INFLUENCE OF AGE ON SOME BEEF CARCASS AND MUSCLE CHARACTERISTICS

By

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INTRODUCTION

The age of the beef animal at the time of slaughter has generally been considered as an important factor influencing the relative muscle development of the carcass and the palatability of the meat. It has been recognized that all parts of the animal body do not mature at the same rate, and consequently the maximum development of these different parts is not reached at the same age (Hammond, 1955; Joubert, 1959). It would seem then, that the beef animal should be slaughtered at an age when the more valuable cuts have reached their maximum lean development or the maximum development which is economically feasible. Yet, there has been some difference of opinion as to which parts of the body are the last to develop and the age at which the hindquarter reaches its maximum development.

The recent rise in the standard of living in this country has not only increased the per capita consumption of beef, but has also caused the consumer to select meat in a more discriminatory manner. Consumer emphasis now seems to be on "quality" of meat rather than economy.

The term "quality", although having a rather vague meaning in the past, should include those factors considered desirable from the consumer viewpoint. Important factors, excluding color and the amount of fat and bone, are tenderness, juiciness and flavor. Of these three, tenderness is considered to be the most important. Yet the causes of tenderness,

or lack of it, are poorly understood. Nevertheless, the general opinion has been that meat becomes less tender with increased age of the animal. Federal grade standards and general trade practices as well, have required a higher degree of marbling with increasing age for a given grade. This has been done in an attempt to compensate for the apparent adverse effect of age on the palatability of meat. Recently however, the validity of the broad idea that age of the animal at time of slaughter influences tenderness has been challenged (Alsmeyer et al., 1959).

Much of the existing experimental data concerning the influence of animal age is somewhat conflicting. Most of these data have been collected from experiments which were designed to answer other problems and contained variables other than age, which cannot be separately evaluated.

Thus, there is definite need for experimentation designed specifically to determine the influence of animal age on meat palatability and on the relative muscular development of the beef animal.

The present study is an initial part of a beef maturity project being conducted at the Oklahoma Agricultural Experiment Station. The project was designed to evaluate the influence of bovine age on meat characteristics relating to quality and to evaluate the influence of age in determining carcass grade.

REVIEW OF LITERATURE

The studies reported here are concerned with the influence of age upon (1) dressing percent and percent of the various wholesale cuts, (2) palatability of the product, and (3) chemical composition.

I. Dressing Percent and Percent Wholesale Cuts

A. Dressing percent

In some of the earliest work concerned with the influence of animal age, Gramlich and Thalman (1924), in comparing calves, yearlings and 2 year olds, found dressing percent to increase with age of animal. This was found to be true for steers, spayed heifers and open heifers which were included in the study. The animals used were uniform in quality and breeding. Age of animal was also uniform within each of the age groups, but specific ages were not reported.

Bull et al. (1931) compared yearling and baby beef using 15 Choice calves and 15 Choice yearling steers, which were full-fed similar rations for 281 days (calves) and 203 days (yearlings). The fattened yearling cattle "dressed" higher than the fattened calves, but the difference was not significant. However, the yearling carcasses graded higher, were fatter and superior in conformation.

Joubert (1959) also found a higher dressing percentage for the older beef animals in a study of Afrikaner oxen. Six of the oxen were 1.8 years of age and 6 were 13 years of age. The average dressing percent for the aged oxen was 55.0 percent, while that for the younger

animals was 53.8 percent.

An average dressing percent for yearlings was reported to be 1.51 percent less than that of 2 year old cattle in a study reported by Hostetler et al. (1937). The yearlings and 2 year olds were fed an identical ration for a period of 154 days prior to slaughter. Both age groups graded high Medium as slaughter cattle and low Good in the dressed carcasses.

Results showing some disagreement with the previous studies were reported by Trowbridge et al. (1929). They found that the 12 to 14 month old heifers in their study "dressed" 3.06 percent higher than did the cows. The exact age of the cows was unknown. Carcasses of both the heifers and the cows graded Good.

B. Percent wholesale cuts

Helser (1930) conducted an experiment in which beef cattle 8-, 20-, and 32-months of age were studied. Representative animals from each age group were slaughtered at the beginning and at the end of a 5 month feeding period. He found that the differences due to age, in the percent of round, loin and rib were not significant in the fattened or unfattened cattle. The percent of each wholesale cut was based on live weight, rather than the more common method of using carcass weight. Therefore the dressing percent would have been considered in the percent of each of the cuts. This could possibly explain why the differences were not significant. However, results of a study by Bull (1931) also indicated that differences in cutting percent were not significant in a comparison of yearling and baby beef. The yearlings were reported to have had more cutting fat.

Foster (1928) compared the carcasses of a 9 year old steer and an immature steer 12 months of age. Results of this study revealed a higher percent of round, loin and foreshank in the immature carcass, while the mature carcass possessed a greater percentage of rib and chuck. A higher percent of forequarter was reported for the mature steer. Carcasses were quartered at the 12th rib.

Gramlich and Thalman (1924), at the Nebraska Station, in a somewhat more extensive study involving steers, spayed and open heifers reported similar findings. Steer calves yielded a higher percentage of hindquarter than the yearlings and 2 year olds. Calves had the lowest percent of chuck, while the yearlings had the highest. They found that the percent of rib and plate increased with age of the animal while the percent loin decreased. Of the 3 age groups, yearlings yielded the lowest percentage of round; calves the highest.

Similar results were reported for the spayed heifers with the exception of the percent of chuck. Data from the 3 carcasses in each age group indicated the highest percentage of chuck for the calves and the lowest for the 2 year olds.

Results of the open heifer study (yearlings vs. calves) disagreed somewhat with the results of the other 2 classes. These calves yielded a lower percentage of hindquarter, plate and loin, and higher percentages of chuck, rib and round than the yearlings. The exact ages of the animals used in this study were not reported.

Hammond (1955), in a review of work conducted on body conformation and composition, has stated that results have shown that the developmental changes in the animal are caused by a primary wave of growth from the cranium down to the facial parts of the head and backwards to the

lumbar region. A secondary wave of growth starts from the lower parts of the limbs down to the digits and upwards along the limbs and the trunk to the lumbar region, which is the last part of the body to attain its maximum growth rate and is consequently, the latest maturing part of the animal. These general principles of growth and development changes have resulted from pig and sheep experiments.

Joubert (1959) stated that a number of generalizations have become common in view of these facts. First, it has been assumed that the hindquarter continues to develop at a later stage than the less valuable forequarter. It has been argued from this, that an animal should be slaughtered when the hindquarter is at its maximum state of development which in view of the above theory, must be late in life.

Joubert's detailed study of the influence of age on the body conformation and carcass composition of cattle has produced some very interesting results. The study was conducted with Afrikaner oxen approximately 2 and 13 years of age. The cattle were quartered at the junction of the thoracic and lumbar vertebrae. According to Joubert's data, the percent hindquarter in the young steers (46.9 percent) was greater than that of the old oxen (44.1 percent). He further stated that fattening of the young steer from 1½ to 2 years of age causes, even then, a rather marked decline in the percent hindquarter from 47.8 percent to 45.5 percent. Reference was made to some preliminary unpublished work of Lombard conducted with steers of the same breed. The results indicated that the maximum development of hindquarter occurs at approximately 8 months of age (52.2 percent), following which there is a progressive decline.

Joubert has concluded from his work that the final stages of development in the beef animal, or at least in Afrikaner oxen, occur in the forequarter with the ribs being the latest to develop and not the lumbar region proper.

II. Palatability Studies

The influence of age has generally been accepted to result in more tender meat from young animals and more flavorful meat from old animals. Results of scientific investigations, bearing on the subject however, are not in complete agreement.

