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Techniques for evaluation of beef muscle "biopsies" as a means of estimating palatability and composition of live animals

George C. Mays

To the Graduate Council:

I am submitting herewith a thesis written by George C. Mays entitled "Techniques for evaluation of beef muscle "biopsies" as a means of estimating palatability and composition of live animals." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

J.W. Cole, Major Professor

We have read this thesis and recommend its acceptance:

C.S. Hobbs, O. Glen Hall

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

December 9, 1963

To the Graduate Council:

I am submitting herewith a thesis written by George C. Mays entitled "Techniques for Evaluation of Beef Muscle 'Biopsies' as a Means of Estimating Palatability and Composition of Live Animals." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

Major Professor

We have read this thesis and recommend its acceptance:

Charles S. Hobbs

O. Glen Hall

Accepted for the Council:

Hilton A. Smith
Dean of the Graduate School

TECHNIQUES FOR EVALUATION OF BEEF MUSCLE "BIOPSIES" AS A MEANS OF ESTIMATING PALATABILITY AND COMPOSITION OF LIVE ANIMALS

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

George C. Mays

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George C. Mays

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CHAPTER I

INTRODUCTION

The livestock industry of today is becoming more cognizant of the importance of producing animals that will yield carcasses with superior meat quality, combined with a high proportion of lean cuts. Until recent years, the emphasis placed on the amount of finish as an indication of quality in live cattle has presented livestock producers with a slightly distorted picture of the characteristics most desirable in meat animals. Some animals produce carcasses with a relatively small amount of fat and a high proportion of muscle tissue, but with meat quality equal, or even superior, to those animals that are much fatter. These desirable animals often are difficult to recognize and do not always receive proper recognition in livestock shows and sales.

The present widely-used method of selecting superior meat-type animals on the basis of their carcass characteristics, as determined by physical and chemical analyses, is a laborious and expensive process. Through the use of high frequency sound instruments, research workers now are able to accurately measure the fat covering

in live animals. These instruments also are used to measure, with a lesser degree of accuracy, the size of selected muscles in live animals. These measurements, when properly calculated to animal weight, may be used to predict the meatiness, or muscle to fat ratio, of the potential carcass.

The development of an accurate and relatively inexpensive method of analyzing live animals to determine the palatability of their carcasses would be helpful to all segments of the beef cattle industry. Therefore, this investigation was undertaken to determine the possible carcass quality factors that could be determined from a small section of the longissimus dorsi muscle, similar to a biopsy sample taken from a live animal, and the relationship of these factors to carcass data from the same animals.

CHAPTER II

LITERATURE REVIEW

The biopsy technique for analyzing muscles of live meat animals is a relatively new technique. However, the application of procedures similar to those employed for removing fat biopsies and liver biopsies from domestic animals are being practiced by some research workers.

Ewing et al. (1918) developed a technique employing a borer, consisting of a twisted clock spring inserted in a cannula, for removing fat samples from the backfat of hogs. Scott (1920) reported a method for removal of fat samples from the ham of live hogs. Scott and Black (1951) advanced a biopsy technique for obtaining backfat samples in swine as a part of their studies of soft pork. The techniques described in these three reports were limited to the extraction of subcutaneous deposits of adipose tissue.

Liver biopsies are routinely taken on domestic animals by means of a cannula-like instrument; this being a widely-used procedure for obtaining samples for checking the vitamin A content of the liver of live animals.

Bray (1953) reported a biopsy technique used on both swine and cattle. The biopsied material, removed by incision through skin, fat, and muscle tissue, was used for a study of subcutaneous fat deposition, histological investigations, and intramuscular fat deposition studies on animals in feeding trials. The incision,1 1/2 to 3 inches in length, for removing these samples was made parallel to and 1 to 2 inches laterally from the vertebral column just posterior to the last rib. These incisions appeared to have no noticeable permanent adverse effects upon the health of the animals and were completely healed in 3-5 weeks. The results of this investigation were reported as being unsatisfactory for determining marbling pattern and other muscle characteristics, primarily as a result of poor staining techniques. However, the location and procedure for removal of the muscle sample was very acceptable.

Spurlock et al. (1962) removed small samples of lean (1. 5 x 1. 5 x 6. 0 cm.) from the semimembranosus and the longissimus dorsi muscle of lambs before slaughter. Portions of these muscle samples were chemically analyzed for moisture, fat, and protein. A portion of the longissimus dorsi muscle sample was cooked by moist heat in a pressure cooker for 5 minutes at 15 pounds pressure. After cooling, these samples were cut to a uniform size for shear tests on the Warner-Bratzler shear machine. The sheared pieces were rated for tenderness

as determined by chew count. The results were correlated with data obtained by accepted carcass evaluation procedures. Percent fat in the longissimus dorsi biopsy and percent fat in the semimembranosus biopsy were highly correlated with percent intramuscular fat in the muscle of origin as well as percent fat in other muscles of the carcass. Although no data were presented from the cooking and shearing tests, it is expected that very little difference in tenderness resulted because of the nature of the cooking procedure. However, the biopsy removal procedure was found to be practical and resulted in no permanent disability to the animals being tested.

