A COMPARISON OF CARCASS CHARACTERISTICS OF EWE, WETHER, AND RAM MARKET LAMBS

by

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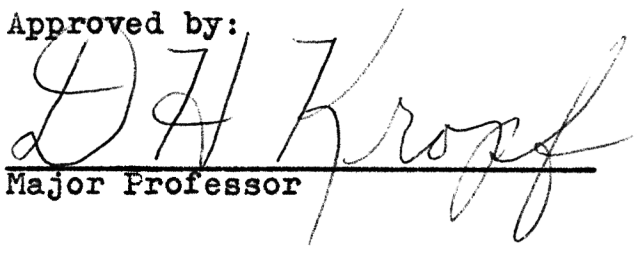
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TABLE OF CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	1
EXPERIMENTAL METHODS	13
History of Animals	13
Collection of Data	14
Statistical Analysis	20
RESULTS AND DISCUSSION	22
Slaughter Data	22
Subjective Indices	22
Objective Measurements	29
Grades	33
Weights of Wholesale Cuts	34
Rack Dissection	35
Cooking Data	37
SUMMARY	39
ACKNOWLEDGMENTS	43
BIBLIOGRAPHY	44

INTRODUCTION

Ram lambs are severely discriminated against in the marketing channels through which lambs are marketed. Reasons often given for discrimination include less desirable conformation, less desirable flavor, less juiciness, lower dressing per cent, and less tenderness. Some markets deduct as much as one dollar per cwt. for ram lambs without attempting to justify the discrimination. Producers and researchers have questioned the justification for this price discrimination. Considerable work has been done in evaluating lamb carcass composition, but very few researchers have dealt with difference due to sex. Most of the sex comparisons made have been done in New Zealand or areas not primarily concerned with Western ewe x meat type ram cross common to the midwestern United States area.

Consequently, this experiment was conducted in an effort to determine if this market discrimination against ram lambs was justified.

REVIEW OF LITERATURE

The retail value of a lamb carcass is determined largely by two factors: 1. QUALITY, the estimated palatability of the saleable meat, and 2. CUTABILITY, the proportion of the carcass weight sold as trimmed retail cuts, and distribution of the weight among the cuts.

According to Oliver *et al.* (1962), tenderness, flavor and

juiciness determine the eating quality or palatability of meat. For many years the meat industry has assumed that finish affected meat quality primarily in the form of marbling. Therefore, more marbling should result in the trimmed retail cuts being more tender, flavorful and juicy.

Some research indicates little or no relationship between fatness and quality factors in lamb. Cover et al. (1944) reported no relationship between fatness and tenderness in lamb. Batcher et al. (1962) reported no relationship between separable fat or intramuscular fat and the tenderness, flavor or juiciness of cooked lamb meat. Tenderness decreased as the lamb matured. Flavor and juiciness were not consistently associated with age nor per cent of separable or intramuscular fat.

Oliver et al. (1962) stated that the problem of low lamb quality seemed to be a minor one. There is much more variation in fat trim on lamb carcasses than there is in meat quality.

According to Oliver et al. (1962), both the USDA (1962) and the Texas A & M University-Safeway Stores study seem to indicate the following:

1. It is easy to attain sufficient marbling for the carcass of market lambs to grade Choice.

2. Excessive and internal fat decreases the carcass cutability, both in percentage of preferred retail cuts and in retail carcass value.

3. Excessive fat represents lower value to the retailer, which is reflected in higher retailer prices and eventually a lower consumer demand which often results in lower prices to the producer.

4. The amount of muscle in the carcass, particularly in the leg and loin region, influences cutability.

5. A wide variation occurs in the amount of internal and external fat and muscle in a group of lambs.

The most objective cutability measure of lamb carcasses is breaking the carcass into closely trimmed retail cuts and determining their total value. Using the sum of the trimmed retail leg, loin, rack and shoulder as a percentage of carcass weight is a satisfactory cutability measure. These trimmed retail cuts represent about 90% of the retail carcass value. The retail cuts had a trim of 1/4" externally and 1/2" internally, where seam fat existed.

Physical separation and proximate chemical analysis of the entire carcass are accurate, but expensive and time consuming ways of determining body composition and estimating retail value, therefore various researchers have attempted to work out simpler and less expensive methods of estimating carcass composition.

Many ways have been tried to predict carcass composition, including use of specific gravity, potassium 40, live animal measurements, and physical separation of various retail cuts. Field et al. (1963) stated that the correlation coefficients of specific gravity of carcass or rib with some other indicators of carcass composition were highly significant, but too low to be of practical value for estimating carcass composition. Zinn (1961) reported specific gravity to be of limited value in determining the amount of carcass fat. Judge et al. (1963)

reported that potassium 40 determination of lamb carcasses could be used to predict the per cent of edible portion or excess fat. However, they found that longissimus dorsi area or fat thickness measurements were equal or better in predictive accuracy.

Hoke (1961) assumed that variations in yield of retail cuts were due largely to variations in conformation and finish. Therefore, he selected carcasses within each grade not only to be typical of the grade, but also to be highly variable in conformation and finish. Carcasses with combinations of superior, average, and low finish together with conformations of superior average, and inferior were used in his study. Prime, choice, good, utility, and cull grades were represented in this study.

Hoke (1961) found that simple correlations between yield of retail cuts and objective measurements such as length of body, length of leg, and width of leg proved to be highly variable and not significant when weight groups in each grade were combined. Within grade-weight groups, simple correlations between fat thickness and yield of various combinations of retail cuts were generally highly significant. As in the case of the within grade-weight correlations, the objective or subjective measure of fatness was the best individual factor for predicting the yield of retail cuts. Relationships between the yield of retail cuts and total fat (surface fat plus kidney and pelvic fat) were negatively, highly significant

for these combined weight groups.

In relating grade to retail cut yield, Hoke found in the Utility and Cull grades that conformation grade was the most important individual factor responsible for the variation in yield of five major cuts (legs, sirloin, loin, rib, and shoulder). Among lambs graded prime, choice, and good, higher conformation grade tended to be associated with higher yields of retail cuts; however, the correlation coefficients were not significant. Increasing fatness and higher conformation grade have opposite effects on the yield of major retail cuts. The apparent greater influence of conformation grade in the lower grades may be attributed to a narrower range in fatness than in higher grades. This, together with the high negative relationship between fatness and yield of major retail cuts, probably masked some of the effects of conformation grade in the prime, choice, and good grades.

The relationships between certain carcass measurements and the combined yield of trimmed retail cuts from the leg, sirloin, loin, rib and shoulder were studied by Hoke. A total of 166 lamb carcasses representing eight grade-weight groups were used. The carcasses were measured and then broken down into regular wholesale cuts, intermediately-trimmed retail cuts and closely-trimmed retail cuts. Since the yield of the five major closely trimmed retail cuts (legs, loin, sirloin, rib, and shoulder) represent about 80 to 90% of the monetary value of a lamb carcass yield, these five cuts were studied in

greatest detail. Considerable variation was encountered within each grade and weight group. Fat thickness measured at the 12th and 13th rib was the most reliable individual measurement for estimating the yield of five closely trimmed retail cuts from lamb carcasses in the prime, choice, and good grades, whereas conformation grade was the factor most closely related to the yield of five major cuts in the utility and cull grades. In the total sample, fat thickness, conformation grade, and per cent of kidney fat accounted for 78% of the variation in yield of the cuts. The addition of a carcass weight to this combination of factors made practically no improvement in this relationship.

At the 14th Reciprocal Meat Conference, D. W. Zinn (1961) summarized some observations about lamb projects which are of interest to us:

> (1) Few of the live animal measurements seem to have any value in predicting carcass merit. (2) Available data indicate an extreme variability of fat and protein content in lamb carcasses. Arizona and Wyoming report the amount of protein in the muscle of the leg gives the best estimates of total body protein and total carcass muscle as determined by physical and chemical analysis. (3) Fat analysis of a single small sample gives a high degree of accuracy in predicting fat content of the entire muscle (California). (4) The use of a probe for determining depth of loin eye offers possibilities for live animal evaluation (New Mexico); however, this was of little value in estimating depth of fat in a group of thin lambs. (5) Organoleptic tests have failed to reveal significant differences in eating quality between sexes (Oregon, California). (6) Work has not progressed to the point where carcass merit in the lamb can be clearly defined.

At the same meeting, Hoke said the factors affecting the cut-out value and yield of retail cuts of a lamb carcass are

basic considerations for an accurate carcass evaluation on a lamb. Previous research in the yield of retail cuts has been conducted largely with pork and beef. Relationships of certain pork carcass measurements to yield of trimmed retail cuts have been well established and generally indicate that from 70 to 75% of the differences in combined yield of major wholesale cuts from a pork carcass within a given weight group can be explained by differences in fatness. In similar beef carcass evaluation studies by the USDA, the differences in degree of fatness were responsible for many of the variations in yield of major retail cuts from a carcass. According to Hoke, precise objective determination of the yield of retail cuts of a beef carcass can be estimated by considering (1) fat thickness over the rib eye at the 12th and 13th ribs, (2) rib eye area, (3) per cent of kidney fat, and (4) carcass weight. Using these factors, one can estimate either the yield of trimmed bone-in or boneless retail cuts with a high degree of precision.