Barbella et al. (1939) gave consideration to 7 groups of cattle, 728 animals in total, classified on the basis of breeding, with respect to changes in desirability of flavor of lean associated with increase of age. The age range of the cattle used was 8 to 42 months. They found that meat flavor was least desirable from cattle under 11 months of age, but desirability increased quite sharply at 11 to 18 months. The flavor of the meat continued to increase in desirability to the 19 to 30 month age group, after which there was little change. The animals used in the study varied in breed, feeding habits, fatness and other characteristics.

Differences in tenderness as measured objectively by shearing were found by Nelson et al. (1930) in calves, yearlings and 2 year olds. The ages of these cattle were 8, 20, and 32 months respectively. The meat from the calves required more pounds to shear than did the beef from the older animals. However, a scoring committee found no significant difference in tenderness.

Juiciness was also studied and the roasts from the 2 year olds were found to be most desirable and those from the calves least desirable. It was reported that flavor was not influenced by age of the

animal.

Cooking loss was greater for calves in the unfattened groups, but when fattened the 2 year olds had the greater loss.

Roasts from fat heifers were found to be less pronounced in flavor of fat, more tender, more juicy and more desirable in aroma than the roasts from fat cows as reported by Trowbridge et al. (1929). The mechanical shear test for tenderness supported the findings of the palatability committee. Total cooking loss of the roasts from heifers was 3.7 percent less than that of the cows. The exact ages of the animals used in the study were not reported.

Hostetler et al. (1937) found that rib roasts from yearlings were more tender, less juicy and had less total cooking loss than did roasts from 2 year olds. Here again the mechanical tenderness test agreed with the panel findings.

Alsmeyer et al. (1959), in a study involving 502 animals found that within carcasses from animals 5 to 30 months of age, tenderness increased slightly with age of animal. Samples tested were from the short loin and were frozen 48 hours after slaughter.

Hiner and Hankins (1950) investigated the tenderness of beef in relation to different ages in the animal. A total of 52 animals were used varying in age from 10 weeks to 5½ years. They reported that as the age of the animal increased tenderness decreased for each of the 9 muscles tested. The difference between veal and cows was highly significant, whereas that between veal and beef from 500 pound steers was not. Degree of tenderness was determined objectively using shear force.

More recently, differences in quality factors of beef from Holstein heifers of 8, 12, 16, and 20 months of age have been found by Jacobson

and Fenton (1955). With increase in age, shear values of both cooked and raw meat increased. Experienced taste panel scores for aroma, flavor, juiciness and tenderness tended to decrease for samples from animals older than 12 months.

In a study using 18- and 30-month old Herefords, Simone et al. (1959) found that the laboratory panel evaluation of tenderness, juiciness and flavor factors in roasted beef resulted in a significant effect of the age difference of the tenderness factor only. Each of 4 different muscles tested proved to be more tender in the younger animals. The older carcasses did, however, show trends of being more juicy and flavorful on a comparable grade basis than did the younger.

III. Chemical Composition

The chemical composition of mammals has been considered for many years to be practically constant when expressed on a fat-free basis, with the exception of percent moisture. Evidence of this has been shown by various investigators.

Murry (1922) has divided the composition of animal bodies into 2 main divisions, namely fat and non-fatty matter. The non-fatty matter consists primarily of water, protein and ash. He has found that the percentage of water varies with the age of the animal in a definite manner. Murry also related that the ratio of protein to ash does not alter with age of animal, but may be influenced to a certain extent by the ration fed an animal.

Similar results have been reported by other workers including Moulton (1923), who has stated that chemical maturity in cattle is reached at about 5 months after birth. After this time, the chemical composition of the animal, on the fat-free basis, is practically constant.

Moulton's data has shown but little decrease in water and but little increase in ash and protein percent with advancing age.

EXPERIMENTAL PROCEDURES

I. Materials

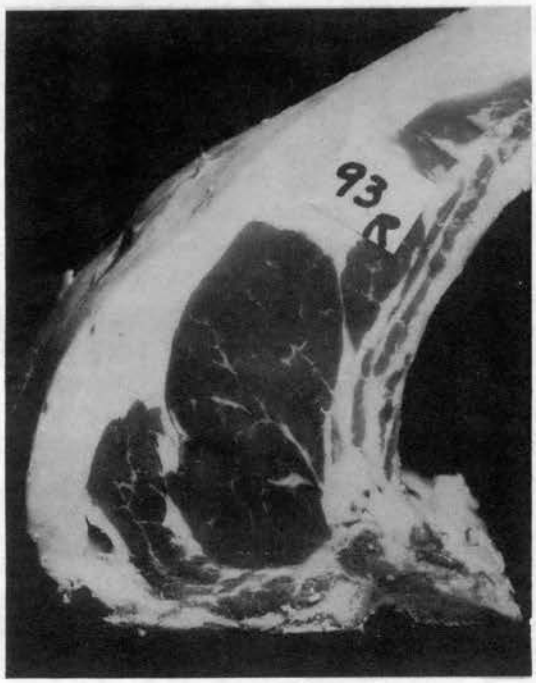
Sixteen (16) Hereford females of 4 different ages, from the Oklahoma Agricultural Experiment Station herd were used for this study. Carcasses included are those which by visual appraisal had or approached a marbling score of "slight amount", as determined by an official meat grader of the United States Department of Agriculture (Plate I). Individual marbling scores and grades are presented in Table I. The 18-month old cattle averaged slightly greater than the desired marbling score of "slight amount". The 6-month old calves were slightly under the desired score. The 18-, 42- and 90-month age groups received similar nutrition and management treatment. They were pastured on native Oklahoma grasses and supplemented ad libitum with cottonseed hulls and milo. Length of time on the supplement varied, in that the older cows took longer to reach the desired finish. The 6-month old calves were creep-fed a ration consisting predominately of ground milo, while obtaining milk from nurse cows that were on dry pasture.

II. Methods

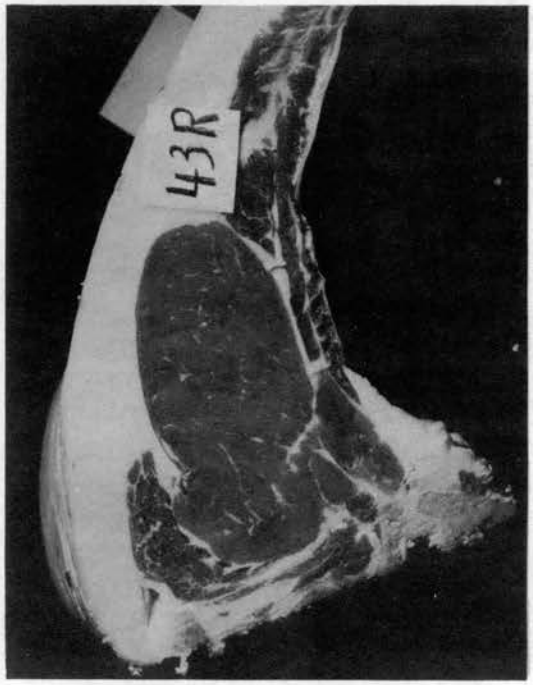
Slaughtering and cutting were done at the Oklahoma State University Meat Laboratory in accordance with the methods described in the Proceedings of the Fourth (1951) and Sixth (1953) Reciprocal Meat Conferences. Experimental animals were delivered to the laboratory holding