While discussing the progress and advancements in beef carcass evaluation in recent years, Cole (1962) stressed the importance of eating quality as a criterion for the selection of the "meat-type" steer and emphasized the need for more proficient techniques for determining eating quality in live animals.

CHAPTER III

PROCEDURE

A small section of the longissimus dorsi muscle was removed from an area adjacent to the thirteenth rib of the left loin of 40 steers representing 5 breeds. These samples were removed through an incision in the hide and fat over the thirteenth rib. The samples, collected over a two-year period, were removed immediately after the animals were stunned and bled for slaughter at the University of Tennessee Abattoir. These samples, which will hereafter be referred to as "biopsies," were chilled for 48 hours at a temperature of approximately 36°F. before being wrapped and frozen in a -20°F. air-blast freezer. After freezing, the samples were stored at 0°F. until all samples had been collected. This storage period ranged from 6 to 29 months.

The samples were cut while still frozen to a uniform size of 25 x 40 x 60 mm. with an electric band saw. After weighing, the samples were cooked from the frozen state in a preheated 250°F. Despatch oven until an internal temperature of 155°F. was reached. Twenty samples were cooked at each of two cookings on small individual roasting utensils made from pyrex beakers covered with a drip

rack made of one-fourth-inch mesh hardware cloth.

The cooked samples were weighed after cooling 30 minutes at room temperature and then were placed in a 36°F. refrigerator overnight before cores were removed for shear tests. The drippings from each sample were collected in the pyrex beakers and weighed to determine drip loss. Evaporation losses were calculated by determining the difference in the weight of the raw sample and the cooked sample plus the drippings.

Two or three one-half-inch cores were removed from each of the chilled samples parallel to the muscle fibers. These cores were then sheared 1 to 3 times, according to their length, by the Warner-Bratzler shear machine and an average shear value for each sample was determined.

After the removal of all surface fat, the frozen muscle trimmings, obtained by cutting the original sample to a uniform size, were chopped and mixed by use of a hand-operated food chopper. This was done in a 36°F. cooler to reduce thawing of the samples and minimize moisture evaporation.

Approximately 2 grams of each sample, in duplicate, was then dried in a 100°C. oven under a vacuum of 4 inches of mercury for 5 hours to determine moisture content. The dried samples then were extracted in anhydrous ether for 6 hours to determine ether extract

content. Protein content was calculated by difference assuming an ash content of 1%.

Slaughter and carcass evaluations of the steers from which the samples were taken were conducted at the University of Tennessee Meat Laboratory. Weights of offal, or non-carcass components, were taken during the slaughter process to be used in other investigations. Carcasses were chilled in a thermostatically-controlled 36°F. cooler for 48 hours prior to physical separation. The left side of each carcass was divided into wholesale cuts according to the procedure recommended by Wellington (1953) except that a conventional square cut chuck was made. The round and the 9-10-11 rib section were physically separated into muscle, fat, and bone. Samples of the longissimus dorsi muscle and the combined fat and muscle from the entire 9-10-11 rib section were ground two or three times, mixed, and sampled for chemical analyses of moisture, ether extract, and protein.

The right side of the carcass was aged in the 36°F. cooler for 2 weeks before being cut into roasts and steaks for cooking tests, shear value determinations, and tenderness, juiciness, and flavor scores by members of laboratory and family taste panels.

The data obtained from the biopsies were correlated to corresponding values from the carcass cuts. These data were

statistically analyzed according to the methods and procedures outlined by Snedecor (1956).

CHAPTER IV

RESULTS AND DISCUSSION

Prior to the beginning of the analysis of the biopsies, preliminary investigations were conducted to determine the most acceptable methods for securing a maximum amount of relevant information from these samples. Small sections of the longissimus dorsi muscle were cut from beef ribs and analyzed to determine (1) a usable sample size, (2) a desirable method of trimming the samples to a uniform size, and (3) the best cooking procedure.

Samples cut to a size of 13 x 13 x 60 mm. and sheared after cooking showed much lower correlations with shear values for carcass cuts than shear values for cores removed from 25 x 40 x 60 mm. samples. These smaller samples became very hard and dry on the outside surface while cooking and had much higher and less uniform shear values than the cores removed from the larger samples. Samples that were trimmed in the frozen state with an electric band saw were easier to secure and were more uniform in size than samples that were trimmed with a knife or meat slicer after thawing.

Samples roasted from the frozen state in a 250°F. Despatch oven had the following advantages over similar samples broiled 4

inches from the heat source in a preheated oven:

(1) The roasted samples were more uniformly cooked.

(2) The cores for shear tests removed from the broiled samples had a hardened exterior layer and a soft watery center resulting from "case-hardening" of the samples during broiling.

(3) The roasted samples more nearly retained their original size and shape than the broiled samples or roasted samples that were allowed to thaw before cooking. The size and shape of the cooked sample is important in order that a minimum of 2 one-half inch cores can be obtained for shearing.

The biopsy samples analyzed in this study were collected from animals of 5 breeds. The carcass grade distribution of these steers within breeds is shown in table I. The carcass weight and grade was more or less representative of the majority of cattle marketed from feedlots in the southeastern United States. The number of animals within breeds varied from 4 for Herefords and Charolais to 13 for Angus.