Hoke (1961) computed the retail value of lamb on the basis of average retail prices from 14 northeastern chain stores for a four-month period (June to September, 1960) which were thought to be typical prices for these retail cuts of lamb. These prices showed that the legs and sirloin represent around 35-36% of the value of a lamb carcass; the legs, sirloin, loin and rib, about 65-67%; and the legs, sirloin, loin, rib, and square cut shoulder, about 88-90% of

the value. Among the factors studied, a combination of fat thickness, conformation grade, and per cent of kidney fat accounted for 74, 85, 78, 53, and 78% of the variation in yields in prime, choice, good, combined utility and cull grades and total sample respectively. Since there is a tremendous overlapping of yields of major retail cuts among and between the various grades of lamb carcasses, grade alone is not a reliable indicator for predicting the yield of retail cuts.

Carpenter et al. (1964) obtained quantitative and qualitative data on 169 lambs representing four breed groups. The per cent of retail leg was highly associated with carcass retail values. Excessive subcutaneous fat was found to exert a highly significant negative effect on the retail carcass value. Fat thickness over the loin eye and loin eye area were found to be useful objective measures for estimating the cut out value of the carcasses.

Tenderness differed among breed groups with the fine X medium wool lambs producing the most tender rib chops. Marbling score was significantly associated with the excess subcutaneous fat trimmed in preparation of retail cuts. These data indicate that selection of trim, muscular carcasses does not affect tenderness, which is one of the most important characteristics.

Kirton and Barton (1962) reported an indication of carcass composition can be obtained from its weight, but the

composition of the carcass can be more accurately estimated from the chemical data derived from any one of the parts of the right side. Apparently the chemical components of the four parts (leg, half loin, ribcut and fore) of the right sides of the carcass were all closely related to the chemical composition of the whole carcass. The right half of the loin was the most satisfactory part for predictive purposes. The 9-10-11 rib cut was a small portion of the whole and it too gave useful predictive information about the composition of the lamb carcass.

Field et al. (1963) studied carcass characteristics on 165 Southdown crossbred lambs ranging in age from 119 to 288 days and slaughtered at approximately 85 lbs. Physical separation of the rib was an accurate method of predicting fat, lean, and bone in the carcass. The leg and shoulder were also good predictors but required more labor in separation. Area of rib eye, fat thickness over the 12th and 13th ribs, percent kidney and pelvic fat, and per cent leg when correlated with per cent lean in carcass had a multiple correlation of 0.75. The combination of these measurements was the most accurate lean estimator noted when no physical separation was done. Rib-eye weight (per cent of loin), and fat thickness between the 12th and 13th ribs were good single measurements for predicting per cent carcass lean with correlation coefficients of 0.61 and .57, respectively.

Hankins (1947) accumulated physical composition data on

the carcasses and six primary cuts of 64 selected lambs of the following breeding: Columbia, 2; Corriedale, 3; Shropshire, 18; Southdale, 6; Southdown, 15; Hampshire x Corriedale, 3; Hampshire x Rambouillet, 6; Southdown x Corriedale, 1; Corriedale x Southdown, 2; Suffolk x Corriedale, 2; Tasmanian Merino, 1; and unknown breeding, 5. Of these lambs, 22 were rams, 30 wethers, and 12 ewes. Forty-two lambs were used to obtain chemical composition data. Hankins (1947) found that of the wholesale cuts the rib cut was the best indicator of fat, protein and water in the carcass, the correlations with each of these constituents being over 0.97.

Information as to the effect of sex on carcasses of lamb seems to be rather limited. Walker (1950) found that sex influenced the rate of growth, carcass weight, and dressing per cent of lambs. Ram lambs were heavier at docking than ewe lambs and ram lambs attained a heavier slaughter live-weight and carcass weight than either wether or ewe lambs when slaughtered at same age. Ewes had a higher dressing per cent than wethers and rams. Although the rams had a lower dressing per cent, they had a higher carcass weight than did the ewes. Financial returns are chiefly influenced by carcass weight. Due to fat thickness requirements, ram lambs were often discriminated against in New Zealand for lacking in fat covering. As for palatability, lambs killed before the age of sexual maturity have little likelihood of sexual "taint."

Walker also found that in conformation, the ram lambs were somewhat superior to wethers and wethers were superior to ewes, except for bad seasons when the rams resembled the wethers. Noncastration results in a leaner, somewhat better proportioned, though slightly coarser, carcass under fair to good conditions. It was noted that rams generally had a higher muscle to bone ratio than did wethers which had more fat. Hiner and Thornton (1962) observed that females were characteristically fatter than males.

In 1962 and 1963, the New Mexico Agricultural Experiment Station reported using 119 and 51 lambs, respectively, for studies involving the effect of sex on feedlot performance and carcass merit. Weaning age had no significant effect on feedlot performance or carcass merit. Fine wool X Suffolk crossbred lambs showed a significant advantage over lambs of fine wool breeding in chilled carcass weight per day of age, yield, percentage of retail trimmed fat, rib eye area, and carcass cut-out value. No differences in carcass grade, fat thickness, or percentage of preferred retail trimmed cuts could be attributed to breeding. Ram lambs produced more pounds of retail trimmed meat per day of age on less feed, and at an earlier age than ewes or wethers.

Data were presented at the twenty-third Annual Feeder's Day at New Mexico State University comparing wether and ram lambs. Thirty-six twin rams and wether lambs representing four breeding groups were compared for feedlot performance and

carcass merit. The 18 rams had an average slaughter weight of 4.1 pounds heavier than the wethers while the rams averaged 19 days younger than the wethers at time of slaughter. A difference of .119 lb. in rate of gain per day was noted in favor of the rams. Only a small variance was observed in pounds of retail trimmed meat per day of age (.015 lbs.). Garrigus et al. (1962) found rams gained faster than ewes and wethers. Garrigus showed wethers gaining faster than ewes in 1959, but less than ewes in 1960.

Off flavors and odors of lamb have been attributed to sex characteristics (Hatfield and Garrigus, 1961). The study was designed to determine if such sex characteristics could be detected in spring lambs using standard organoleptic techniques. Thirty-six crossbred lambs consisting of selected full and half-brother ram and wether pairs were fed rations consisting of either regular or high oil corn until they reached market weight (90 to 120 days of age). A 1 1/2-2 lb. sirloin roast was saved from the right leg for taste panel analysis. Each roast was cooked in a separate covered pan to an internal temperature of 180°F. All of the external fat was trimmed off after roasting. Uniform unseasoned lamb samples were analyzed by a trained taste panel. The organoleptic qualities of aroma, flavor, and tenderness were evaluated on a ten point scoring system. Under these conditions lamb of this age showed no significant differences among the organoleptic characteristics evaluated due to sex or ration

treatment. Jacobson et al. (1962) concluded individual animal variations affected flavor more than differences in sex of the animal or extreme differences in age.

EXPERIMENTAL METHODS

History of Animals

Data used in this study were collected over a two-year period from lambs which were a part of a breeding experiment at the Kansas Agricultural Experiment Station. The lambs were from ewes in the fine-wool flock and were sired by ten performance-tested Hampshire rams. This was the fifth and sixth lamb crop for these ewes. A total of 160 lambs, 39 rams, 34 wethers, and 87 ewes were used to compare carcass characteristics.

All lambs were creep fed a pelleted ration of 45% dehydrated alfalfa, 45% sorghum grain, 7.5% molasses, and 2.5% soybean oil meal. The ration contained 10 to 15 mgs. aureomycin per pound. Approximately half of the male lambs were castrated and half were left intact. Lambs were weaned and weighed at 65 days of age. When individual lambs weighed approximately 95 pounds, they were sheared and slaughtered.

After being held off feed for 12 hours, all lambs were slaughtered at the Kansas State University Meat Lab., using conventional slaughter procedures.

Collection of Data

Data collected at the time of slaughter included slaughter weight, pelt weight, hot dressed weight, and caul fat weight.

The carcasses were chilled for 48 hours, after which the chilled carcass weight was determined. The carcasses were graded to the nearest one-third grade by a representative of the federal grading service. In addition to grade, the subjective indices of quality in the carcass which are considered in grading or have been used in the past were scored by the grader using a scale from 1 to 11 as outlined in Table 1. Estimated marbling was also scored. A score of 11 represented the highest degree of development of a characteristic while a score of 1 represented the lowest degree of development or a lack of the characteristic.

The carcasses were ribbed between the twelfth and thirteenth rib and the actual marbling score, color of lean and firmness of lean in the longissimus dorsi muscle were determined by the grader. The longissimus dorsi muscles were traced, and fat thickness over the rib eye was included on the tracing. Later the area of the longissimus dorsi was measured from the tracings using a compensating polar planimeter. The area was recorded for both the left and right longissimus dorsi muscles which were combined to give the total area of longissimus dorsi muscle. Fat thickness is reported as an average of six measurements, three over each longissimus dorsi muscle over

Table 1. Scoring system for subjective carcass indices.