P L A T E I

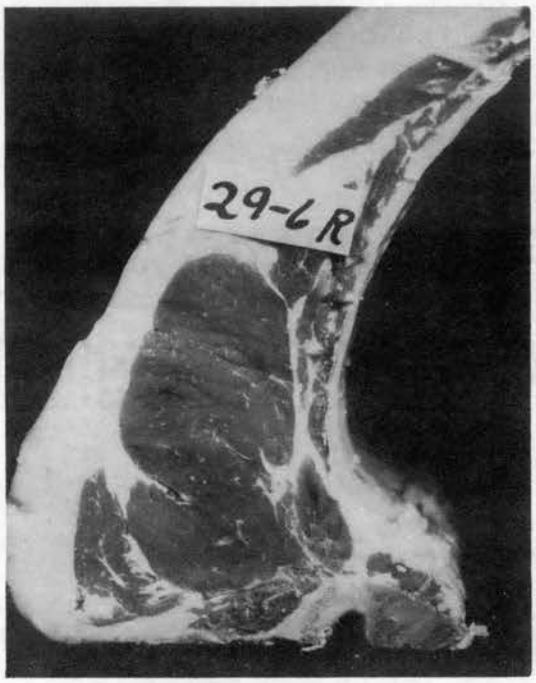
A REPRESENTATIVE RIBEYE FROM EACH OF THE FOUR AGE GROUPS



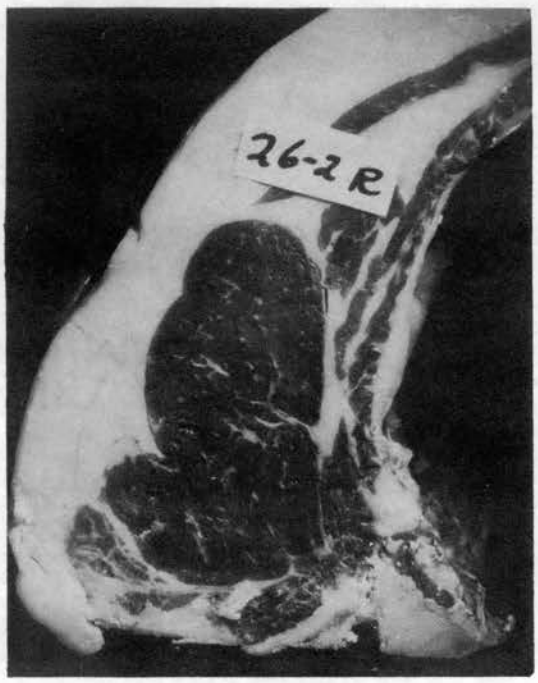
6 months



18 months



42 months



90 months

TABLE I

INDIVIDUAL ANIMAL WEIGHT, MARBLING SCORE AND FEDERAL GRADE

6-Month Old Calves				
Animal Number	Live Weight (Lbs.)	Chilled Carcass Weight (Lbs.)[1]	Marbling Score[2]	Federal Grade[3]
886	403.0	231.0	Traces	Good
059	420.0	239.5	Traces +	Choice -
93	504.0	306.5	Traces +	Choice -
025	495.0	299.5	Modest	Prime -
Mean	455.5	269.1		

18-Month Old Heifers				
Animal Number	Live Weight (Lbs.)	Chilled Carcass Weight (Lbs.)	Marbling Score	Federal Grade
26	812.0	496.0	Moderate	Choice
43	738.0	428.0	Small Amt.	Good +
45	760.0	455.0	Small Amt.	Good +
58	738.0	453.0	Slight Amt.	Good
Mean	762.0	458.0		

42-Month Old Cows				
Animal Number	Live Weight (Lbs.)	Chilled Carcass Weight (Lbs.)	Marbling Score	Federal Grade
29-5	1097.0	654.5	Slight Amt.	Utility +
51-5	1044.0	615.5	Slight Amt.	Utility +
23-6	1220.0	786.0	Slight Amt.	Utility +
29-6	1124.0	670.0	Slight Amt.	Good -
Mean	1121.3	681.5		

90-Month Old Cows				
Animal Number	Live Weight (Lbs.)	Chilled Carcass Weight (Lbs.)	Marbling Score	Federal Grade
26-2	1356.0	818.0	Slight Amt.	Utility +
59-2	1065.0	605.0	Slight Amt.	Utility
66-2	1466.0	931.0	Slight Amt.	Utility
80-2	1081.0	659.0	Slight Amt.	Utility
Mean	1242.0	753.3		

[1]Based on 48 hour chill weight.

[2]Determined by Federal Grader.

[3]Determined to within one-third of a grade.

pens on the afternoon of the day prior to slaughter. Feed was withheld after this time, but the animals were allowed free access to fresh water. Slaughtering of the animals was done over a period of approximately 1½ years. A picture of a representative carcass from each age group is shown in Plate II.

Immediately after slaughtering and dressing, the carcasses were placed in a 34-36°F. cooler for a 48 hour chilling period. The carcasses were then weighed and ribbed prior to establishing the degree of marbling and Federal grade. Both the right and left sides of the carcasses were then divided into wholesale cuts. Sample steaks were removed from the left side wholesale loin cuts at this time. The right loins were hung in a 34-36°F. cooler for an additional 12 day aging period before the sample steaks were removed.

Experimental steaks used throughout this study were from the short loin. The location and thickness of the steaks used for the Warner-Bratzler shear test, organoleptic evaluations and cooking loss are shown in Plate III. The bone and excess fat were removed, leaving the steaks uniform in fat covering. Each steak was wrapped individually, quick frozen in an air blast freezer and then held at -20°F. until the time of evaluation.

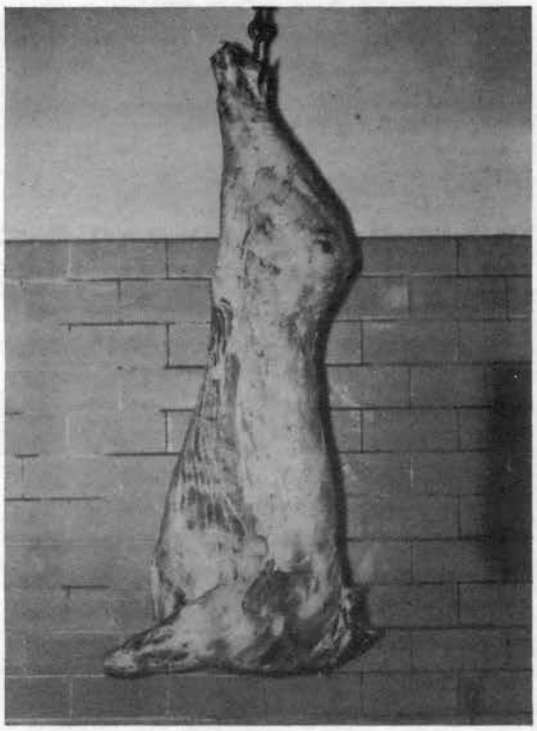
A. Carcass cut-out

Wholesale cuts were weighed to the nearest one-tenth pound immediately after cutting. Percent of carcass for each wholesale cut was calculated using total chilled carcass weight and the combined weight of the cuts from the right and left sides.