The average percent total cooking losses for the small biopsy samples were much higher than for either loin steaks or rib roasts (table II). Greater dehydration of the biopsy samples during cooking

TABLE I

CARCASS GRADE DISTRIBUTION WITHIN BREEDS

Breed	Carcass grade			Breed totals
	Choice	Good	Standard	
Angus	12	1	--	13
Brahman	--	7	4	11
Charolais	1	3	--	4
Hereford	--	4	--	4
Jersey	--	7	1	8
Carcass grade totals	13	22	5	40

TABLE II

AVERAGE PERCENT TOTAL COOKING LOSSES AND SIMPLE CORRELATION COEFFICIENTS FOR BIOPSIES, LOIN STEAKS, AND RIB ROASTS BY BREEDS

Breed	Average total cooking loss			Simple correlation coefficients		
	Biopsies	Loin steaks	Rib roasts	Biopsies vs. loin steaks	Biopsies vs. rib roasts	Loin steaks vs. rib roasts
	%	%	%			
Angus	34.71	21.87	19.00	0.20	0.23	0.46
Brahman	35.68	24.37	20.27	0.15	0.51	-.32
Charolais	39.41	22.35	18.17	0.02	0.33	-.89
Hereford	35.57	23.43	20.04	0.15	0.03	0.50
Jersey	27.86	20.43	16.21	0.14	0.05	0.27
All breeds	34.16	22.47	18.77	0.33*	0.44**	0.25

*Significant at the 5% level of probability.

**Signicifant at the 1% level of probability.

was expected because of the smaller size of these samples. The biopsies were about one-fifth as large as the loin steaks and about one-twentieth as large as the rib roasts; therefore, the surface area exposed per total volume for dehydration by the cooking environment was much greater in the biopsies than in either loin steaks or rib roasts. Biopsies from the Jersey steers had the lowest cooking losses, being 6.3% lower than the average for all animals. Although these losses for biopsies from the Jersey steers were somewhat lower than for other breeds, they more or less paralleled losses for the steaks and roasts from animals of this breed. The highest percent total cooking losses were obtained from biopsies of the Charolais steers. Average total cooking losses for biopsies from Angus, Brahman, and Hereford steers varied less than 1 %.

Relatively low simple correlation coefficients ($r = 0.02$ to $r = 0.51$) were obtained when total cooking losses for the biopsy samples were correlated with total cooking losses for the loin steaks and rib roasts on a within breed basis. However, when all animals were considered, the association ($r = 0.44$) of total cooking losses in biopsies and rib roasts was significant at the 1% level of probability. Also the association ($r = 0.33$) of total cooking losses in biopsies and loin steaks was significant at the 5% level of probability while the association of total cooking losses in loin steaks compared to rib

roasts was much lower and only approached significance at the 5% level of probability. This indicates that total cooking losses for the biopsies were more closely associated with total cooking losses for either of the two carcass cuts than were cooking losses of loin steaks and rib roasts.

Evaporation losses for the biopsies were almost twice as great as for the broiled loin steaks and almost two and one-half times as great as evaporation losses for the oven-roasted rib roasts when data from all animals were analyzed. This same evaporation loss pattern with only minor variations was observed when breed means were compared as shown in table III and Appendix table IX. Most of the increase in total cooking loss for biopsies compared to loin steaks or rib roasts as shown in table II can be explained by the tremendous comparative evaporation loss of biopsies and loin steaks or rib roasts as shown in table III. These differences in evaporation losses are partially justified on the basis of the small sample size and absence of outside fat on the biopsies compared to rib roasts and much slower cooking of the biopsies compared to the loin steaks. However, the evaporation losses for the biopsies were significantly associated with evaporation losses for both rib roasts and loin steaks while evaporation losses between loin steaks and rib roasts were not significantly associated at the 5% level of probability when all animals were analyzed.

TABLE III

AVERAGE EVAPORATION LOSSES AND SIMPLE CORRELATION COEFFICIENTS FOR BIOPSIES, LOIN STEAKS, AND RIB ROASTS BY BREEDS

Breed	Average evaporation loss			Simple correlation coefficients		
	Biopsies	Loin steaks	Rib roasts	Biopsies vs. loin steaks	Biopsies vs. rib roasts	Loin steaks vs. rib roasts
	%	%	%			
Angus	32.11	15.81	12.79	0.36	0.46	0.89**
Brahman	32.44	17.50	15.88	-.06	0.56	-.36
Charolais	34.13	15.90	14.06	0.26	-.18	-.99
Hereford	32.46	17.89	13.96	0.78	-.27	0.01
Jersey	25.67	14.77	12.19	0.39	-.01	0.21
All breeds	31.24	16.29	13.73	0 32*	0.36*	0.30

*Significant at the 5% level of probability

**Significant at the 1% level of probability.

The small biopsy samples having little or no external fat produced less than one-half the amount of drip loss collected from loin steaks and approximately 60% of the average drip loss from rib roasts as shown in table IV and Appendix table IX. Also, there was a low negative association ($r = -.03$ and $r = -.01$) between average drip loss from the biopsies and either loin steaks or rib roasts when all animals were considered. Average drip losses for loin steaks and rib roasts also had a very low association ($r = 0.09$) in the analysis of all animals. In this table, several high correlations may be observed within the breeds. Because of the small number of samples, none were significant at the 5% level of probability except the loin steak versus rib roast correlation within the Brahman breed. This correlation proved to be highly significant, indicating a high association between drip loss percentage in loin steaks and rib roasts from Brahman steers.