Characteristic	Degree of Development 11	10	9	8	7	6	5	4	3	2	1
Conformation	Very Blocky	Blocky	Mod. Blocky	Sli. Blocky	Sli. Rangy	Mod. Rangy	Rangy	Very Rangy			
Quantity of external finish	Very Thick	Thick	Mod. Thick	Sli. Thick	Sli. Thin	Mod. Thin	Thin	Very Thin	Extra Thin	Pract. Devoid	Devoid
Color of lean 1. Flank steak 2. Other flank muscles 3. Longissimus dorsi muscle	Light Pink	Sli. Dark Pink	Dark Pink	Light Red	Sli. Dark Red	Dark Red	Very Dark Red	Ext. Dark Red			
Feathering	Very Abundant	Abundant	Mod. Abundant	Sli. Abundant	Moderate	Modest	Small	Slight	Traces	Pract. Devoid	Devoid
Overflow fat	"	"	"	"	"	"	"	"	"	"	"
Fat streakings 1. Flank steak 2. Other flank muscles	"	"	"	"	"	"	"	"	"	"	"
Kidney & pelvic fat	"	"	"	"	"	"	"	"	"	"	"
Estimated marbling	"	"	"	"	"	"	"	"	"	"	"
Actual marbling	"	"	"	"	"	"	"	"	"	"	"
Firmness of fat	Very Hard	Hard	Mod. Hard	Sli. Hard	Sli. Soft	Mod. Soft	Soft	Very Soft	Sli. Oily	Oily	Very Oily
Firmness of lean	Very Firm	Firm	Mod. Firm	Sli. Firm	Sli. Soft	Mod. Soft	Soft	Very Soft			
Longissimus dorsi firmness	"	"	"	"	"	"	"	"			

the 12th and 13th ribs. During the latter part of the second year, fat measurements were taken at thickest point on the right and left rib in addition to the six fat measurements recorded throughout the experiment.

All carcasses were broken down into the wholesale cuts following the recommended method of cutting lamb carcasses as presented at the Fourteenth Annual Reciprocal Meat Conference by D. W. Zinn (1961). The weight of each untrimmed wholesale cut was recorded. The fat covering was then trimmed to 1/4 inch. Trimmed weights were obtained for the leg and loin.

A complete physical separation was made on the hotel rack and weights of the following constituents were recorded: longissimus dorsi muscle, other lean, fat, bone, overflow, and intercostal muscle. The hotel rack was used for the physical separation because it has been reported by Hankins (1947) and other workers that its composition is the best objective index of total carcass composition.

The loins were split and the right side from each loin was sent to the Food and Nutrition Department in the School of Home Economics for cooking and sensory determinations. Before the right side was sent, the excess flank portion was trimmed to within an inch from the loin eye in the second half of the second year's study and recorded as an extra trimmed loin.

Immediately after breaking the carcasses, samples were taken randomly from the right or left longissimus dorsi muscle

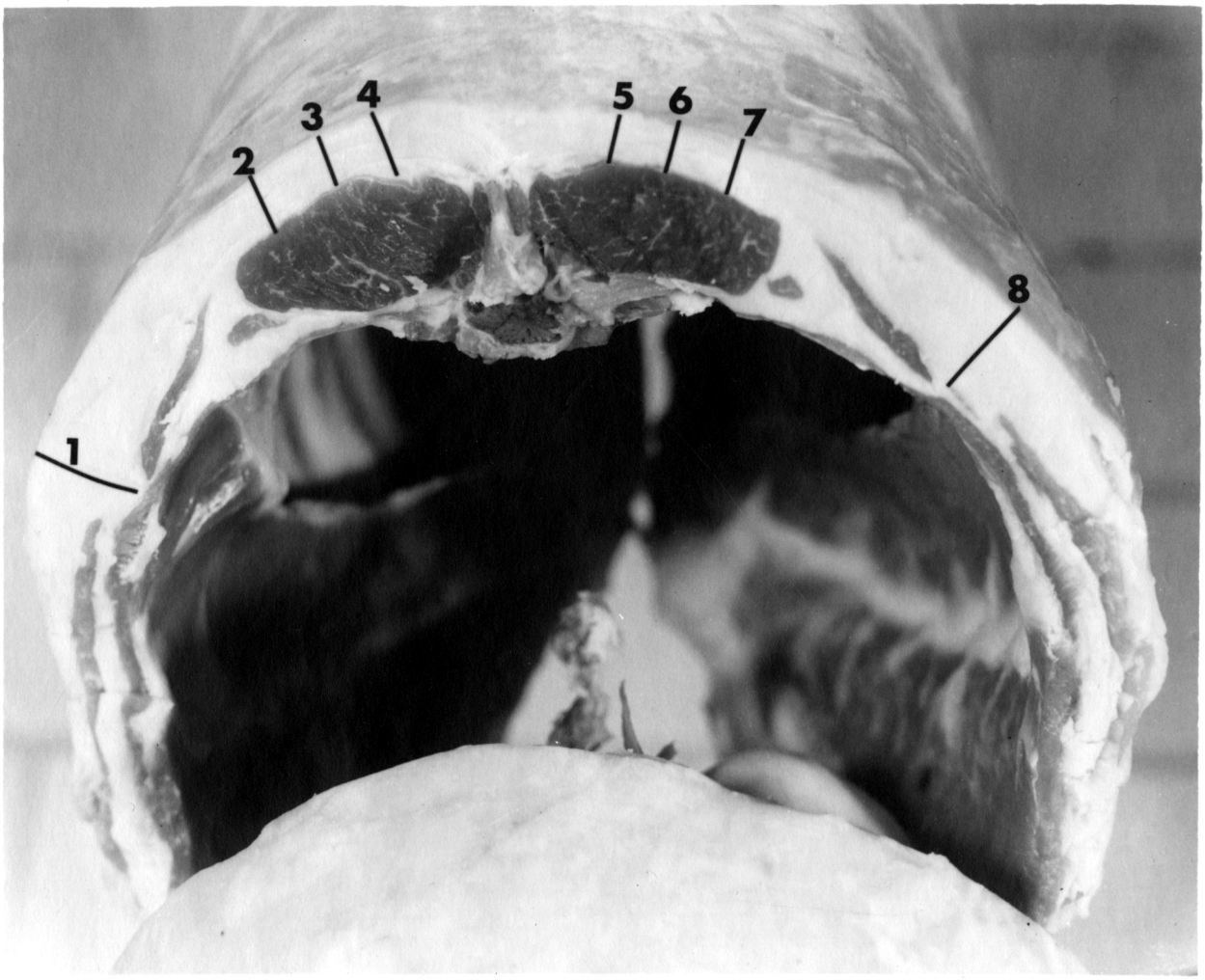


Fig. 1. Illustration of fat thickness measurements. The numbered lines indicate points at which fat thickness measurements were recorded. Lines 2, 3, 4, 5, 6, and 7 were averaged to obtain average fat thickness. Line 1 represents measurement of fat at the thickest point on the left side. The thickest fat measurement over the right rib is represented by line 8.

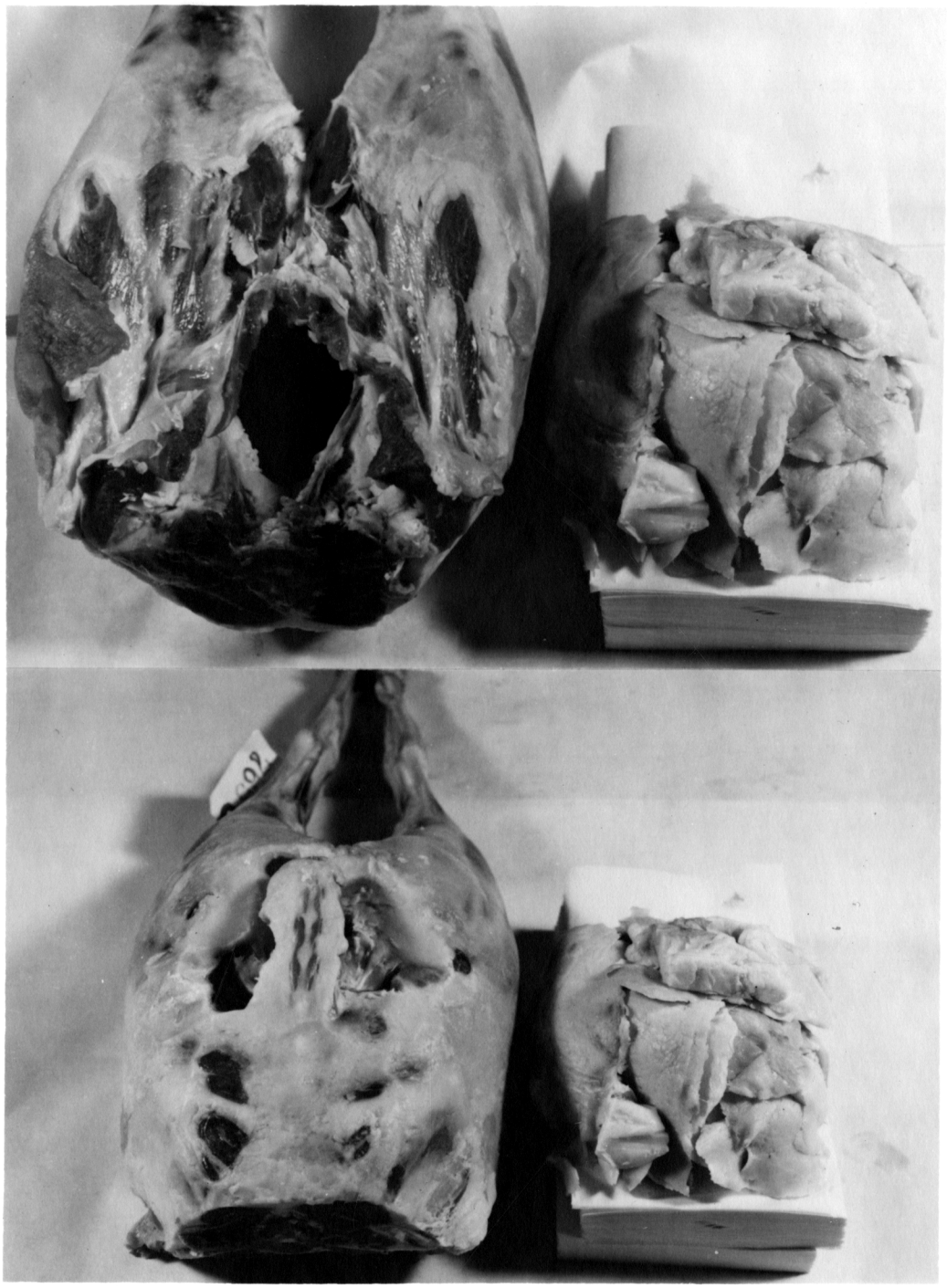


Fig. 2. Illustration of a trimmed leg showing a dorsal and ventral view with fat trim.