Percent high priced cuts was calculated by combining the weights of the round, rump, loin and rib from both sides of the carcass. This

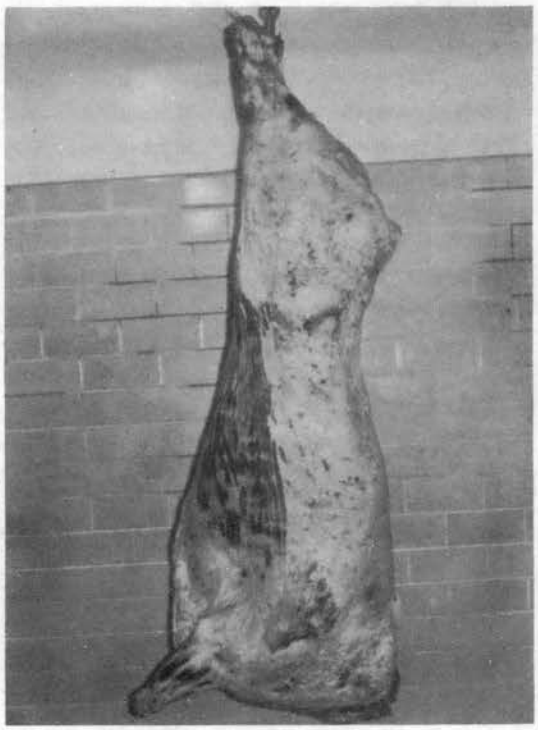
P L A T E II

A REPRESENTATIVE CARCASS FROM EACH OF THE FOUR AGE GROUPS



6 months

18 months



42 months

90 months

was expressed as a percent of the chilled carcass weight. The rump was included because the general practice is to market round and rump as a single cut.

Percent hindquarter was also based on the total chilled carcass weight.

B. Physical separation

The 9-10-11th rib cuts were separated from the wholesale ribs in the manner outlined by Hankins and Howe (1946). The cuts were then wrapped, frozen and held until separation in the same manner as were the experimental loin steaks. The frozen cuts were thawed in a 34-36°F. cooler for a period of 12 to 14 hours before separation. Weights of the 9-10-11th rib sections and the separable fat, lean and bone were obtained to the nearest gram using a Toledo balance. The separations were made in a constant temperature (58-60°F.) and humidity (58-60%) cutting room. The percent fat, lean and bone in each carcass was estimated from the 9-10-11th rib separation data by applying the equation of Hankins and Howe. Both the right and left rib sections were separated to reduce possible error that may have resulted in splitting the carcass. The fat, lean and bone data were figured using the combined weight of both sections.

C. Cookery, shear values and organoleptic evaluations

Shear values were determined through the use of the Warner-Bratzler shearing device. The values presented are the number of pounds of mechanical force required to shear a core of cooked meat 1 inch in diameter. The 2-inch steaks used for shear tenderness evaluation were removed from the -20°F. freezer and permitted to thaw 12 to 14 hours in a

34-36°F. cooler. An open-face, gas, griddle-broiler was used to broil the steaks. The broiler was preheated for 30 minutes to an internal temperature of 350°F. prior to inserting the steaks. Each steak was placed in the broiler so that the top surface was approximately 4 inches from the overhead flame. An internal temperature of 150°F. was used to determine the degree of doneness; the steaks being turned so that both sides were done equally. Internal temperature was determined through the use of thermocouple leads from a recording micromax (Plate III). Precaution was taken to locate the tips of the thermocouples in the center of each of the steaks, so that the true internal temperature would be recorded.

Three cores 1 inch in diameter (lateral, dorsal and medial) were removed from the longissimus dorsi muscle of each loin steak for shearing purposes (Plate IV). Three shears were made on each core, giving a total of 9 shear values per steak. The shear value presented for each individual animal was the average of the 9 shears. All shears were determined as soon as possible after the steaks were removed from the broiler.

Steaks used for organoleptic evaluation were 1 inch thick and were handled in the same manner as were the steaks for shear determination. Cores, three-fourths inch in diameter, were removed as individual samples from the longissimus dorsi muscle of the steaks for taste analysis. These cores were small enough to allow 6 to 10 samples to be obtained from each steak, and at the same time each was a desirable "bite size" portion. Use of a core such as this also made it possible to serve samples very uniform in size.

A maximum of 6 samples were evaluated at any 1 sitting and usually only 1 sitting was accomplished per day. Never more than 2 sittings per day were required of the panel. The days on which 2 sittings were required, one was held between 10 and 12 a.m. and the other between 3 and 4 p.m. The time of day at which single sittings were held was also at one or the other of these periods.

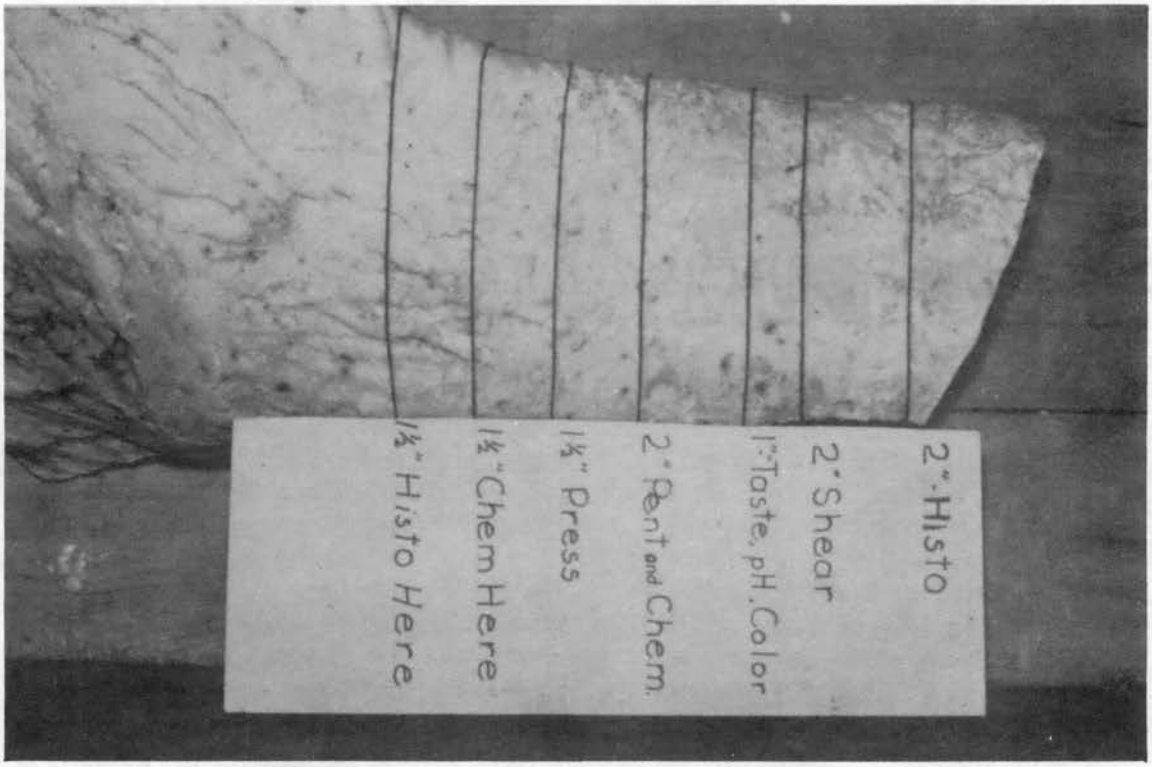
The panel used throughout this study consisted of experienced staff members and research assistants (Plate III). The number of members present at each of the sittings ranged from 6 to 10. Panel members were instructed to score each of the samples for tenderness, juiciness and flavor using the score sheet presented in Figure 1. Bread and a rinse of tap water were provided for use by the judges between samples. The organoleptic values to which statistical analysis was applied were average panel scores for tenderness, juiciness and flavor.

An 8 point hedonic scale without a neutral point was used for scoring the samples, with a score of 8 being the highest rating and 1 the lowest. This same scale was used for all 3 of the factors being evaluated.

D. Cooking loss

Cooking loss determinations were made on the same steaks that served for shear determinations. The weight of each thawed steak was recorded to the nearest 0.5 gram just prior to placing it in the broiler. Immediately upon removal of the steak from the broiler the weight was again taken. The weight lost during the cooking period was expressed as a percent of the original or precooked weight.