Although average shear values for one-half inch cores from the biopsies were much higher than average shear values for either the loin steaks or rib roasts, there was a highly significant association between these values when all animals were analyzed, as shown in table V and Appendix table X. The higher average shear values for the biopsies were probably caused primarily by the temperature of the cooked samples when they were sheared. The biopsy samples were

TABLE IV

AVERAGE DRIP LOSSES AND SIMPLE CORRELATION COEFFICIENTS FOR BIOPSIES, LOIN STEAKS, AND RIB ROASTS BY BREEDS

Breed	Average drip loss			Simple correlation coefficients		
	Biopsies	Loin steaks	Rib roasts	Biopsies vs. loin steaks	Biopsies vs. rib roasts	Loin steaks vs. rib roasts
	%	%	%			
Angus	2.61	6.07	6.21	0.10	-.08	0.13
Brahman	3.24	6.87	4.39	-.16	0.07	0.78**
Charolais	5.23	6.45	4.11	-.80	0.81	0.65
Hereford	3.10	5.69	6.08	-.38	-.44	0.39
Jersey	2.19	5.66	4.02	-.02	0.17	0.08
All breeds	3.01	6.21	5.04	-.03	-.01	0.09

**Significant at the 1% level of probability.

TABLE V

AVERAGE SHEAR VALUE AND CORRELATION COEFFICIENTS FOR BIOPSIES AND CARCASS CUTS BY BREEDS

Breed	Average shear value			Simple correlation coefficients		
	Biopsies (1/2" cores)	Loin steaks (1/2" cores)	Rib roasts (1" cores)	Biopsies vs. loin steaks	Biopsies vs. rib roasts	Loin steaks vs. rib roasts
	lb.	lb.	lb.			
Angus	18.26	5.50	16.32	-.09	-.10	0.74**
Brahman	23.40	7.32	17.76	0.66*	0.31	0.43
Charolais	22.62	5.76	13.48	0.94	-.45	0.29
Hereford	20.36	5.40	16.24	-.38	0.39	0.02
Jersey	15.16	4.90	13.66	0.22	0.34	0.37
All breeds	19.61	5.87	15.40	0.45**	0.58**	0.55**

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

chilled overnight in a 36°F. refrigerator to facilitate the removal of uniform one-half inch cores for shearing from the small samples while the cores from loin steaks and rib roasts were removed and sheared after only 30 minutes cooling at room temperature. It appears from these data that the relationship between tenderness ratings of biopsies and either loin steaks or rib roasts is as high as the relationship between loin steaks and rib roasts. Associations for shear values of the biopsies and carcass cuts within breeds were not as high in most instances as the association for all animals. However, the rank of breeds when shear values for biopsy samples and loin steaks were compared was quite similar. It is expected that this similarity was influenced by the fact that the loin steaks came from the longissimus dorsi muscle at a location that closely paralleled the location from which the biopsy sample was taken. The shear values for the same muscle taken from rib roasts showed less similarity of rank for the breeds. However, these roasts were removed from the sixth and seventh rib section of the animal rather than from the thirteenth rib section from which the biopsies were removed.

As shown in table VI and Appendix table X, shear values for the biopsies were correlated with tenderness ratings as determined by a five-member taste panel for broiled loin steaks and rib roasts cooked by dry heat in a moderate oven. The negative correlation ($r = -.53$)

TABLE VI

SIMPLE CORRELATION COEFFICIENTS OF BIOPSY SAMPLE SHEAR VALUES AND TASTE PANEL TENDERNESS RATINGS FOR LOIN STEAKS AND RIB ROASTS

Breed	Simple correlation coefficients: Biopsy sample shear value vs. loin steaks tenderness rating	Simple correlation coefficients: Biopsy sample shear value vs. rib roasts tenderness rating
Angus	0.04	0.69
Brahman	-.72*	-.42
Charolais	-.42	0.25
Hereford	-.22	-.97*
Jersey	-.47	-.61
All breeds	-.53**	-.32*

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

for biopsies versus loin steaks was significant at the 1% level of probability and the negative correlation ($r = -.32$) for biopsies versus rib roasts was significant at the 5% level of probability. Both of these correlation coefficients indicate a tendency for taste panel tenderness scores to increase as shear force decreases. This trend was anticipated since a higher taste panel score and a lower shear value designate a "more-tender" product. These significant correlations indicate that average shear value for cores removed from cooked biopsies might be used as relatively accurate predictors of taste panel tenderness rating for broiled loin steaks or rib roasts from the carcass.

Moisture content of the biopsy samples, as determined by drying in a vacuum oven, was lower for each of the breeds than the moisture content of a sample of the longissimus dorsi muscle taken from the 9-10-11 rib section of the carcass as shown in table VII. Although these biopsies averaged 3.9% less moisture than the carcass muscle, the correlation coefficient of 0.59 obtained when these values were compared for all animals was highly significant. The moisture contents of the biopsies and carcass muscles were closely associated in the majority of animals tested, especially in the Angus and Jersey breeds as shown in Appendix table XI.