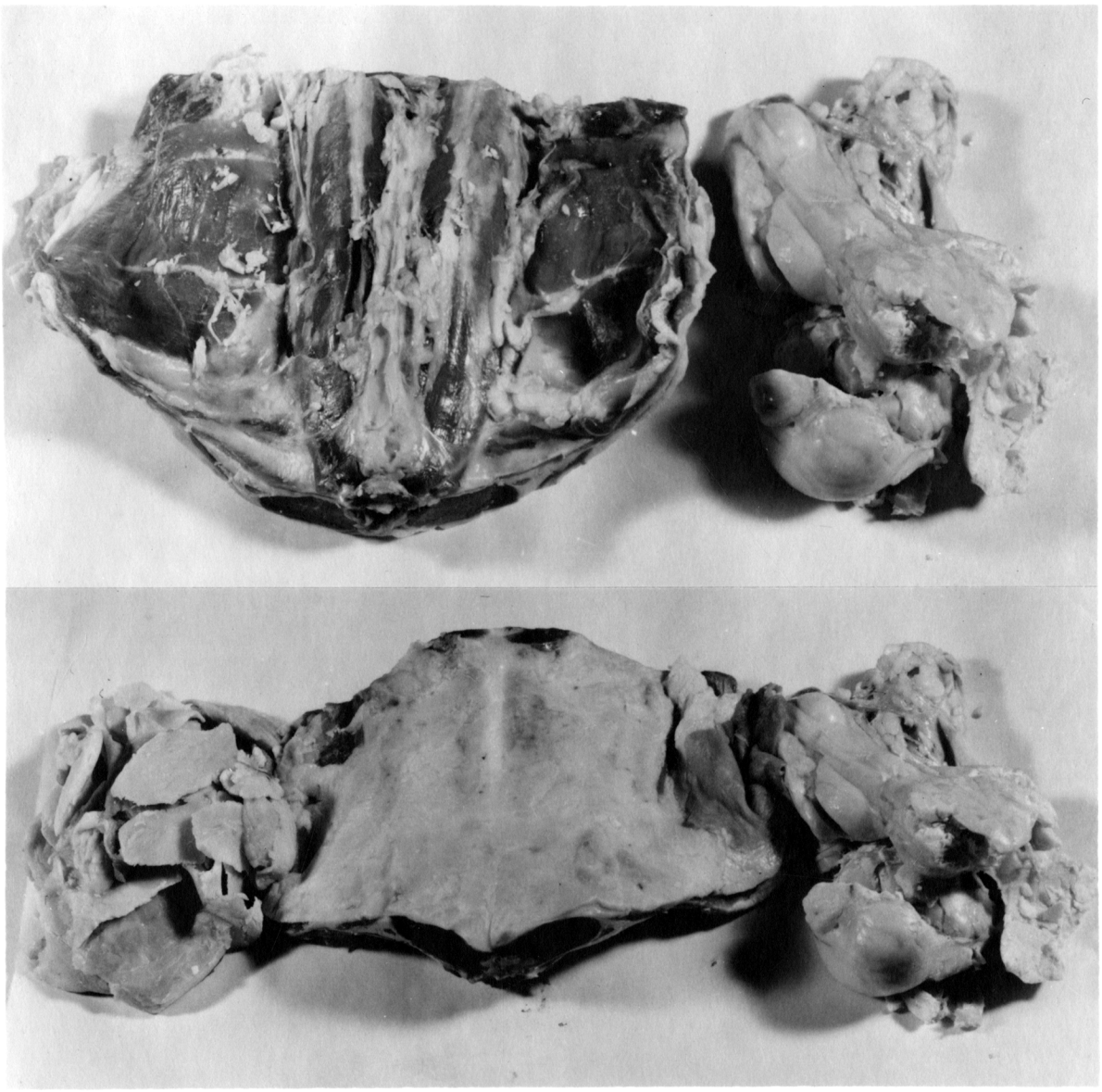


Fig. 3. Top: Ventral view of trimmed loin and interior fat trim.
Bottom: Dorsal view of trimmed loin with exterior and interior fat trim.

of the hotel rack and the rectus abdominis muscle from the right side for color intensity determination with a Photovolt Reflectance Colorimeter using the green filter. Results are reported as per cent reflectance.

The remaining longissimus dorsi muscle from the hotel rack was ground three times through an Oster food grinder. The intercostal muscle from the rack was given a similar treatment. Samples were taken from these ground tissues and stored frozen for subsequent analysis for fat content. The chemical analysis for fat determination used was ether extract as outlined in the Official Methods of Analysis of the Association of Official Agricultural Chemists, 1960, with slight modifications.

Statistical Analysis

The analysis of all data was done by the Statistical Laboratory of the Kansas Experiment Station. Analysis of variance was performed on the factors in this study with sex being considered as the treatment. When significant variance ratios (F values) were calculated, the l.s.d. test was used to locate the significant differences between means. These tests were applied as described in Snedecor (1962).

Simple correlation coefficients were calculated between all possible combinations of the factors studied within each sex group. The combined data for 1964 and 1965 were used for both analysis of variance and analysis of correlation coefficients.

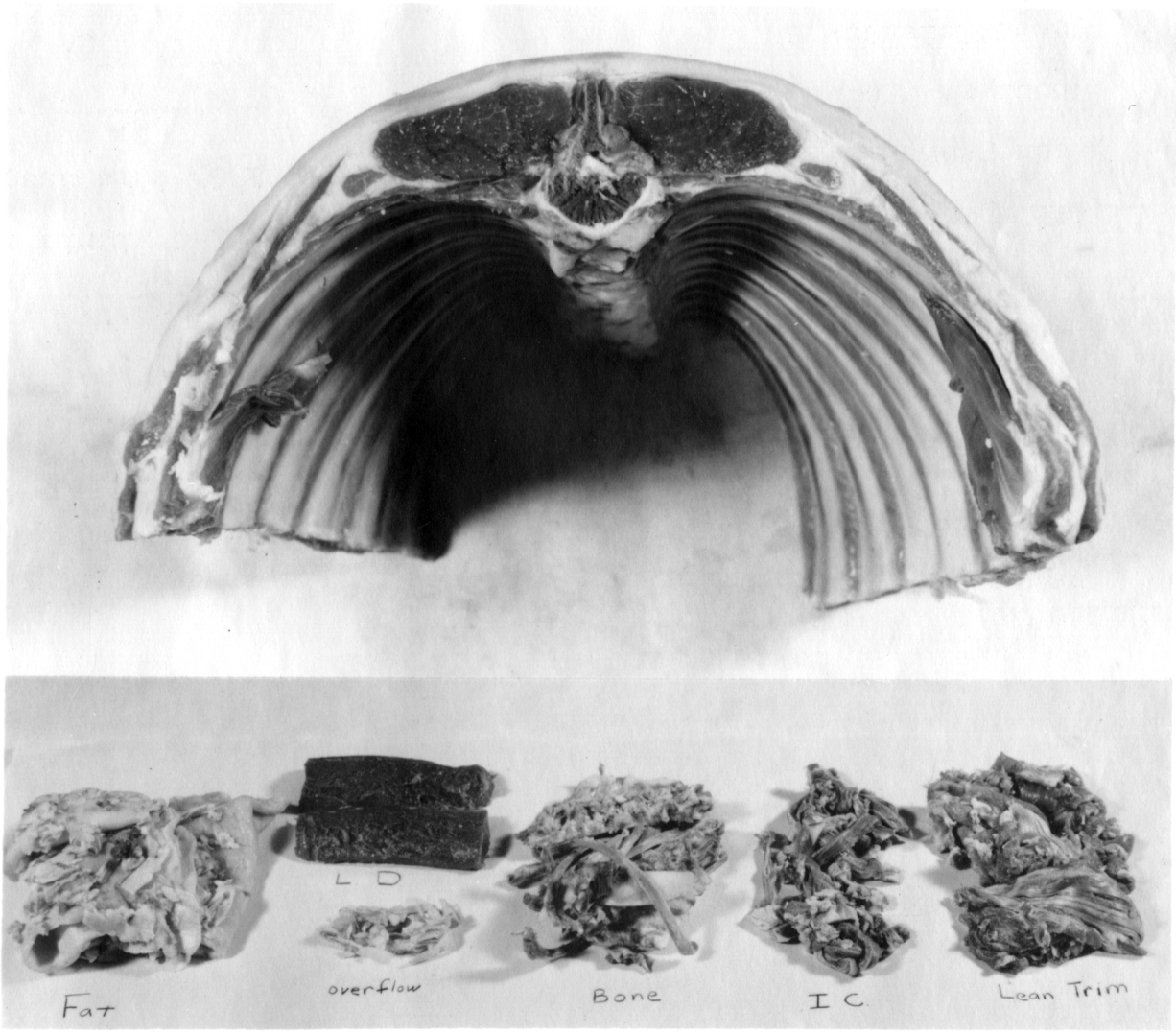


Fig. 4. Top: A typical hotel rack before physical separation.
Bottom: Illustration of components obtained from physical separation of the hotel rack.