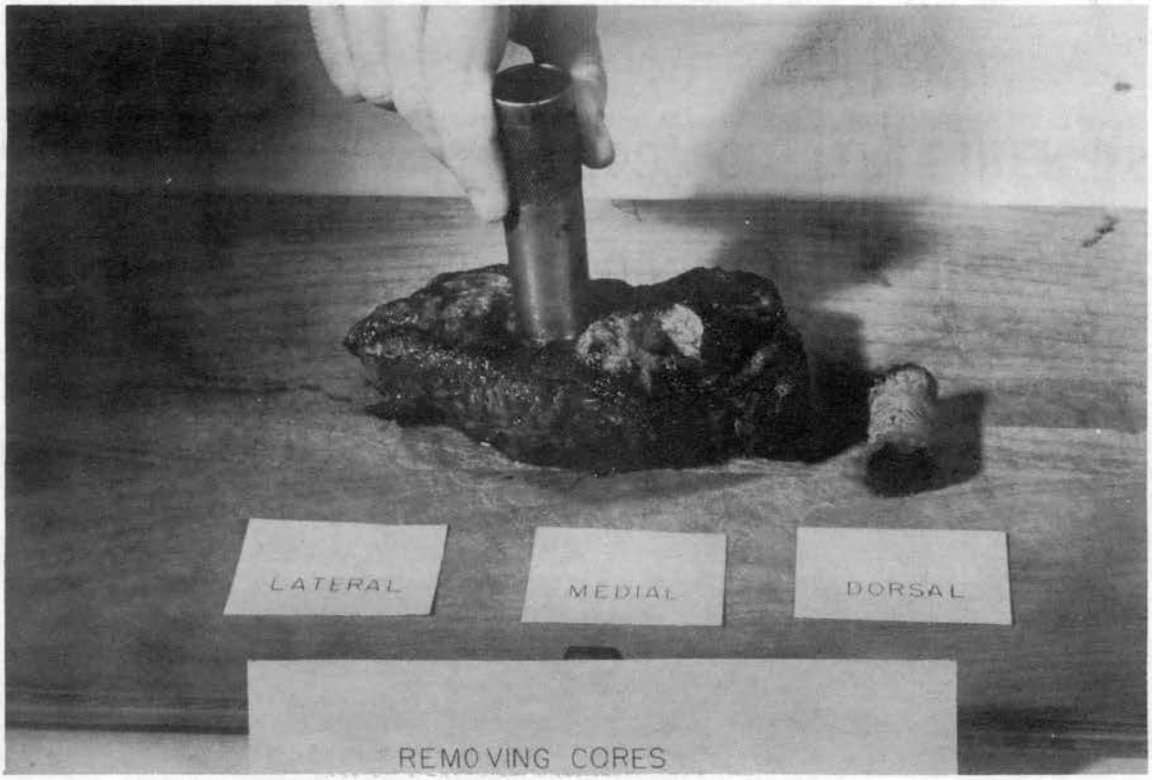
P L A T E III



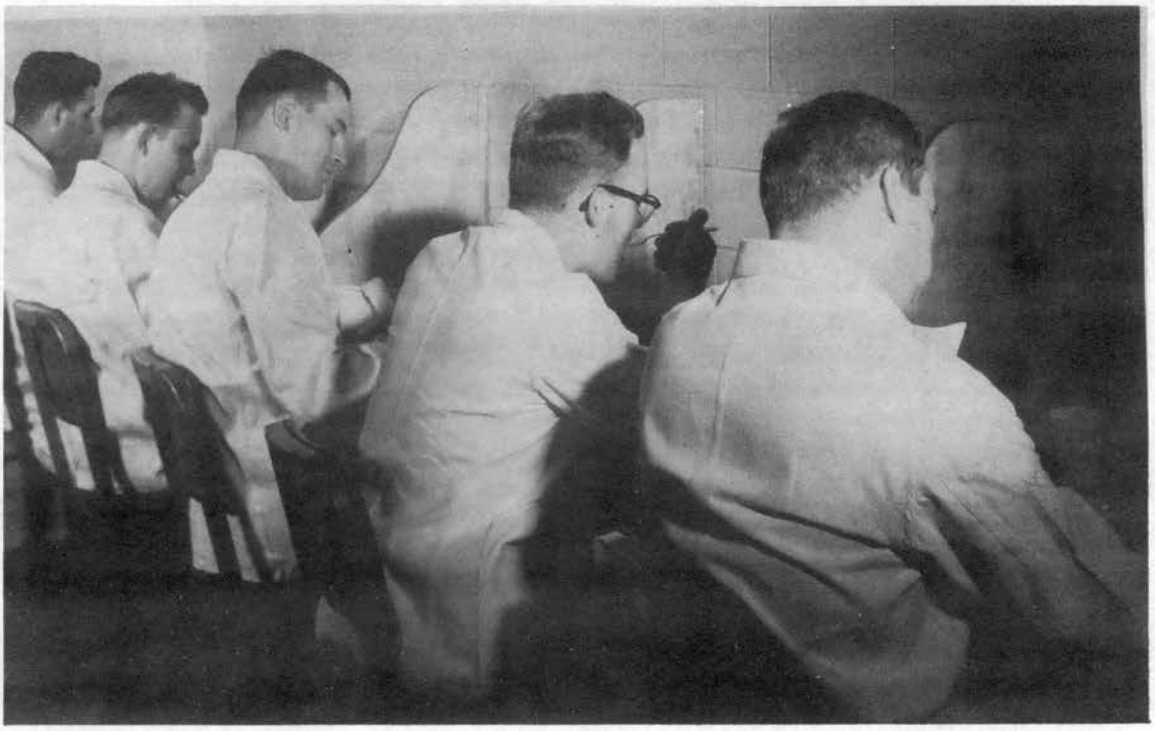
1- Location for removal of the various sample steaks

2- Broiling steaks with thermocouples inserted

PLATE IV



1- Removing shear cores



2- Tasting of the steaks

SCORE SHEET
FOR
QUALITY FACTORS

	TENDERNESS		FLAVOR		JUICINESS
8. Extremely Tender		Extremely Desirable		Extremely Juicy	
7. Very Tender		Very Desirable		Very Juicy	
6. Moderately Tender		Moderately Desirable		Moderately Juicy	
5. Slightly Tender		Slightly Desirable		Slightly Juicy	
4. Slightly Tough		Slightly Undesirable		Slightly Dry	
3. Moderately Tough		Moderately Undesirable		Moderately Dry	
2. Very Tough		Very Undesirable		Very Dry	
1. Extremely Tough		Extremely Undesirable		Extremely Dry	

Figure 1. Taste Panel Score Sheet

E. Chemical analysis

The longissimus dorsi muscle from the right and left 9-10-11th rib sections provided the sample for the proximate analysis. The longissimus dorsi was removed intact from the rib section during the physical separation process. It was then wrapped, refrozen in the air blast freezer and again stored in a -20°F. freezer. While still frozen, each ribeye muscle was cut into cubes and ground in a hand operated meat chopper. The ground, frozen, muscle tissue was placed in a pre-chilled glass jar that was closed with a seal type lid. Preparation of the samples was conducted in a 30-32°F. cold room. The individual samples in this form, were then transferred to the Station Biochemistry laboratories for analysis. The samples remained frozen in sealed jars until the time of analysis. AOAC procedures,with slight modification, were followed in conducting the proximate analysis.

The percent moisture, fat, protein and ash reported in this study were averages of the ribeye muscles from the right and left 9-10-11th rib sections from each of the carcasses.