The percentage of each biopsy sample and carcass muscle sample extracted by ether is shown in Appendix table XI. The average

percentage of ether extract from the carcass muscle and biopsy sample for each of the 5 breeds and all animals grouped together, along with simple correlation coefficients for these values, is shown in table VII. The ether extract percentage was higher for biopsies in the Angus and Brahman breeds but higher for carcass muscle samples in the Charolais, Hereford, and Jersey breeds. When all animals were considered, the ether extract from the biopsies was 0.13% higher than for carcass muscles. The correlation coefficient ($r = 0.56$) obtained when ether extract percentages for the carcass muscle were compared to ether extract percentages for the biopsies from all animals was significant at the 1% level of probability.

Protein content of carcass muscle and biopsy samples was determined by the difference in the combined weight of moisture and ether extract and the weight of the original sample, assuming that 1% of the weight was ash. This value was 2.84% higher for biopsy samples than for carcass muscles when all animals were compared as shown in table VII. A relatively low association ($r = 0.21$) was observed when protein content of biopsies was compared to protein content of the carcass muscle for all animals. However, when protein content was calculated on a dry sample basis, the percentage protein content of the biopsies more closely paralleled the protein content of the carcass muscle.

TABLE VII

AVERAGE PER CENT MOISTURE, ETHER EXTRACT, AND PROTEIN WITH SIMPLE CORRELATION COEFFICIENTS FOR BIOPSIES AND LONGISSIMUS DORSI MUSCLES FROM 40 STEERS

Breed	Moisture			Ether extract			Protein		
	Biopsies	L. dorsi	r	Biopsies	L. dorsi	r	Biopsies	L. dorsi	r
	%	%		%	%		%	%	
Angus	67.62	71.42	0.75**	6.47	5.11	0.15	23.32	20.97	0.39
Brahman	69.13	74.63	-.07	2.80	2.58	-.22	25.26	21.52	-.31
Charolais	69.27	73.29	-.30	3.25	3.26	0.29	24.74	21.91	-.66
Hereford	71.87	73.80	0.30	3.52	4.52	-.31	22.15	20.67	-.29
Jersey	66.52	69.36	0.73*	6.73	7.77	0.78*	24.08	21.14	0.00
All breeds	68.45	72.37	0.59**	4.81	4.68	0.56**	24.07	21.23	0.21

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Average subjective marbling scores for the biopsy samples had a highly significant association ($r = 0.76$) with average subjective marbling scores for the corresponding carcasses when all animals were considered. As shown in table VIII and Appendix table XII, there was less than one-half degree difference in the mean marbling score for biopsy samples and carcasses from all animals. In the Angus, Hereford, Brahman, and Jersey breeds biopsy samples had slightly more marbling than carcasses while the biopsies from the Charolais steers had slightly less marbling than the carcasses. However, these differences in mean marbling score within breeds were very small with the greatest difference within any breed being 0.7 of one marbling score difference. This high association indicates that marbling scores for biopsy samples may be used as relatively accurate predictors of carcass marbling.

TABLE VIII

AVERAGE MARBLING SCORE AND CORRELATION COEFFICIENTS BY BREED FOR BIOPSY SAMPLES AND CARCASSES

Breed	Average marbling score#		Simple correlation coefficient
	Biopsy sample	Carcass	Biopsy sample marbling score vs. carcass marbling score
Angus	6.3	6.1	0.20
Brahman	3.8	3.3	0.54
Charolais	4.5	5.0	0.00
Hereford	5.5	4.8	0.67
Jersey	7.2	6.8	0.29
All breeds	5.6	5.2	0.76**

#Key to marbling scores: 3 = Traces, 4 = Slight amount, 5 = Small amount, 6 = Modest, 7 = Moderate.

**Significant at the 1% level of probability.

CHAPTER V

SUMMARY AND CONCLUSIONS

Small sections of the longissimus dorsi muscle, removed from 40 steers of 5 breeds at the beginning of the slaughter process, were analyzed to determine marbling score, chemical composition, shear value, and cooking losses. The data obtained from these "biopsies" were correlated to corresponding values for carcass cuts.

Shear values for broiled loin steaks and oven-roasted rib roasts were much lower than those for the oven-roasted biopsies. However, the relationships among breed means were very similar and the association between biopsy shear values and shear values of either loin steaks or rib roasts was significant. The correlations between biopsy shear values and taste panel tenderness ratings likewise were significant.

Moisture content of the biopsies was slightly lower than, but closely paralleled, the moisture content of the longissimus dorsi muscle sample from the 9-10-11 rib section of the carcass. The correlation of ether extract percentage of the biopsies with carcass muscle ether extract percentage was significant at the 1% level of probability. Marbling score for the biopsies appeared to be a relatively accurate

predictor of carcass marbling as was shown by a highly significant correlation when these two values were compared.

Total cooking losses for the biopsies were much higher than for the larger carcass cuts having a greater volume per surface area exposed to the dehydration of the cooking environment. However, the association of total cooking losses of the biopsies compared to loin steaks and rib roasts was significant when all animals were compared.

LITERATURE CITED

LITERATURE CITED

Bray, R. W. 1953. Biopsy techniques. Proc. Sixth Ann. Recip. Meat Conf. 6:98.