RESULTS AND DISCUSSION

Slaughter Data

Rams, wethers, and ewes weighed approximately the same at slaughter. The lambs were slaughtered weekly as the individually reached ninety-five pounds or heavier. Consequently one would not expect a significant difference in slaughter weight. The ranges in slaughter weights may be observed in Table 2. The rams had a significantly lower cold dressed weight when compared to wethers and ewes. The rams showed a lower cold dressed weight when compared to ewes and wethers which resulted in a lower dressing percentage in Table 3. The heavier pelt weight for ram lambs appeared to account in part for the difference in dressing per cent when compared to the dressing per cent of wethers and ewes. While the cold dressed weight of the rams was approximately two to three pounds lighter than the other lambs, the rams reached a ninety-five pound slaughter weight on the average fifteen days earlier than the wethers (Table 4). The average slaughter age for ewes was 22.8 days older than rams.

Subjective Indices

The subjective indices of lamb quality were evaluated on an eleven point scale. The rams had a significantly lower average conformation score when compared to the wethers and ewes. While the difference is statistically significant, less

Table 2. Range in slaughter and carcass data for ram, wether, and ewe lambs.

	Rams		Wethers		Ewes		Combined	
	L	H	L	H	L	H	L	H
Slaughter wt., lbs.	82	104	82	96	78	96	78	104
Cold dressed wt., lbs.	43	55	44	54	45	55	43	55
Dressing per cent	46.77	60.76	53.54	58.70	50.54	64.74	50.54	64.74
Conformation	6	9	6	10	6	10	6	10
Quan. Ext. fat	7	9	8	10	7	10	7	10
Kidney & pelvic fat	3	6	4	8	4	9	3	9
Feathering	3	11	3	8	3	8	3	11
Marbling	3	6	3	7	4	8	3	8
Thickness of fat, inches	.07	.32	.10	.33	.12	.43	.07	.43
Shear value, lbs./ 1/2 inch core	4.2	15.2	4.8	13.5	3.4	15.3	3.4	15.3
Chews score (tenderness)	2.8	6.2	4.4	6.1	4.8	6.4	2.8	6.2
Hotel rack, lbs.	3.8	5.9	4.1	5.8	4.4	6.3	3.8	6.3
Loin wt., lbs.	4.1	6.1	4.5	6.1	4.0	6.9	4.0	6.9
Trimmed loin wt., lbs.	3.7	5.7	4.3	5.6	3.5	6.0	3.5	6.0
Leg wt., lbs.	13.7	16.5	14.3	17.9	13.4	17.1	13.4	17.1
Trimmed leg wt., lbs.	13.5	16.0	13.7	17.0	12.6	16.5	12.6	17.0
Trimmed leg and loin, lbs.	17.3	21.5	17.0	22.4	16.9	22.3	16.9	22.4
Kidney knob wt., lbs.	0.4	1.5	0.5	1.6	0.9	2.8	0.4	2.8
Total L. Dorsi area, sq. in.	3.52	5.76	3.18	5.54	3.30	5.63	3.18	5.76
U.S.D.A. carcass grade[+]	7	11	7	11	8	11	7	11

[+]Seven on a twelve point scale represents low choice, 8 is average choice, and 11 corresponds to average prime.

Table 3. Lot averages, F values and l.s.d. of slaughter data (2 year summary, 1964-65)

Item	Ram	Wether	Ewe	F value	l.s.d.
Slaughter wt., lbs.	89.4[a+]	88.6[a]	88.4[a]	1.14 N.S.	---
Hot dressed wt., lbs.	48.9[a]	50.4[b]	51.0[b]	11.87***	0.91
Cold dressed wt., lbs.	47.9[a]	49.2[b]	50.0[b]	12.44***	0.87
Dressing percent[&]	53.47[a]	55.44[b]	56.70[c]	24.78***	1.20
Caul fat wt., lbs.	0.7[a]	0.9[b]	0.9[b]	12.70***	0.10
Pelt wt., lbs.	10.2[a]	9.1[b]	9.2[b]	16.50***	0.40

[+]Sex averages with the same superscript (a, b, or c) are not significantly different at the 5% level.

[&]Cold dressed weight was used in calculating dressing per cent.

N.S. Nonsignificant at 5% level.

***$P < .001$.

Table 4. A sex comparison of average age, average slaughter weight and average weight per day of age at slaughter.

	Rams	Wethers	Ewes
No. of lambs	39	34	87
Ave. days of age at slaughter	126.3	141.3	149.1
Ave. shrunk weight at slaughter	89.4	88.6	88.4
Ave. weight per day of age at slaughter	0.71	0.63	0.59

than one-third of a grade is represented.

A significant difference in quantity of external finish was noted between each sex. Apparently the quantity of external finish is related to the conformation score. The larger the amount of external fat cover, the higher the conformation score tended to be. The average quantity of external finish ranged from a low score of 8.2 for ram carcasses to a high of 9.2 for ewes.

Along with lower fat and lean firmness scores, rams were noted to have a softer fat and muscle. The ewes and wethers individually had firmer lean than the rams as noted by subjective evaluations of firmness of lean. One might speculate that a higher degree of finish helped to convey an impression of greater firmness of fat and lean.

Feathering and fat streakings in other muscles showed no significant differences among sexes. The rams had the lowest overflow fat and rib eye marbling scores while the ewes had the highest overflow fat and rib eye marbling scores.

The rams had a significantly lower average score for fat streakings in flank steaks muscle and rib eye firmness scores when compared to the wethers and ewes. When comparing rib eye firmness score with the firmness of lean score, the rams had both the least firm longissimus dorsi muscle and the least firm lean.

The subjective and objective indicators of color showed little or no difference in the color of the rectus abdominus muscle between sexes. Color of the longissimus dorsi muscle

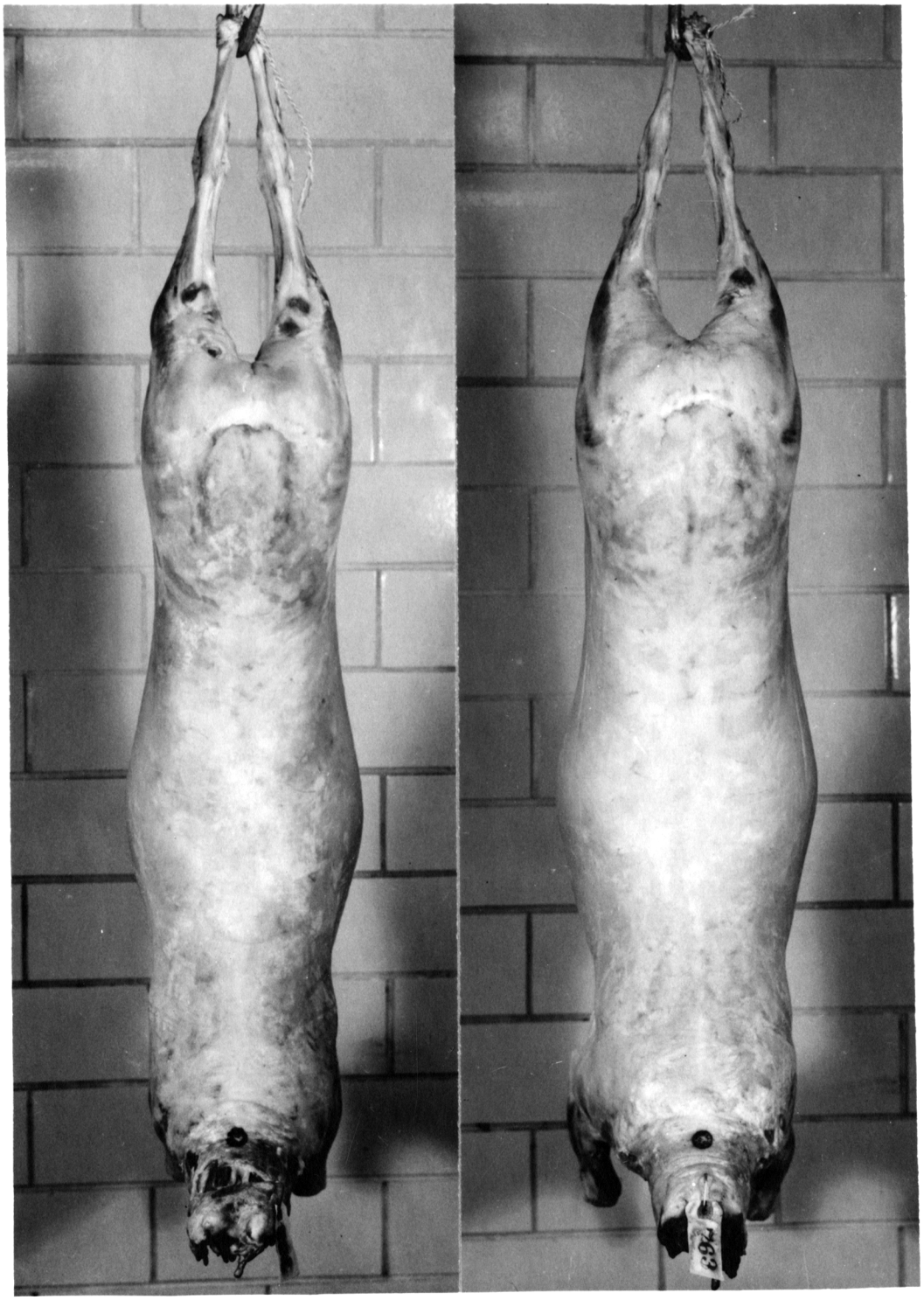


Fig. 5. Illustration of a comparison of an average choice carcass conformation on the left and low prime carcass conformation on the right.

