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The Influence of Connective Tissue in Meat Tenderness (A Histological and Comparative Study)

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THE INFLUENCE OF CONNECTIVE TISSUE IN MEAT TENDERNESS
(A HISTOLOGICAL AND COMPARATIVE STUDY)

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Thesis submitted in partial fulfillment
of the requirements for the degree

of

UNIVERSITY HONORS
WITH DEPARTMENTAL HONORS

in

Animal, Dairy, and Veterinary Sciences

Approved:

Thesis/Project Advisor

Department Honors Advisor

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ABSTRACT

There are several means of determining the tenderness of meat. Recently, a great deal of effort has been focused on connective tissue, or collagen, as a measure of tenderness. These foci have included biochemical determination of collagen types, the ratios of soluble and insoluble collagen, changes of collagen with age, and abundance of collagen.

The purpose of this study is to evaluate the abundance of collage as a means of differentiating levels of tenderness , using histology. Steaks taken from the bovine tenderloin, inside round, and bottom round (eye) were observed histologically using special stains for connective tissue. This method, compared with accepted methods of measuring tenderness, showed similar trends, but its use is limited.

INTRODUCTION

Meat is generally sold at higher prices than other sources of protein (Wulf et al), therefore it is very important to the industry that methods can be found to more efficiently determine acceptable and unacceptable, or higher quality of acceptable carcasses. Many consumers desire and will pay the high price for a tender steak. These same individuals develop an ability to differentiate cuts by name and pricing. For example, a tenderloin may be priced at $7.99/lb,whereas, a top round $3.49/lb, and an eye of round steak is $3.89/lb; the cost/lb being an indication of how tender the steak should be in comparison to others.

There have been several methods developed for determining tenderness in the meat industry both subjective and objective. Subjective measures such as the age of animals at the time of slaughter, marbling, meat color, and breed are fast and fairly good predictors of tenderness. However even within these divisions there is a great deal of variation. Further study and objective methods such as pH of muscle tissue has developed. The pricing of meat cuts shows and even deeper level of classification, however classification based on price is somewhat limited.

To best study muscle tenderness it is important to understand the composition of meat. Steaks may be differentiated by fragmentation of muscle fibers, collagen solubility ratios, and other biochemical analysis, but the most common methods involve taste panels and tissue shear cutting force. A great deal of emphasis has been placed on the study of the connective tissue found within the muscle. This collagen not only functions in supporting the muscles and their movement with the bones but also surrounds individual fibers and muscle bundles. The strength and stability of this collagen increases with age, sexual maturity, and use of the particular muscle or muscle group. One very important factor is how much collagen is present in various cuts of meat. The more connective tissue (collagen), that is found within a group of fibers, the less tender the steak is.

The purpose of this study is to see if quantitative histology is an effective method to predict tenderness in three beef steak cuts.

MATERIALS AND METHODS

Meat Sample.

The steaks used for this study were obtained from an "A" maturity, select heifer. The heifer had a 600 lb dress weight with 4% KPH (kidney-pelvic are) fat, slight marbling, light cherry red color score, and a yield grade of 3. Consecutive steaks were taken from the tenderloin, inside round, and eye of round for evaluation. All exterior fat was trimmed and the steaks were stored at -6 C^0 for 7 days. On day 7 the steaks were removed and thawed at room temperature for approximately 7 hours, then tempered in a standard refrigerator at 4^0C for 4 hours.

Histology Evaluation.

One cm^3 samples of the tenderloin, top round and eye of the round were fixed in a 10% buffered formalin solution after which they were trimmed and prepared for sectioning. A longitudinal and cross-section were made of each sample. The tissues were stained with a standard H&E and a Van Giessen connective tissue stain.

Light microscopy was used for quantitating collagen fibers at various chosen reference points. It was difficult to assure a representative reference point among the samples.

Next, photos were taken of the slides at 40X and 100X power. Photos were then labeled and scored for connective tissue. Two individuals made a blind judgement to classify the photos on the abundance of collagen in each of the three tissues. The photos were placed in order of most, moderate, and slight collagen. The histological evaluations produced identical results compared with the results of the taste panel and the Warner-Bratzler shear test procedures. Consistency and reproducibility needs to be further studied.

Student Taste Panel.

The steaks were cooked on an open grill to an internal temperature of approximately 160^{0}C. The temperature was monitored by a meat thermometer and all steaks were cooked for the same period of time. One in square pieces of each steak were served on sections of a plate which was divided into thirds. The samples were served warm to the panelists.

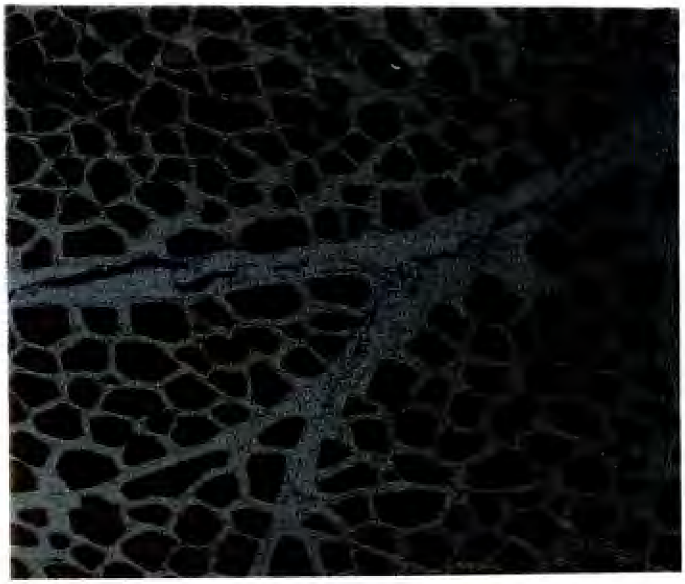
The panelist were chosen from a class of pathology students and random participants of various backgrounds in terms of meat knowledge. The panelist were given a score sheet and asked to rate the different samples on a scale from 1 to 8; 1 being a poor score for the category and 8 the most acceptable. The categories consisted of tenderness, amount of connective tissue, flavor intensity, juiciness and overall quality. The scores were then evaluated for their means and standard deviations.