Cole, J. W. 1962. Trends in beef carcass evaluation. Proc. Fifteenth Ann. Recip. Meat Conf. 15:93.

Ewing, P. W., L. H. Wright, and L. B. Burk. 1918. Method of extracting fat samples from live hogs. Texas Agr. Exp. Sta. Bul. 226.

Orts, F. A. 1962. Beef carcass measures and cutting procedures. Proc. Fifteenth Ann. Recip. Meat Conf. 15:125.

Ramsey, C. B., and J. W. Cole. 1963. Unpublished data concerning ash content of meat samples. Tenn. Agric. Exp. Station.

Scott, J. M. 1920. Soft pork studies. Florida Agr. Exp. Sta. Bul. 157, p. 67.

Scott, E. L., and H. W. Block. 1951. A method for removing fat samples from live hogs. J. Agr. Res. 42:47.

Snedecor, G. W. 1956. Statistical Methods (5th ed.). Iowa State College Press, Ames, Iowa.

Spurlock, G. M., G. E. Bradford, and J. D. Wheat. 1962. The biopsy technique for estimation of meat quality in lambs. Proc. Fifteenth Ann. Recip. Meat Conf. 15:178.

Spurlock, G. M., and G. E. Bradford. 1963. Muscle biopsy and certain body proportions as indicators of carcass merit in sheep. Progress Report, California Agr. Exp. Sta., October, 1963.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York, N. Y.

Wellington, G. H. 1953. Recommended procedure for cutting beef. Proc. Sixth Ann. Recip. Meat Conf. 6:73.

Ziegler, P. T. 1962. The Meat We Eat. The Interstate Printers and Publishers, Inc., Danville, Illinois.

APPENDIX

APPENDIX TABLE IX

PERCENT COOKING LOSSES FOR BIOPSY SAMPLES, LOIN STEAKS AND RIB ROASTS FROM 40 ANIMALS

Animal number	Total cooking loss			Drip loss			Evaporation loss		
	Biopsy sample	Loin steak	Rib roast	Biopsy sample	Loin steak	Rib roast	Biopsy sample	Loin steak	Rib roast
	%	%	%	%	%	%	%	%	%
A7-1	36.76	23.80	22.00	2.86	5.54	7.04	33.90	18.26	14.96
A8-1	35.57	17.57	20.25	2.68	3.98	7.26	32.89	13.59	12.99
A9-1	34.33	22.89	17.72	2.13	5.38	5.88	32.20	17.51	11.84
A10-1	45.41	21.95	17.69	2.41	5.60	4.98	43.00	16.35	12.71
A11-1	37.42	19.62	19.15	3.38	4.97	4.84	34.04	14.83	14.31
A12-1	26.63	20.44	---	1.53	3.18	--	25.10	17.26	---
A31-2	30.78	19.23	15.15	2.30	5.04	4.88	28.48	14.19	10.27
A61-2	27.93	22.58	18.70	1.53	6.96	6.88	26.40	15.62	11.82
A91-2	39.41	26.12	20.59	3.41	8.09	6.86	36.00	18.03	13.73
A101-2	34.66	21.62	16.69	3.33	6.67	4.60	31.33	14.95	12.09
A141-2	32.66	18.30	17.90	2.94	5.87	8.38	29.72	12.43	9.52
A191-2	33.59	27.31	20.63	2.16	11.27	6.52	31.43	16.04	14.11
A251-2	36.14	22.87	21.55	3.25	6.34	6.38	32.89	16.53	15.17

APPENDIX TABLE IX (continued)

Animal number	Total cooking loss			Drip loss			Evaporation loss		
	Biopsy sample	Loin steak	Rib roast	Biopsy sample	Loin steak	Rib roast	Biopsy sample	Loin steak	Rib roast
	%	%	%	%	%	%	%	%	%
B20-1	36.65	22.73	21.79	2.79	6.82	6.45	33.86	15.91	15.34
B143-1	39.46	27.46	19.30	4.32	7.32	3.68	35.14	20.14	15.62
B176-1	33.84	26.95	19.31	3.80	6.62	3.95	30.04	20.33	15.36
B760-1	41.55	23.83	24.07	3.38	9.42	6.70	38.17	14.41	17.37
B762-1	37.97	23.87	---	4.32	4.69	--	33.65	19.18	---
B812-1	33.27	27.15	18.73	3.34	5.47	3.36	29.93	21.68	15.37
B1-2	33.41	24.14	19.11	2.69	6.62	3.37	30.72	17.52	15.74
B2-2	28.76	23.05	20.71	1.62	9.13	5.62	27.14	13.92	15.09
B3-2	34.91	20.38	20.07	3.86	6.05	3.81	31.05	14.33	16.26
B65-2	34.65	22.74	18.93	1.54	5.37	2.00	33.11	17.37	16.93
B600-2	38.07	25.80	20.64	3.98	8.08	4.96	34.09	17.72	15.68
C3-2	40.45	16.09	21.79	6.90	2.90	5.44	33.55	13.19	16.35
C5-2	41.14	25.60	16.20	3.85	8.50	3.18	37.28	17.10	13.02
C9-2	35.49	22.72	16.54	5.02	6.22	3.23	30.47	16.50	13.31
C10-2	40.57	24.98	18.15	5.34	8.17	4.60	35.23	16.81	13.55