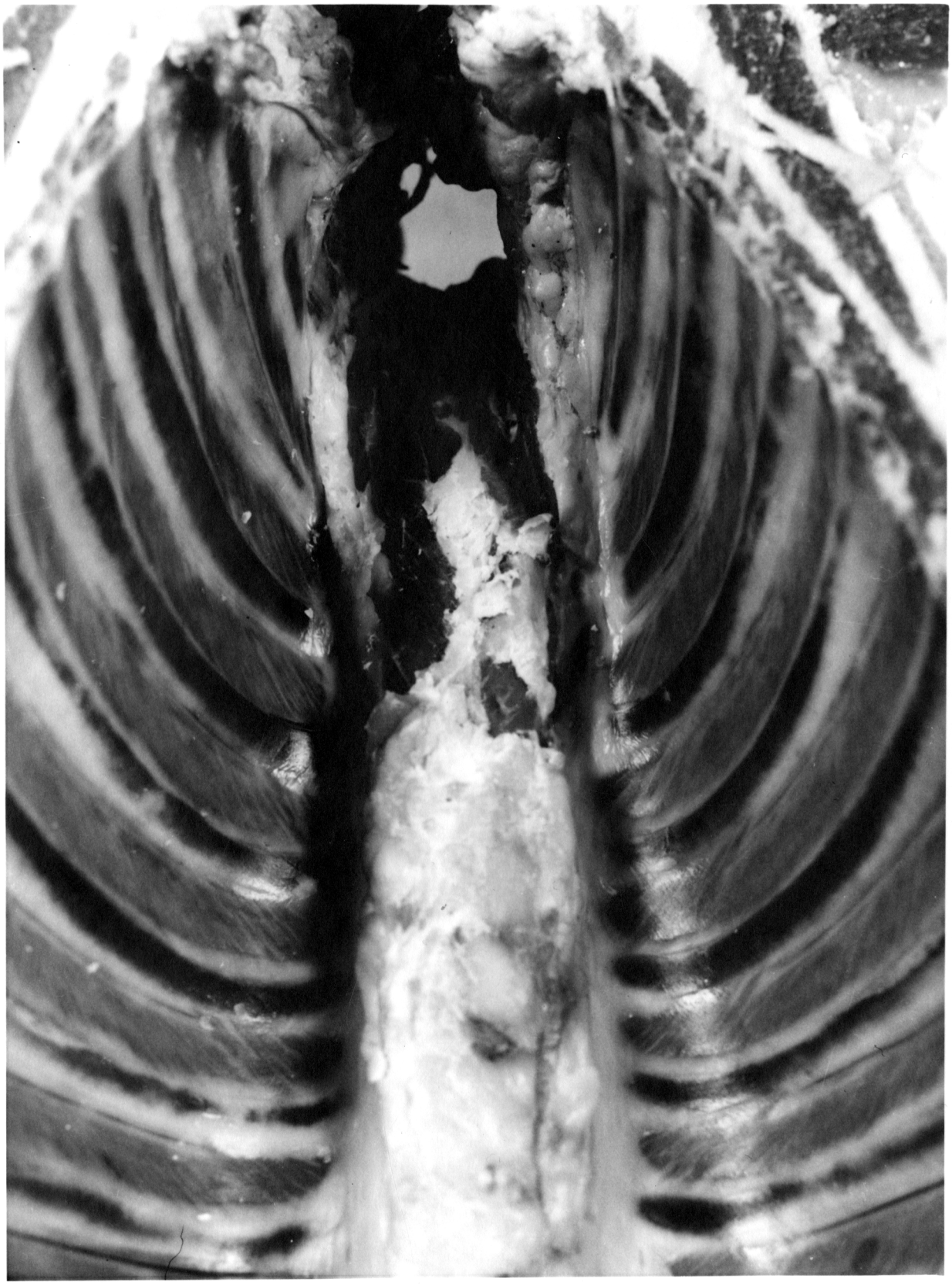


Fig. 6. Illustrates a moderate amount of feathering.



Fig. 7. Illustration of a moderate amount of kidney and pelvic fat which represented the mean kidney and pelvic fat score for ewes.

did not indicate any significant differences between sexes. Statistically significant differences in color of flank steak can be observed in Table 5, however, the small actual differences recorded make the statistical significance of questionable importance. Most lamb carcasses were scored as either light pink or slightly dark pink in color of flesh. No significant difference was observed in color of other flank muscles or longissimus dorsi muscle.

Objective Measurements

Kidney and pelvic fat showed significant differences among sexes. The kidney and pelvic fat subjective scores were 4., rams; 5., wethers; and 6., ewes. These values represented approximately slight (4), small (5), and modest (6) amounts of kidney and pelvic fat. The kidney knob weight, (Table 6) points to a significant difference in the amount of kidney and pelvic fat removed from each sex. The least amount of fat was trimmed from the rams. The kidney knobs from the ewes weighed significantly more than the kidney knobs from the wethers.

Fat measurements indicated ram carcasses were the thinnest in covering between the 12th and 13th ribs. The wethers had less fat covering between the 12th and 13th ribs than ewes.

In comparing lamb carcasses, perhaps the total area of longissimus dorsi muscle surface in square inches between the 12th and 13th ribs is of more interest than the surface area

Table 5. Lot averages, F values and l.s.d. of subjective carcass scores (2 year summary, 1964-65).

Item	Ram	Wether	Ewe	F value	l.s.d.
Conformation score	7.59[a+]	8.12[b]	8.32[b]	8.29***	0.38
Quantity external finish score	8.21[a]	8.76[b]	9.20[c]	34.55***	0.25
Firmness of fat score	8.15[a]	9.42[b]	9.49[b]	55.67***	0.27
Firmness of lean score	8.95[a]	9.48[b]	9.67[b]	19.56***	0.24
Color flank steak score	10.67[a]	10.88[b]	10.87[b]	3.10*	0.18
Color other flank muscles score	10.64[a]	10.79[a]	10.82[a]	2.02 N.S.	---
Feathering score	5.56[a]	5.58[a]	5.51[a]	0.05 N.S.	---
Overflow fat score	4.46[a]	4.91[b]	5.25[c]	14.70***	0.31
Fat streakings in flank steak score	4.10[a]	4.58[b]	4.87[b]	7.74***	0.41
Fat streakings other muscles score	4.41[a]	4.48[a]	4.83[a]	2.59 N.S.	---
Kidney & pelvic fat score	4.28[a]	5.24[b]	6.05[c]	46.44***	0.39
Rib eye marbling score	4.50[a]	5.48[b]	5.90[c]	22.71***	0.42
Rib eye firmness score	10.08[a]	10.48[b]	10.61[b]	12.82***	0.22
Rib eye color score	10.77[a]	10.79[a]	10.77[a]	0.03 N.S.	---
U.S.D.A. Carcass Grade[++]	8.56[a]	9.15[b]	9.51[c]	17.03***	0.34

+ Sex averages with the same superscript (a, b, or c) are not significantly different at the 5% level.

N.S. Nonsignificant at 5% level.

*$P < .05$.

***$P < .001$.

++U.S.D.A. Carcass Grades were scored on a twelve point scale, rather than the eleven point scale used for subjective carcass scores.

Table 6. Lot averages, F values and l.s.d. of objective carcass measures and selected cuts of lambs (2 year summary, 1964-65).

Item	Ram	Wether	Ewe	F value	l.s.d.
Thickness of fat, inches	0.16[a+]	0.21[b]	0.26[c]	37.15***	0.03
L. dorsi right side (sq. in.)	2.32[a]	2.30[a]	2.23[a]	1.91 N.S.	---
L. dorsi left side (sq. in.)	2.36[a]	2.30[ab]	2.20[b]	5.98**	0.10
L. dorsi total (sq. in.)	4. 68[a]	4.60[ab]	4.42[b]	4.08*	0.20
L. dorsi average (sq. in.)	2.34[a]	2.30[ab]	2.21[b]	4.13*	0.10
Color reading flank steak[+]	19.32[a]	18.54[b]	18.43[b]	3.51*	0.72
Color reading L. dorsi	13.19[a]	12.76[ab]	12.65[b]	3.29*	0.44
Per cent moisture	75.55[a]	74.52[b]	74.31[b]	11.77***	0.69
Per cent ether extract (fresh basis)	3.04[a]	3.70[a]	4.53[b]	12.76***	0.78
Breast wt., lbs.	8.4[a]	8.5[a]	8.7[a]	1.88 N.S.	---
Shoulder wt., lbs.	13.0[a]	13.1[a]	13.0[a]	0.21 N.S.	---
Hotel rack wt., lbs.	4.8[a]	5.0[b]	5.3[c]	20.48***	0.2
Loin wt., lbs.	5.0[a]	5.3[b]	5.6[c]	12.53***	0.2
Trimmed loin wt., lbs.	4.8[a]	4.9[a]	4.9[a]	0.87 N.S.	---
Leg wt., lbs.	15.3[a]	15.6[a]	15.3[a]	2.03 N.S.	---
Trimmed leg wt., lbs.	14.8[a]	14.9[a]	14.5[b]	5.70**	0.3
Trimmed leg and loin, lbs.	19.6[a]	19.8[a]	19.3[a]	3.01 N.S.	---
Kidney knob wt., lbs.	0.8[a]	1.1[b]	1.5[c]	68.16***	0.1

[+]Sex averages with the same superscript (a, b, or c) are not significantly different at the 5% level.

