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To the Graduate Council:

I am submitting herewith a thesis written by Donald D. Brannan entitled "Consumer Preference and Organoleptic Studies as Related to Federal Beef Grades and Selected Beef Carcass Characteristics." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

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CONSUMER PREFERENCE AND ORGANOLEPTIC STUDIES AS RELATED TO FEDERAL BEEF GRADES AND SELECTED BEEF CARCASS CHARACTERISTICS

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
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Master of Science

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by

Donald D. Brannan

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Donald D. Brannan

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CHAPTER I

INTRODUCTION

It has been generally agreed in the past that the more highly finished the beef animal the more desirable are market characteristics of it's carcass and retail cuts. Marbling, a measure of quality, has been associated with a highly finished carcass. Recently, however, more study has been given as to what the consumer of beef actually prefers in the cuts of meat he buys. Many times this or similar questions have been asked, "Are consumers willing to accept a heavy rind of fat with the better quality steaks and roasts they buy at the same or at a higher price that for which they may purchase a leaner portion?" Presently, holding age constant, our federal grading system for beef carcasses reflects largely the degree of fatness of the animal from which it came, and to as much lesser extent, conformation of the carcass.

Extensive research has been conducted on measurements, grades, dressing percentages, and composition of various type carcasses. However, little work has been done with relating these carcass characteristics to what consumers of beef actually prefer.

This study was designed to investigate what consumers desire by using grades as they now exist. It was decided that if families were allowed to cook samples of beef in their homes under consumer conditions a comparison might be made between grades of steaks, independent of price, and an association with actual carcass characteristics could be studied.

Specifically, the objectives of the study are:

1. To make a study of carcass measurements and the percentage of

wholesale cuts with regard to grade.

2. To determine the percentages of lean, fat, and bone in the beef carcass with regard to grade.

3. To determine the ratios of moisture, crude protein, and fat that the meat of the grades studied actually yields.

4. To compare grades by a trained taste panel and to measure organoleptic factors under controlled conditions.

5. To compare grades by giving meat to forty families in units of two samples, each representing a different grade.

6. To correlate carcass characteristics with tasting results.

CHAPTER II

REVIEW OF LITERATURE

Extensive data are available on beef carcass characteristics in the literature. Various workers have used body measurements as a method of determining how experimental animals compared to controls. Others have attempted to determine the composition of the carcass by using representative portions. Some have made complete studies of the various components of the beef carcass. Many have attempted to summarize their findings by using carcass grades and various subjective evaluations. However, only limited work is available on consumer preference for beef. This is particularly true where tests or surveys have been repeated using the same persons to determine if an actual preference exists.

Hiner and Hankins (1950) showed that calves weighing around 500 pounds yielded carcasses that were more tender than older animals. Little difference was found in the tenderness of the three round muscles.

Branaman et al. (1936) found that as dressing percentage increases carcass grade will increase. Also they showed the percentage of protein, water, lean, and bone will decrease as the animal fattens. In comparing steers and heifers, he showed that increased conditioning resulted in firmer lean of the rib eye, and more marbling in the eye muscle.

Callow (1945) in analysis of carcass data of steers over two and one-half years of age found 71.5 percent of the gain in weight attributed to fat and only 4.45 percent attributed to protein. Trowbridge et al. (1919) also related that lean and bone increased with added weight but not as rapidly as fat. Black et al. (1931) showed in chemical analysis of the

rib that a higher percentage of fat was found in a supplement-fed lot of cattle. Also Black et al. (1940) found in cattle fed grass alone there was a higher percentage of lean and bone. The fattest cattle had the smallest eye muscle and grass fed cattle had more yellow fat. Woodard et al. (1954) related that no correlation was evident between the lean and fat in the carcass and the thickness of fat over the eye muscle.

Hall and Emmett (1912) recorded more protein and more boneless meat per dollar value in thinner wholesale cuts. Also, the cost per 1000 calories was less in thinner wholesale cuts. Retail cuts followed a similar pattern. These workers also showed that the moisture content of the beef carcass decreases percentage-wise as the animal fattens.

Meyer and Ensminger (1952) reported that when Choice, Good, and Commercial beef steaks were offered at the same price more people chose Commercial. When the same grades were priced at Office of Price Stabilization ceiling price a higher percentage chose the Commercial grade. In each of these trials roasts followed a similar pattern. Lasley et al. (1955) using Prime in addition to Choice, Good, and Commercial found the trend was to choose the lower grade steaks and roasts at the same dollar value. In a follow-up of this study, most purchasers were satisfied with their selections. Consumers indicated preference for a creamy, white color of fat. Freshness and appearance were given as the reasons for preferring a particular color. Many indicated that they looked for marbling as they thought it was an indication of tenderness and good flavor. Seltzer (1955) showed that when consumers were asked to choose between pictures of steaks representing Choice, Good, and Commercial that 41 percent selected Good, 31 percent Choice, and 27 percent Commercial. A limited

amount of fat was desired by many of those interviewed.