APPENDIX TABLE IX (continued)

Animal number	Total cooking loss			Drip loss			Evaporation loss		
	Biopsy sample	Loin steak	Rib roast	Biopsy sample	Loin steak	Rib roast	Biopsy sample	Loin steak	Rib roast
	%	%	%	%	%	%	%	%	%
H13-1	37.28	23.41	18.08	3.82	3.63	5.76	33.46	20.38	12.32
H14-1	35.54	24.16	26.57	3.48	7.14	6.28	32.06	17.02	20.29
H17-1	34.63	21.05	16.45	2.66	6.61	5.84	31.97	14.44	10.61
H18-1	34.83	25.10	19.06	2.56	5.38	6.45	32.37	19.72	12.61
J1-1	35.71	22.07	16.81	6.17	6.27	4.22	29.54	15.80	12.59
J2-1	27.08	21.27	15.94	1.70	7.03	3.03	25.38	14.24	12.91
J5-1	29.31	16.12	15.26	2.59	2.72	4.89	26.72	13.40	10.37
J1-2	25.79	18.80	17.19	1.57	4.96	3.52	24.22	13.84	13.67
J2-2	24.88	20.27	15.90	1.27	7.21	4.74	23.61	13.06	11.16
J4-2	27.09	24.44	14.30	1.27	5.66	2.70	25.82	18.78	11.60
J5-2	26.05	19.25	17.24	1.58	6.38	5.59	24.47	12.87	11.65
J6-2	26.95	21.21	17.04	1.36	5.02	3.49	25.59	16.19	13.55
Mean	34.16	22.47	18.77	3.01	6.21	5.04	31.24	16.29	13.73

APPENDIX TABLE X

AVERAGE SHEAR VALUE FOR BIOPSY SAMPLES, LOIN STEAKS, AND RIB ROASTS AND TASTE PANEL TENDERNESS RATING FOR LOIN STEAKS AND RIB ROASTS FROM 40 STEERS

Animal number	Shear value, lb.			Taste panel tenderness rating	
	Biopsy sample (1/2-in. core)	Loin steak (1/2-in. core)	Rib roast (1-in. core)	Loin steak	Rib roast
A7-1	15.64	6.72	22.36	6.8	6.5
A8-1	18.00	5.41	14.48	7.3	7.5
A9-1	22.60	6.82	22.48	6.3	8.3
A10-1	---	4.25	19.80	8.3	7.5
A11-1	15.32	5.62	17.44	7.7	7.8
A12-1	17.38	5.57	---	7.5	--
A31-2	10.30	5.41	19.58	7.8	7.7
A61-2	9.80	5.27	11.60	8.3	5.2
A91-2	24.30	4.81	13.93	8.0	8.0
A101-2	23.08	5.70	12.32	8.5	8.7
A141-2	21.30	4.91	17.10	8.8	7.2
A191-2	20.42	4.70	11.95	8.0	7.7
A251-2	20.95	5.02	16.26	8.2	8.3

APPENDIX TABLE X (continued)

Animal number	Shear value, lb.			Taste panel tenderness rating	
	Biopsy sample (1/2-in. core)	Loin steak (1/2-in. core)	Rib roast (1-in. core)	Loin steak	Rib roast
B20-1	22.90	7.60	19.30	5.8	6.3
B143-1	27.32	11.35	19.15	4.7	5.3
B176-1	24.77	9.68	23.00	3.8	5.5
B760-1	22.50	5.67	17.35	7.0	6.3
B762-1	25.78	6.62	---	6.2	--
B812-1	22.72	5.52	18.85	7.3	5.7
B1-2	19.97	5.83	17.35	7.5	6.8
B2-2	19.45	7.10	16.00	8.0	7.0
B3-2	24.95	8.03	15.18	7.0	7.3
B65-2	22.50	5.77	15.55	6.8	7.7
B600-2	24.56	---	15.92	--	7.2
C3-2	20.14	5.40	13.66	7.7	7.2
C5-2	25.75	6.06	13.65	6.5	7.5
C9-2	23.86	5.88	11.90	8.2	8.8
C10-2	20.75	5.69	14.70	7.3	8.0

APPENDIX TABLE X (continued)

Animal number	Shear value, lb.			Taste panel tenderness rating	
	Biopsy sample (1/2-in. core)	Loin steak (1/2-in. core)	Rib roast (1-in. core)	Loin steak	Rib roast
H13-1	19.43	5.49	18.38	6.5	8.2
H14-1	20.53	5.72	15.56	8.0	7.7
H17-1	25.03	5.10	16.65	7.2	6.2
H18-1	16.46	5.31	14.35	7.8	8.5
J1-1	21.45	4.81	13.98	7.8	8.0
J2-1	18.94	5.32	13.24	8.8	8.5
J5-1	14.64	5.39	13.62	8.7	8.2
J1-2	20.62	5.00	13.22	8.8	8.7
J2-2	10.61	5.52	13.76	8.8	9.0
J4-2	21.65	4.45	15.38	7.7	6.7
J5-2	5.78	3.86	10.52	9.0	9.0
J6-2	7.63	4.87	15.54	8.2	8.5
Mean	19.61	5.87	15.40	7.5	7.5