N.S. Nonsignificant.

*P < .05.

**P < .01.

***P < .001.

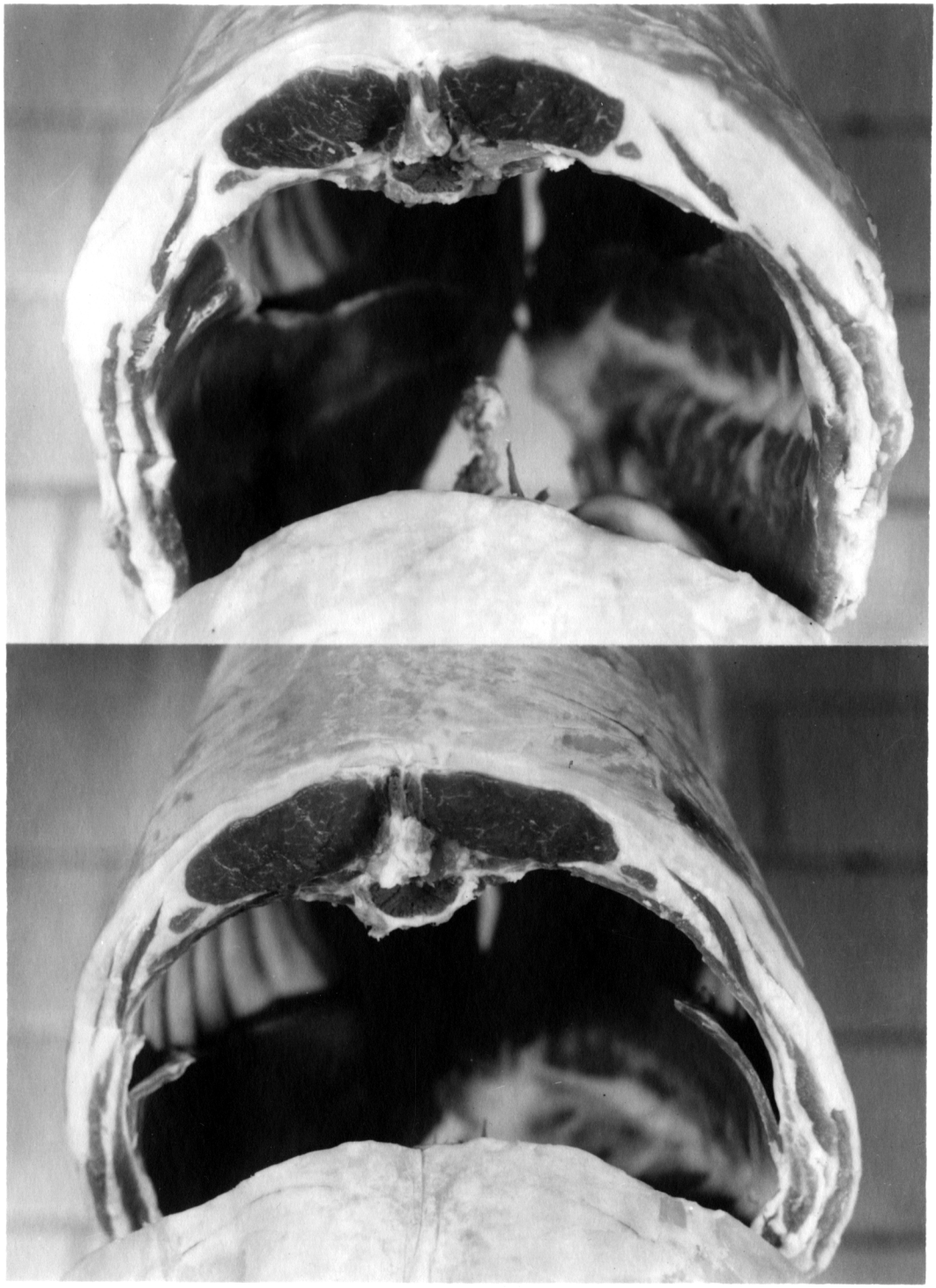


Fig. 8. Illustration of varying amounts of fat thickness observed in this study.

of the right or left longissimus dorsi muscle independently. The total area of longissimus dorsi muscle indicates that rams averaged 0.26 square inches larger longissimus dorsi muscle than the ewes which was a significant difference. A significant difference did not exist between rams and wethers or wethers and ewes in total longissimus dorsi area.

The rams had a significantly higher per cent of moisture in the longissimus dorsi muscle (Table 6) than did the remainder of the lambs. No significant difference was noted in per cent moisture between wethers and ewes. Wethers and rams showed little variation in per cent of ether extract of longissimus dorsi muscle. A significantly higher per cent of ether extract was noted for the ewes in relation to the other lambs. The ether extract data exhibited the same general trend followed by rib eye marbling between sexes.

Grades

Significant grade differences were found with rams having the lowest mean grade and the ewes the highest grade. While the differences were statistically significant, the average grade spread between ram and ewe carcasses was only one-third grade. The scoring system for U.S.D.A. carcass grade was based on a twelve point scale rather than the eleven point scale used for the quality factors. On the twelve point scale, each whole number represents one-third of a grade.

Weights of Wholesale Cuts

Significant differences did not exist between sexes regarding breast weight, shoulder weight, trimmed loin weight, leg weight, and trimmed leg and loin. The untrimmed loin weight was significantly different between sex with the heaviest for ewes, then wethers, and rams, respectively, while the trimmed loin weight failed to be significantly different between sexes. Trimming the dorsal surface of the loin to 0.25 inches and the ventral surface as close as possible without scoring the muscle seems to equalize the loin weight. As mentioned earlier, the thickness of fat over the 12th rib, the kidney knob weight, quantity of external finish, pelvic and kidney fat indicate a larger amount of fat to be removed from ewe carcasses than wether carcasses. Ram carcasses needed the least trimming. There seemed to be quite a variation in fat trim which was also noticed by Oliver *et al*. (1962). When the trimmed loin and trimmed leg weights were combined, no significant difference was observed between each sex. The extra trim loin weight (Table 7) failed to show any significant differences between sexes.

Fat thickness measurements over the left and right ribs between the 12th and 13th rib taken at points 1 and 8 illustrated in Fig. 1 indicated that rams have less fat than wethers and ewes.

Table 7. Lot averages, F values and l.s.d. for fat thickness over left rib, fat thickness over right rib, and extra trim loin weight.[&]

Item	Ram	Wether	Ewe	F value	l.s.d.
Fat thickness over left rib (in.)	0.45[a+]	0.57[b]	0.64[b]	38.50***	0.11
Fat thickness over right rib (in.)	0.49[a]	0.58[ab]	0.65[b]	10.67***	0.10
Extra trim loin wt., lbs.	3.37[a]	3.72[a]	3.45[a]	1.60 N.S.	---

[&]Data was collected only for 1965.

[+]Sex averages with the same superscript (a, or b) are not significantly different at the 5% level.

N.S. Nonsignificant.

***P < .001.

Rack Dissection

Hankins (1947) and other workers have reported the hotel rack to be a good indicator of carcass composition. Consequently, the hotel rack was physically dissected to obtain comparisons of the following weights in grams: longissimus dorsi muscle, other lean, fat, bone, overflow fat, and intercostal muscles (Table 8).

Some interesting observations can be made from the rack dissection data. The weight of the rack in grams was significantly different with the ewes having the heaviest rack. The rams had the lightest rack as was noticed in the pound weights of the rib. While the ram hotel rack had the least total weight, it provided the most lean upon physical separation.

Table 8. Lot averages, F values and l.s.d. of physical separation of hotel rack (2 year summary, 1964-65).

Item	Ram	Wether	Ewe	F value	l.s.d.
Hotel rack wt., gms.	2135.5[a+]	2237.4[b]	2352.1[c]	20.93***	71.5
L.D. from hotel rack, gms.	367.8[a]	366.4[a]	351.3[b]	4.09*	14.0
Other lean from hotel rack, gms.	536.5[a]	529.9[a]	541.2[a]	0.46 N.S.	---
Fat from hotel rack, gms.	620.9[a]	737.1[b]	885.1[c]	43.23***	61.1
Bone from hotel rack, gms.	384.0[a]	370.7[b]	346.6[c]	19.08***	13.3
Intercostal muscle, gms.	197.0[a]	180.4[b]	179.4[b]	9.67***	8.6
Overflow fat from hotel rack, gms.	28.4[a]	29.8[a]	31.6[a]	1.95 N.S.	---

[+]Sex averages with the same superscript (a, b, or c) are not significantly different at the 5% level.