RESULTS AND DISCUSSION

I. Dressing Percent, Carcass Composition and Cut-Out

A. Dressing percent

The results from this experiment have shown a slight increase in dressing percent with advanced maturity. Yet, the difference in the dressing percent between the 6-, 18-, 42-and 90-month old animals was non-significant at the 5 percent level. The individual yields, the means and standard deviations for each age group are given in Table II. The analysis of variance is shown in Table III.

TABLE II

DRESSING PERCENT FOR BEEF ANIMALS OF FOUR AGES[1]

6 Months		18 Months		42 Months		90 Months	
Animal Number	Dr. %	Animal Number	Dr. %	Animal Number	Dr. %	Animal Number	Dr. %
866	57.3	26	61.1	29-5	59.7	26-2	60.3
059	57.0	43	57.9	51-5	59.0	59-2	56.8
93	60.8	45	59.9	23-6	64.3	66-2	63.5
025	60.5	58	61.4	29-6	59.6	80-2	61.0
Mean	59.1		60.1		60.8		60.7
Std.Dev.	2.03		1.59		2.45		2.77

[1] Based on 48 hour chilled carcass weight.

TABLE III

ANALYSIS OF VARIANCE FOR YIELD, CARCASS CUT-OUT AND COMPOSITION FACTORS

Source	d/f	Yield	Mean Square Percent of Carcass				
			High Pr. Cuts	Hindquarter	Round	Loin	Rib
Total	15						
Age	3	2.40	0.35	5.04**	7.62*	2.57**	0.47
Individuals	12	5.08	1.38	0.73	1.78	0.28	0.19

Source	d/f	Percent of Carcass			Percent of Carcass[1]		
		Chuck	Brisket	Plate	Fat	Lean	Bone
Total	15						
Age	3	2.94	0.68	1.83*	48.37	23.37	1.13
Individuals	12	0.85	0.34	0.32	32.37	15.41	0.87

*$P < 0.05$

**$P < 0.01$

[1]Determined from 9-10-11th rib separation using formula of Hankins and Howe (1946).

B. Carcass composition

Statistical analysis of the data collected on the percent fat, lean and bone of the carcass revealed no significant difference due to the age of the animal. A possible trend for the percent lean to decrease as the age of the animal increases was indicated. These data are presented in Table IV. The average percent lean value for the 6-month old calves was somewhat high in comparison with the other age groups because the calf carcasses carried slightly less finish. Likewise, the mean value for the 18-month old group may be somewhat low due to a slightly higher degree of finish.

Hankins and Howe (1946) have stated that in heifers the use of the lean meat of the 9-10-11th rib section for estimating that of the carcass appeared questionable. However, for the purposes of this study, they served as a basis for a comparison of the carcass lean between the 4 different ages. Although the cattle used in this study varied considerably more in age than those used in formulating the estimating equation, no additional attempt was made to correct for age differences. These data should be viewed with these facts in mind.

The percent fat data indicated a slightly increased percentage of fat in the older carcasses, although the differences were not significant at the 5 percent level. This suggests that a greater amount of external finish is required in the older animal to obtain the same degree of marbling. The deviations in the degree of finish for the 6-and 18-month old animals were again apparent in these data.

Difference in the percent bone of the carcasses indicated that the percent bone became slightly less with increased age of the

animal. This difference was not significant at the 5 percent level.

TABLE IV

PERCENT FAT, LEAN AND BONE IN CARCASSES FROM BEEF ANIMALS OF FOUR AGES[1]

6-Month Old Calves				18-Month Old Heifers			
Animal Number	Percent Fat	Percent Lean	Percent Bone	Animal Number	Percent Fat	Percent Lean	Percent Bone
886	24.39	61.43	14.03	26	38.60	51.97	12.20
059	33.24	56.11	12.63	43	35.27	53.25	13.14
93	35.93	52.89	13.00	45	37.31	50.73	13.46
025	39.68	50.29	12.46	58	39.61	49.50	12.94
Mean	33.31	55.18	13.03		37.70	51.36	12.94
Std. Dev.	6.51	4.80	0.71		1.87	1.61	0.54
42-Month Old Cows				90-Month Old Cows			
29-5	27.32	59.45	13.92	26-2	45.30	47.45	11.06
51-5	34.39	55.16	12.55	59-2	33.68	54.32	13.40
23-6	43.41	48.93	11.24	66-2	46.42	46.76	10.85
29-6	40.36	49.74	12.42	80-2	41.39	49.84	11.80
Mean	36.37	53.32	12.53		41.70	49.59	11.78
Std. Dev.	7.10	4.94	1.10		5.76	3.42	1.16

[1]Estimated from 9-10-11th rib separation (Hankins and Howe, 1946).

C. Carcass cut-out

Age of the animal at time of slaughter did not seem to influence the percent of high priced cuts, which included the round (rump on), loin and wholesale rib. These data are presented in Table V. However, when percent hindquarter was considered, a highly significant difference was found. The percent hindquarter decreased with age of the animal.

The difference in the percent round (rump on) was also found to be significant at the 5 percent level. A higher percent of

TABLE V

PERCENT HIGH PRICED CUTS FROM BEEF ANIMALS OF FOUR AGES

Animal Number	High Priced Cuts[1]	Round[2]	Loin	Rib
6-Month Old Calves				
886	48.00	26.79	13.72	7.49
059	48.39	27.01	13.24	8.14
93	45.64	23.59	13.80	8.25
025	46.27	23.87	14.59	7.81
Mean	47.08	25.32	13.84	7.92
Std. Dev.	1.33	1.84	0.56	0.35
18-Month Old Heifers				
26	45.99	22.24	15.46	8.29
43	46.63	24.20	14.67	7.76
45	47.58	23.45	14.97	9.16
58	47.08	23.82	15.06	8.21
Mean	46.82	23.42	15.04	8.36
Std. Dev.	0.68	0.85	0.33	0.58
42-Month Old Cows				
29-5	46.69	24.24	13.97	8.48
51-5	47.92	24.66	14.76	8.50
23-6	45.95	22.24	14.73	8.98
29-6	46.29	24.17	13.93	8.19
Mean	46.71	23.83	14.35	8.54
Std. Dev.	0.86	1.08	0.46	0.33
90-Month Old Cows				
26-2	44.66	21.17	14.98	8.51
59-2	48.51	24.00	15.39	9.12
66-2	46.14	21.39	15.67	9.08
80-2	46.12	21.27	16.65	8.20
Mean	46.36	21.96	15.67	8.73
Std. Dev.	1.59	1.37	0.71	0.45

[1]High priced cuts include the round (rump on), loin and rib.

[2]Rump is included with round.

round was found in the calves and as the age of the animal increased a progressive decline in the percent round was noted. These results agree with those of Joubert (1959).

A highly significant difference in percent loin was found and the data indicated an increase in percent loin with increased age. The average percent loin figure for the 18-month old group, which appears to be somewhat high, may be explained by the greater amount of external finish on these carcasses.

The difference in percent rib was not significant at the 5 percent level, although a small increase in the percent of rib with increased age of animal was observed.

The percent chuck difference, due to age of animal, approached significance at the 5 percent level of probability. The results pointed out that there was a slightly greater percentage of chuck in the 90-month old animals than in the other 3 age groups studied. The percent chuck for the 6-, 18-, and 42-month age groups increased with age of animal, but the increase was very small.

Analysis of variance of the wholesale plate data has shown an age difference, which approached significance at the 1 percent level. The mean values ranged from 7.97 percent for the calves to 9.50 percent for the 90-month old cows, as shown in Table VI.

The percent brisket for the 2 younger groups was slightly greater than that for the older groups. However, statistical analysis showed the difference to be non-significant at the 5 percent level.