Warner-Bratzler Shear Evaluation.

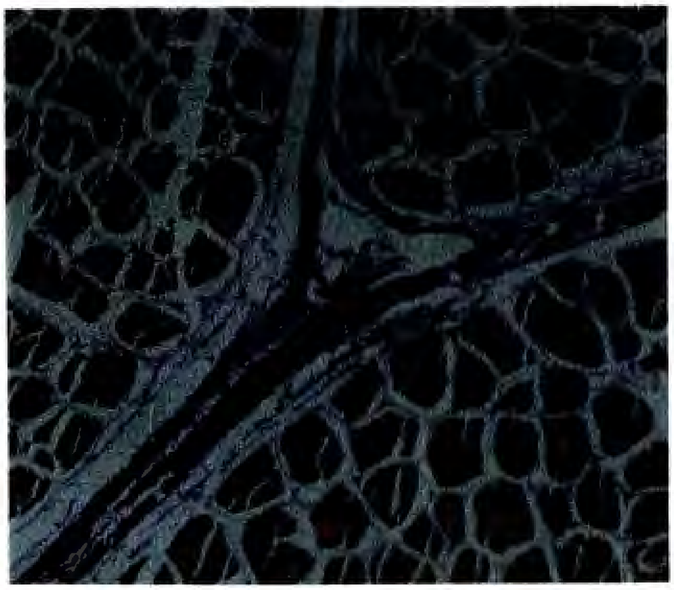
The steaks were cooked in the same manner as in the taste panel. Five cores were taken, one from each steak type. Each core was sheared once. The mean shear force was then calculated.

The cores were taken both perpendicular to and at an angle to the muscle fibers. This contributed to the variability in scoring (Wheeler et al).

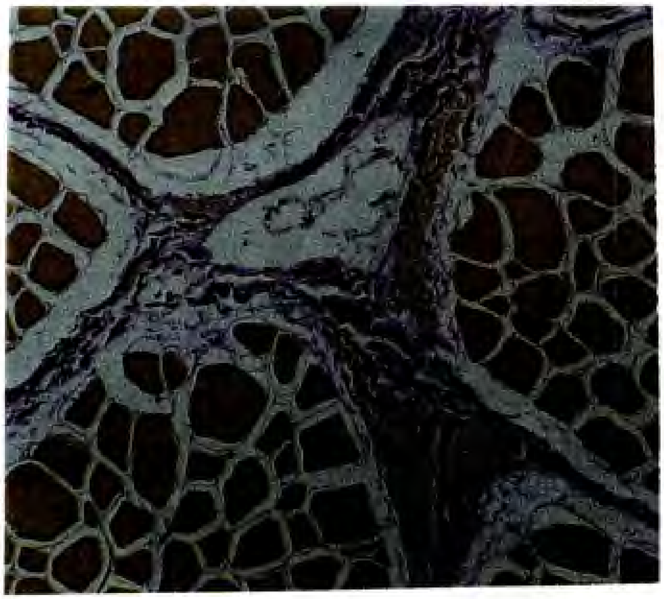
RESULTS



a. Crossection of the longissimus dorsi (tenderloin) at 100X. Van Giessen connective tissue stain.



b. Crossection of the top round steak at 100X. Van Giessen connective tissue stain.



c. Crossection of the eye of round steak at 100X. Van Giessen connective tissue stain.

Taste panel: N=17
Scale =1 (Bad)--8 (Good)

Mean score and SD	Tenderloin	Top Round	Eye of Round
Tenderness	6.65 ± .93	4.94 ± 1.75	4.76 ± 1.20
Amount of C.T.	6.41 ± .94	3.94 ± 1.75	5.06 ± 1.43
Flavor	6.29 ± .77	5.65 ± 1.32	5.47 ± .94
Juiciness	6.18 ± .95	6.18 ± .95	4.76 ± 1.44
Total	25.53	24.76	20.05
Overall	6.53 ± .87	5.00 ± 1.69	5.24 ± 1.09

*SD =standard deviation

Warner-Bratzler shear force values
lb/cm^2 diameter (core)

	Tenderloin	Top Round	Eye of Round
core 1	5.75	8.5	8
core 2	7	8	8.5
core 3	6	5	6.5
core 4	7.5	4	10.5
core 5	6	9	11
mean and SD*	6.45 ± .75	6.9 ± 2.25	8.9 ± 1.85

*N=5

DISCUSSION

General abundance of collagen as seen histologically showed the same trends of the other methods used. The cuts used for this study were chosen because they were generally known to have a larger difference. If a tenderloin, top loin, and ribeye were tested using this method, results would be more difficult and perhaps unattainable. To differentiate these closer cuts it is not the amount of collagen that makes the difference, but the kind. More specific collagen solubility methods are then required. There are presently 25 known types of collagen, each consisting of one or more specific alpha-chains. These distinct amino acid chains and their cross links determine the solubility of the collagen (Basic Medical Histology pp.108).

Results for the taste panel and Warner-Bratzler shear test methods were statistically insignificant for this study. However, with present information and standard deviations an appropriate sample size could be used to further study the implications of the tenderness variation in the differing cuts.

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