N.S. Nonsignificant.

*P < .05.

***P < .001.

The wethers and rams were fifteen to sixteen grams heavier in dorsi muscle weight than ewes.

Lot averages in other lean trim from the hotel rack did not vary to any extent. Rams also had more intercostal muscle than wethers and ewes. Apparently, fat trimmed from the hotel rack accounts for much of the extra rack weight of ewes and wethers, respectively, when compared to the hotel rack weight of rams. The weight of the overflow fat has only a small effect on the total weight of the hotel rack. A sex difference was not observed for overflow fat.

A discrepancy was noted between the overflow fat score and the actual amount of overflow fat obtained by physical separation of the rack. While overflow fat is three dimensional, the subjective overflow fat score represented only two dimensions. Another source of error might be found in the lack of refinement in separating the overflow fat from the rack.

Data obtained from physical separation of the hotel rack seems to be consistent with other data presented in suggesting carcasses are fatter than those from wethers or rams. Weights of trimmed leg, and trimmed loin indicated that the sexes had approximately the same amount of edible meat as did weights of longissimus dorsi muscle, other lean, and intercostal muscle from physical separation of the rack.

Cooking Data

Five of the twelve factors considered in cooking and sensory evaluations proved to be statistically nonsignificant. The nonsignificant factors were cooking time, total cooking loss, intensity of flavor, desirability of flavor, and juiciness. The lot averages indicate differences between sexes in tenderness and water holding capacity.

Table 9 shows the volatile loss and dripping loss of ram loin roasts is significantly higher and lower, respectively, than ewe and wether lambs. While differences exist in volatile and dripping losses, no significant difference was noted in

Table 9. Lot averages, F values and l.s.d. of lamb loin roast cooking and sensory data (2 year summary, 1964-65).

Item	Ram	Wether	Ewe	F value	l.s.d.
Cooking time, minutes/lb.	39.22[a+]	35.87[a]	36.53[a]	2.93 N.S.	---
Total cooking loss (%)	11.68[a]	12.26[a]	11.97[a]	0.856 N.S.	---
Volatile loss, %	8.85[a]	8.28[b]	7.75[c]	10.48***	0.36
Dripping loss,%	2.63[a]	3.78[b]	4.06[b]	23.90***	0.31
Shear value, lbs. for 1/2 in. cores	8.81[a]	7.77[b]	7.19[b]	7.96***	0.60
Press fluid, ml/25 gms.	7.82[a]	8.01[b]	8.24[c]	6.89***	0.06
Intensity of flavor score[++]	4.72[a]	4.53[a]	4.58[a]	2.44 N.S.	---
Flavor Desirability score[++]	5.52[a]	5.62[a]	5.56[a]	1.11 N.S.	---
Juiciness score [++]	6.02[a]	6.03[a]	6.12[a]	1.71 N.S.	---
Initial (tenderness) score[++]	5.36[a]	5.62[b]	5.78[c]	8.61***	0.05
No. of chews (tenderness)	33.6[a]	32.1[b]	29.1[c]	13.78***	0.04
Chews score (tenderness) score[++]	5.16[a]	5.48[b]	5.69[c]	13.52***	0.05

[+]Sex averages with the same superscript (a, b, or c) are not significantly different at the 5% level.

N.S. Nonsignificant.

[++]The scale is 1 to 7. The scoring system in Table 10.

*** $P < .001$.

total cooking loss. The higher volatile loss for ram loin roasts may be explained by a thinner fat covering over the longissimus dorsi muscle.

The Warner-Bratzler Shear mean values show rams to be less tender than wethers and ewes but does not indicate a significant difference in tenderness between wethers and ewes. Subjective scores of tenderness (based on a scale of 1 to 7, as shown in Table 10) point to small, but significant differences between each sex in tenderness. Chews score and initial tenderness scores show ewes to be the most tender with wethers and rams being less tender in that order. Even though ram lamb carcasses graded lower and were less tender than those of wethers and ewes, they were trimmer. The rams showed faster gains. Putting more lamb on the market of acceptable quality with a shortened feeding period might have quite an impact on the lamb industry.

SUMMARY

Ram market lambs are being discriminated against in the channels through which Kansas lambs are marketed. The question was raised whether such discrimination was justified. In view of the limited information on carcass comparisons of ewe, wether, and ram lambs, the study was undertaken to determine what differences, if any, exist between carcasses of ram, wether, and ewe market lambs.

Table 10. Sample of taste panel data sheet.

Score Card For Lamb

Judge _____ Code _____ Date _____

Sample No.	Desirability of flavor			Tenderness		Comments
					Chews	
	Fat	Lean	Juiciness	Initial	No. Score	
1						
2						
3						
4						

Descriptive terms for scoring

Desirability and Intensity of flavor	Juiciness	Tenderness
7. Very desirable	7. Very juicy	7. Very tender
6. Desirable	6. Juicy	6. Tender
5. Moderately desirable	5. Moderately juicy	5. Moderately tender
4. Slightly desirable	4. Slightly dry	4. Slightly tough
3. Neutral	3. Dry	3. Tough
2. Slightly undesirable	2. Very dry	2. Very tough
1. Undesirable	1. Extremely dry	1. Extremely tough

A total of 160 crossbred lambs were slaughtered over a two year period at an approximate individual live weight of 95 pounds. Thirty-nine rams, 34 wethers, and 87 ewes were evaluated for subjective indices, objective measurements, grade, weight of cuts, and slaughter data associated with lamb quality, cutability, and value. The hotel rack was physically separated into the longissimus dorsi muscle, other lean muscle, fat, bone, overflow fat, and intercostal muscle. The longissimus dorsi muscle was used in ether extract and color reflectance analysis. The intercostal muscle was used in ether extract determinations. The rectus abdominus muscle was used in color reflectance analysis.

Rams reached a live weight of 95 pounds 15 to 20 days before wethers and ewes. Ewes had the highest dressing per cent while rams had the lowest dressing per cent.

Subjective and objective measurements of fat consistently indicated ewes to be fatter than wethers and rams, respectively. Quantity of external fat score, kidney and pelvic fat score, kidney knob weight, and the average of six fat measurements between the 12th and 13th ribs were used to determine the fatness of the lambs. Fat thickness measurements over the left and right ribs between the 12th and 13th ribs indicated the rams to be less fat than wethers and ewes. The extra trim loin weight failed to show any difference between sexes as was the case for the trimmed loin.

Rams had a higher per cent of moisture in the longissimus

dorsi muscle than did the other lambs. Correspondingly, the rams and wethers had the smallest percentage of ether extract in the longissimus dorsi muscle while the ewes had the least per cent moisture and the largest per cent ether extract. Significant U.S.D.A. carcass grade differences were found with rams having the lowest grade and ewes the highest. While these differences were statistically significant, the average grade spread between ram and ewe carcasses was only one-third of a grade.

Physical separation of the hotel rack showed that rams yielded more lean meat than wethers and ewes, even though ewes and wethers produced heavier racks. The difference in weights can be explained by the ewe and wether lambs having more trimmable fat.

Cooking time was similar for lamb loin roasts from ram, wether, and ewe carcasses. Ewe and wether lambs had no significant advantage over ram lambs in intensity of flavor, desirability and juiciness. Loin roasts from rams were significantly less tender than those from wethers or ewes, both by shear test and sensory evaluations.

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A COMPARISON OF CARCASS CHARACTERISTICS OF EWE, WETHER, AND RAM MARKET LAMBS

by

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AN ABSTRACT OF A MASTER'S THESIS

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Ram market lambs are discriminated against in channels through which Kansas lambs are marketed. The question was raised whether such discrimination was justified. In view of the limited information on carcass comparisons of ewe, wether, and ram lambs, this study was undertaken to determine what differences, if any, exist between carcasses of ram, wether, and ewe market lambs.

A total of 160 Hampshire-Western crossbred lambs were slaughtered over a two year period at an approximate individual live weight of 95 pounds. Thirty-nine rams, 34 wethers, and 87 ewes were evaluated for subjective carcass characteristics, objective measurements, grade, weight of cuts, and slaughter data associated with lamb quality, cutability, and value.

Rams reached a live weight of 95 pounds 15 to 20 days before wethers and ewes. Ewes had the highest dressing per cent while rams had the lowest dressing per cent.

Subjective and objective measurements of fat consistently indicated ewes to be fatter than wethers and rams, respectively. These included quantity of external fat score, kidney and pelvic fat score, kidney knob weight, and the average of six fat measurements taken over the rib eye between the 12th and 13th ribs.

Both a regular trimmed loin and a very closely trimmed loin failed to show any difference between sex groups.

Rams had a higher per cent of moisture in the <u>longissimus dorsi</u> muscle than did the other lambs. Correspondingly, the

rams and wethers had a smaller percentage of ether extract in the longissimus dorsi muscle while the ewes had the least per cent moisture and the largest per cent ether extract.

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Physical separation of the hotel rack showed that rams yielded more lean meat than wethers and ewes, even though ewes and wethers produced heavier racks. The difference in weights can be explained by the ewe and wether lambs having more trimmable fat.

Cooking time was similar for lamb loin roasts from ram, wether, and ewe carcasses. Ewe and wether lambs had no significant advantage over ram lambs in intensity of flavor, desirability and juiciness. Loin roasts from rams were significantly less tender than those from wethers or ewes, both by shear test and sensory evaluations.