TABLE VI

PERCENT HINDQUARTER[1], CHUCK, PLATE AND BRISKET FROM BEEF ANIMALS OF FOUR AGES

6-Month Old Calves				
Animal Number	Hind-quarter	Chuck	Plate	Brisket
886	49.98	24.85	8.01	4.68
059	50.61	23.67	7.60	4.63
93	49.07	24.21	8.29	5.42
025	51.99	23.57	7.98	4.44
Mean	50.41	24.08	7.97	4.79
Std. Dev.	1.23	0.59	0.28	0.44

18-Month Old Heifers				
Animal Number	Hind-quarter	Chuck	Plate	Brisket
26	49.35	24.11	9.13	5.06
43	49.16	25.54	9.63	4.21
45	48.73	23.93	9.01	4.95
58	49.23	24.26	8.96	4.90
Mean	49.12	24.46	9.18	4.78
Std. Dev.	0.26	0.73	0.30	0.39

42-Month Old Cows				
Animal Number	Hind-quarter	Chuck	Plate	Brisket
29-5	48.10	24.86	8.64	3.15
51-5	50.06	23.18	8.61	4.22
23-6	47.16	25.73	9.78	4.61
29-6	48.82	25.36	9.67	3.99
Mean	48.54	24.78	9.18	3.99
Std. Dev.	1.22	1.13	0.64	0.62

90-Month Old Cows				
Animal Number	Hind-quarter	Chuck	Plate	Brisket
26-2	47.42	24.69	10.17	5.32
59-2	47.77	26.36	8.91	4.13
66-2	48.36	25.78	10.27	3.58
80-2	47.45	27.38	8.66	3.70
Mean	47.75	26.05	9.50	4.18
Std. Dev.	0.44	1.12	0.84	0.79

[1]Side ribbed between the 12th and 13th ribs.

II. Palatability Factors

A. Tenderness

Results of this phase of the study have indicated that the difference in tenderness, of the longissimus dorsi muscle chilled 48 hours, was not significant at the 5 percent level. It was noted however, that the pounds of shear force required for the steaks from the 6-month old calves were as great as those required for the 2 oldest groups studied. The average shear value for the 18-month olds was approximately 4 pounds less than the average shear for the other groups, indicating that the steaks from this group were the most tender (Table VII).

Marbling has generally been recognized as having some influence on tenderness. Possibly the lower shear value for the 18-month old group was associated with the slightly higher degree of marbling of the longissimus dorsi muscle. A smaller amount of marbling may also have been associatedwith the higher shear values for the 6-month old calves, in that the marbling score for this group was slightly less than the desired score of "slight amount".

Another possible reason for the high shear value for the calves may have been the connective tissue content of the samples. Wilson et al. (1954) have found that veal contained more collagen and elastin than did beef from steers and cows. The kind of connective tissue present, and more specifically, the elastin:collagen ratio may also play an important role, as suggested by Joubert (1956). Muscle fiber size and bundle size have been suggested as factors causing meat from older animals to be less tender (Hiner et al., 1953; Joubert, 1956).

TABLE VII

SHEAR VALUES FOR STEAKS AGED FORTY-EIGHT HOURS AND FOURTEEN DAYS FROM BEEF ANIMALS OF FOUR AGES[1]

6-Month Old Calves			18-Month Old Heifers		
Animal Number	Aged 48 Hours	Aged 14 Days	Animal Number	Aged 48 Hours	Aged 14 Days
886	15.78	12.33	26	14.98	10.94
059	25.48	11.20	43	16.54	12.36
93	23.26	13.88	45	19.85	17.25
025	27.06	10.10	58	18.69	14.96
Mean	22.90	11.88		17.52	13.88
Std.Dev.	4.99	1.62		2.18	2.80
42-Month Old Cows			90-Month Old Cows		
Animal Number	Aged 48 Hours	Aged 14 Days	Animal Number	Aged 48 Hours	Aged 14 Days
29-5	25.03	21.33	26-2	19.29	22.50
51-5	27.20	21.45	59-2	24.63	25.30
23-6	23.29	21.29	66-2	17.81	17.97
29-6	15.73	17.30	80-2	24.21	26.39
Mean	22.81	20.34		21.48	23.04
Std.Dev.	4.99	2.03		3.45	3.75

[1]Figures represent an average of 9 shears for each steak (pounds).

Aging the steaks for 14 days prior to the tenderness evaluation produced a marked effect on the shear values. The tenderness difference between the 4 age groups was found to be highly significant with the shear values increasing steadily with increasing age of the animal. It was observed that the 14 day aging period had a much greater influence on the tenderness of the steaks from the younger animals than it did on those from the older groups. A decrease of 11 pounds was noted in the mean shear value for the 6-month old age group with the additional 12 day aging period, while no decrease was noted in the 90-month old group.

The taste panel scores have indicated essentially the same tenderness trends as were found by the objective tenderness measurement (Table VIII). The experienced taste panel rated the 48 hour steaks from the 18-month old cattle the most tender, followed by the 6-month old calves and the 42-and 90-month old cows respectively. This indicated an increase in tenderness with age of animal to an age somewhere between 6 and 42 months and then a decrease with a further increase in age.

TABLE VIII

ORGANOLEPTIC TENDERNESS SCORES FOR STEAKS AGED FORTY-EIGHT HOURS AND FOURTEEN DAYS FROM BEEF ANIMALS OF FOUR AGES[1]

6-Month Old Calves			18-Month Old Heifers		
Animal Number	Aging Period 48 Hours	14 Days	Animal Number	Aging Period 48 Hours	14 Days
886	7.00	7.25	26	6.30	7.17
059	4.83	6.83	43	6.10	6.63
93	4.00	6.00	45	4.25	6.17
025	3.33	7.33	58	4.90	6.17
Mean	4.79	6.85		5.39	6.54
Std.Dev.	1.60	0.61		0.98	0.48
42-Month Old Cows			90-Month Old Cows		
Animal Number	Aging Period 48 Hours	14 Days	Animal Number	Aging Period 48 Hours	14 Days
29-5	4.89	5.63	26-2	3.78	5.20
51-5	3.13	5.63	59-2	4.33	4.89
23-6	4.44	5.20	66-2	4.60	6.22
29-6	5.20	6.33	80-2	3.10	4.44
Mean	4.42	5.70		3.95	5.19
Std.Dev.	0.91	0.75		0.66	0.76

[1]Average taste panel score based on an eight point hedonic scale (eight being the highest rating and one the lowest). Panels ranged from six to ten members.

The panel tenderness evaluation of the steaks aged 14 days has shown the difference between the age groups to be statistically significant at the 5 percent level. The 6-month old calves were rated the most tender and the 90-month old cows the least tender.

A highly significant correlation coefficient of .84 (d.f.= 30) was obtained between the Warner-Bratzler shear values and the taste panel tenderness scores.

It was interesting to note that most of the workers who have reported tenderness to decrease with age of animal have used samples which were aged 7 or more days. Recently however, Alsmeyer et al. (1959) have reported using samples aged 48 hours for tenderness evaluation and have found results similar to those reported in this study. They reported tenderness to increase slightly with age of animal up to 30 months of age.

B. Juiciness

The organoleptic evaluation of the steaks aged 48 hours has indicated that juiciness was not appreciably influenced by animal age. Statistical analysis of the taste panel scores has shown that the difference in juiciness of the 48 hour steaks between the 4 age groups was not significant at the 5 percent level, but a highly significant difference was found for the steaks aged 14 days. The data presented in Table IX, indicated that juiciness scores for the 6- and 18-month old animals increased slightly with aging, while a decrease in the scores was observed for the 2 older groups.