APPENDIX TABLE XI

MOISTURE, ETHER EXTRACT, AND PROTEIN CONTENT OF BIOPSIES AND CARCASS LONGISSIMUS DORSI MUSCLE SAMPLES FROM 40 STEERS

Animal number	Moisture		Ether extract		Protein	
	Biopsy	L. dorsi muscle	Biopsy	L. dorsi muscle	Biopsy	L. dorsi muscle
	%	%	%	%	%	%
A7-1	72.50	72.96	3.02	5.36	22.03	20.68
A8-1	66.32	70.95	6.62	6.61	24.36	21.44
A9-1	66.32	72.16	4.56	6.02	26.21	20.82
A10-1	---	71.59	--	6.70	---	20.71
A11-1	70.00	71.14	5.46	7.12	22.09	20.74
A12-1	---	69.08	--	9.88	---	20.04
A31-2	70.62	72.75	2.82	2.47	23.90	22.48
A61-2	62.34	69.17	15.44	5.02	20.00	19.80
A91-2	67.98	71.35	8.98	4.64	20.75	21.82
A101-2	67.36	70.05	5.30	5.00	24.61	20.09
A141-2	67.94	71.74	7.93	6.33	21.72	19.91
A191-2	68.34	71.54	3.51	3.83	25.33	21.04
A251-2	64.08	71.40	7.58	3.79	25.51	21.03

APPENDIX TABLE XI (continued)

Animal number	Moisture		Ether extract		Protein	
	Biopsy	L. dorsi muscle	Biopsy	L. dorsi muscle	Biopsy	L. dorsi muscle
	%	%	%	%	%	%
B20-1	67.34	75.48	1.80	2.40	27.77	21.12
B143-1	68.56	74.11	3.59	2.56	25.07	22.33
B176-1	69.90	73.51	1.48	3.44	25.76	22.05
B760-1	72.92	73.69	3.11	3.38	21.58	21.93
B762-1	70.56	74.23	1.92	2.63	24.77	22.14
B812-1	69.20	74.22	0.98	4.45	26.84	20.33
B1-2	66.70	74.77	3.69	1.50	26.65	21.92
B2-2	69.00	75.33	2.14	1.03	25.97	21.18
B3-2	66.58	73.54	5.42	3.20	25.20	21.64
B65-2	70.23	76.74	3.20	1.04	23.91	21.49
B600-2	69.48	75.36	3.42	2.72	24.39	20.56
C3-2	68.94	73.73	4.44	2.96	23.96	21.92
C5-2	69.94	74.21	1.60	2.70	25.61	21.56
C9-2	70.09	71.83	3.58	4.60	23.70	22.18
C10-2	68.10	73.40	3.38	2.78	25.67	21.97

APPENDIX TABLE XI (continued)

Animal number	Moisture		Ether extract		Protein	
	Biopsy	L. dorsi muscle	Biopsy	L. dorsi muscle	Biopsy	L. dorsi muscle
	%	%	%	%	%	%
H13-1	72.67	74.56	3.32	3.56	21.61	20.88
H14-1	71.27	72.00	3.82	6.13	22.42	20.87
H17-1	71.39	75.27	4.34	3.27	15.17	21.84
H18-1	72.16	73.38	2.58	5.14	22.73	20.48
J1-1	67.88	68.64	6.44	6.62	23.11	23.74
J2-1	66.18	68.54	5.48	8.66	25.51	21.80
J5-1	64.81	64.58	9.20	11.76	23.39	22.66
J1-2	67.76	70.78	5.13	7.00	24.40	20.08
J2-2	65.74	70.30	9.24	7.40	22.52	19.73
J4-2	69.00	73.68	3.14	3.13	25.07	20.92
J5-2	64.80	67.03	8.82	11.61	23.74	18.82
J6-2	65.94	71.36	6.39	6.02	24.88	21.36
Mean	68.45	72.37	4.81	4.68	24.07	21.23

APPENDIX TABLE XII

SUBJECTIVE MARBLING SCORE FOR BIOPSY SAMPLES AND CARCASSES FROM 40 STEERS

Animal number	Biopsy sample marbling score#	Carcass marbling score#
A7-1	6	7
A8-1	6	6
A9-1	6	4
A10-1	7	5
A11-1	7	7
A12-1	7	6
A31-2	4	6
A61-2	9	7
A91-2	6	6
A101-2	7	6
A141-2	6	7
A191-2	6	6
A251-2	5	6
B20-1	3	3
B143-1	4	3
B176-1	3	4
B760-1	5	4
B762-1	3	3
B812-1	4	2
B1-2	4	3
B2-2	5	5
B3-2	4	4
B65-2	3	2
B600-2	4	3
C3-2	5	5
C5-2	4	5
C9-2	5	6
C10-2	4	4

APPENDIX TABLE XII (continued)

Animal number	Biopsy sample marbling score#	Carcass marbling score#
H13-1	4	4
H14-1	7	6
H17-1	5	5
H18-1	6	4
J1-1	7	8
J2-1	6	8
J5-1	8	8
J1-2	7	6
J2-2	8	7
J4-2	6	4
J5-2	8	7
J6-2	8	6
Mean	5.6	5.2

#Key to marbling score: 1 = devoid; 12 = extremely abundant.