or magnesium activated myofibrillar ATPase activity, pH or myofibrillar protein solubility of bovine longissimus dorsi muscle.