A trend for the steaks to increase or decrease in juiciness with animal age was not evident in the taste panel scores. The slightly higher fat content of the steaks from the 18-month old heifers was

perhaps responsible for the higher panel juiciness rating for this group.

TABLE IX

ORGANOLEPTIC JUICINESS AND FLAVOR SCORES FOR STEAKS AGED FORTY-EIGHT HOURS AND FOURTEEN DAYS FROM BEEF ANIMALS OF FOUR AGES

Age (Months)	Scores[1] Juiciness 48 Hour	Juiciness 14 Day	Flavor 48 Hour	Flavor 14 Day
6	5.57 ± 0.42	5.73 ± 0.49	5.99 ± 0.23	6.28 ± 0.36
18	6.08 ± 0.45	6.91 ± 0.18	5.86 ± 0.33	6.63 ± 0.17
42	5.83 ± 0.57	5.62 ± 0.26	6.02 ± 0.33	6.15 ± 0.33
90	6.01 ± 0.23	5.66 ± 0.57	6.09 ± 0.28	6.04 ± 0.37

[1] Average taste panel scores with standard deviations.

C. Flavor

The taste panel scores have indicated that age of the animal had very little influence on the flavor of the steaks tasted. The difference in flavor was not significant at the 5 percent level for the steaks aged 48 hours nor for those aged 14 days. There was essentially no observable difference in the desirability of flavor between the 2 aging levels in the 90-month old cows. However, the scores for the other 3 age groups, indicated that the panel preferred the flavor of the steaks aged 14 days slightly more than those aged 48 hours.

The cooking loss data, which are presented in Table X, did not reveal a significant age difference. This same observation was made for both the 48 hour and the 14 day aged steaks.

TABLE X

PERCENT COOKING LOSS OF LOIN STEAKS AGED 48 HOURS AND 14 DAYS FROM BEEF ANIMALS OF FOUR AGES

Age[1] (Months)	Aging Period	
	48 Hours	14 Days
6	24.89 ± 4.45	28.71 ± 4.84
18	27.32 ± 2.10	26.81 ± 1.59
42	30.03 ± 5.15	28.73 ± 2.10
90	29.12 ± 4.10	31.91 ± 2.57

[1]Four animals included at each age level.

III. Chemical Composition

The proximate analysis data are presented in Table XII. The percent moisture of the longissimus dorsi muscle from the 9-10-11th rib section differed significantly with animal age. The generally recognized trend for percent moisture to decrease with age was observed.

Percent fat (ether extract) did not differ significantly at the 5 percent level. In that the carcasses used in this study were selected on the basis of having a certain degree of marbling, a great difference was not expected. These data again reveal that the longissimus dorsi muscle of the 18-month old carcasses had a slightly greater degree of marbling than the desired amount and the calf carcasses a slightly smaller degree.

Neither percent protein nor percent ash were found to be significantly influenced by age of the animal at time of slaughter.

TABLE XI

ANALYSIS OF VARIANCE FOR PALATABILITY FACTORS AND COOKING LOSS

Source	d/f	Mean Square					
		Shear Value		Tenderness Score		Juiciness Score	
		48 Hour	14 Day	48 Hour	14 Day	48 Hour	14 Day
Total	15						
Age	3	25.51	111.09**	1.47	1.99*	0.20	1.54**
Individuals	12	16.60	7.16	1.03	0.43	0.19	0.17

Source	d/f	Mean Square			
		Flavor Score		Cooking Loss	
		48 Hour	14 Day	48 Hour	14 Day
Total	15				
Age	3	0.04	0.26	20.51	17.85
Individuals	12	0.08	0.10	16.78	9.23

*P < 0.05
**P < 0.01

TABLE XII

PROXIMATE ANALYSIS OF THE LONGISSIMUS DORSI MUSCLE FROM BEEF ANIMALS OF FOUR AGES[1]

6-Month Old Calves				
Animal Number	Percent			
	Moisture	Fat	Protein	Ash
886	73.08	1.54	21.53	1.12
059	72.98	3.47	21.38	1.10
93	73.41	3.46	22.07	1.14
025	73.03	5.92	19.74	1.07
Mean	73.13	3.60	21.18	1.11
Std. Dev.	0.20	1.80	1.01	0.035

18-Month Old Heifers				
Animal Number	Percent			
	Moisture	Fat	Protein	Ash
26	68.74	9.64	20.47	1.04
43	71.67	4.02	21.84	1.09
45	71.29	5.78	21.09	1.06
58	72.50	3.62	21.58	1.02
Mean	71.05	5.77	21.25	1.05
Std. Dev.	1.62	2.75	0.60	0.035

42-Month Old Cows				
Animal Number	Percent			
	Moisture	Fat	Protein	Ash
29-5	71.42	4.37	21.65	1.05
51-5	72.01	3.28	21.25	1.14
23-6	70.48	4.55	21.85	1.08
29-6	71.86	3.05	21.50	1.07
Mean	71.44	3.81	21.56	1.09
Std. Dev.	0.69	0.76	0.25	0.045

90-Month Old Cows				
Animal Number	Percent			
	Moisture	Fat	Protein	Ash
26-2	70.32	5.11	21.40	1.02
59-2	70.34	4.23	21.92	1.04
66-2	69.12	4.97	21.73	1.08
80-2	71.47	5.12	21.09	1.04
Mean	70.31	4.86	21.54	1.05
Std. Dev.	0.96	0.43	0.36	0.035

[1]Analysis of longissimus dorsi from 9-10-11th rib section.

TABLE XIII

ANALYSIS OF VARIANCE FOR MOISTURE, FAT, PROTEIN AND ASH OF MUSCLE FROM FOUR ANIMAL AGE GROUPS[1]

Source	d/f	Moisture	Fat	Protein	Ash
Total	15				
Age	3	5.67**	4.02	0.15	0.003
Individuals	12	1.02	2.88	0.39	0.001

**$P < 0.01$

[1]Longissimus dorsi muscle from 9-10-11th rib section.

SUMMARY

The influence of animal age at time of slaughter on the beef carcass composition, percent wholesale cuts and certain palatability factors was studied using 16 Hereford females, 6-, 18-, 42- and 90-months of age. The animals possessed a similar genetic background and received similar nutrition and management treatment. In addition, the "ribeye" of the carcasses at the 12th rib had, or closely approached, a marbling score of "slight amount", as determined by visual appraisal.

In that only 4 animals at each of the age levels were included in this study, definite conclusions should not be drawn. However, the findings have indicated trends which may be of value in further research.

Animal age did not significantly influence the dressing percent of the animals used in this study, but a slight increase with increased age was noted.

The percent fat, lean and bone of the carcass was not greatly influenced by age of the animal. Percent fat of the older carcasses was slightly higher. This indicated that the older carcass may require a slightly greater amount of external finish than the more youthful carcass to obtain an equivalent degree of marbling.

The wholesale cuts which were significantly influenced by age of the animal included the round, loin, chuck and plate. The

percent loin, chuck and plate increased with animal age, while the percent round decreased.

Tenderness was evaluated by the Warner-Bratzler shearing device and a trained taste panel with very good agreement between the 2 measures ($r = .84$). Tenderness of the broiled loin steaks aged 14 days decreased significantly with age of animal. However, the difference in tenderness of the steaks frozen after the 48 hour chill period was not significant. The results pointed out that the influence of age on tenderness may not be as great as has been commonly thought, but rather the tenderizing effect of aging beef may be greater for the younger animal.

The experienced panel scores for juiciness and flavor of the loin steaks showed these palatability factors to be influenced only slightly by animal age.

The chemical composition of the longissimus dorsi muscle was not significantly influenced by animal age, with the exception of percent moisture. The generally recognized trend for percent moisture to decrease with age was observed.

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