Rhodes et al. (1954) found that, although preference was based upon tenderness, juiciness, flavor, color of lean, bone, the amount of internal and external fat, and texture, there was a trend to choose the higher grades of meat. When surveys were conducted in stores selling higher grades of beef, the customers chose the higher grades more often. People in higher income brackets preferred the top grades. Males showed a preference for higher grades of beef than females, and as education level increased, the number of persons choosing the top three grades increased. Rhodes et al. (1956) studied 120 beef loins and related that when Prime and Good were compared, some grade influence was noticed, but it was smaller than ideally desired. Shear values showed a significant influence on grades. These workers concluded that eating characteristics were not closely related to grade.

Wanderstock and Miller (1948) reported that palatability scores were higher on grain-fed steers than grass-fed animals. They found only slight differences in color of lean between the two groups of cattle. Analysis of the 9-10-11 rib section favored the grain fed steers as having a higher proportion of meat to bone. Cooking losses were quite similar between groups.

Brady (1957) found most consumers are adverse to fat, and that tenderness is an important factor for complete satisfaction. Most consumers had very little knowledge about quality factors of beef. U. S. Good showed a high degree of acceptability. Hankins and Ellis (1939) in a study to determine usable meat found most was obtained from carcasses grading top Good and low Choice.

Armsby (1908, 1917), Bull (1916), Barbella et al. (1939) and Helser (1929) believed that fattening of an animal increased the tenderness and juiciness of the meat. Black et al. (1931) and Hankins and Ellis (1939) thought that the degree of finish had little to do with tenderness. Butler et al. (1956) showed that juiciness was more closely correlated with fatness in a broiled loin than in a braised loin or in broiled or braised bottom round steak. Fatness was more closely correlated with tenderness in bottom round than in the loin. He suggests that breeding may have something to do with tenderness.

Gardner et al. (1926) in a survey revealed that most families thought they had adequate meat in their diets. Beef was preferred over other meats. Steaks and chops were purchased most often because of their palatability. Economy was often given as the reason for buying boiling meat. In this study it was found that on the average housewives could name only three steaks and two roasts. Over 50 percent of the purchasers thought they were buying top quality beef but only 9 percent of the beef slaughtered at that time was considered top quality. The reason given most often for buying meat from a particular dealer was that the dealer handled "good meat."

Ashby et al. (1941) found that consumers had very little knowledge of government grades. Two-thirds of the persons contacted wanted only a small amount of fat on their meat and one-fourth wanted a goodly amount. The higher income groups preferred higher finished beef. The largest group thought they were buying either Prime or Choice meat. Retailers felt that by handling graded meat they could depend on a more uniform product. Many retailers and consumers thought that it would be helpful if the sex were stamped on the carcass.

Liston (1937) in her findings revealed that roasts are very popular retail cuts. Many persons preferred them because of the evident quality stamp. Factors considered most were amount of fat, color of lean, and marbling. Roasts were often ordered as a specific cut and many people relied on the butcher to supply cuts that would fit their needs.

Sloop et al. (1952) showed that consumers preferred a self-service meat market because of rapidity of service. Also opportunity to examine the meat was considered important. Many of those not liking self-service thought the meat was not as fresh. A large percentage of those interviewed used the butchers recommendation. Steaks were found to be the most popular at one-half to one inch in thickness. Steaks and chops were bought most often by serving numbers, while roasts and ground meat most often by the pound. Meat was selected on amounts of fat and lean, appearance and price. About one-fourth of those interviewed based their choices on government grades and about one-tenth on packer grades.

Many workers have used the 9-10-11 rib section as an index of the composition of the entire carcass. Among them are Black et al. (1931) and Barbella et al. (1939). Hankins and Emmett (1939) found a high correlation between fat content of the 9-10-11 rib and the entire carcass. Hankins and Ellis (1946) in a study of 120 cattle related that the separable fat of the 9-10-11 rib was a good index of the separable fat of the entire carcass. It was also correlated with the edible portion of the carcass. Correlations between the percentage of separable lean in the 9-10-11 rib and in the entire carcass were higher for steers than for heifers. As an index for protein the lean meat of the 9-10-11 rib was valuable. The relationships between bone of the entire carcass and of the 9-10-11 rib

were large enough to be useful. The correlation between the moisture content of the meat from the 9-10-11 rib section and the water content of the entire carcass was high. Also a highly significant relationship between the total separable fat of the carcass and the ether extract percentage was shown.

Crown (1953) reported a correlation between the lean, fat, and bone of the 12th rib with that of the 9-10-11 rib.

CHAPTER III

PROCEDURE

Thirty-six beef carcasses representing four U. S. D. A. grades were purchased at a local packing company. These were divided equally between the Choice, Good, Standard, and Commercial grades. The top three grades had six steers and three heifers in each grade, while the Commercial grade consisted entirely of cow carcasses. The carcasses were purchased in lots of four. Weights were matched as closely as possible. Difficulty was encountered in finding cow carcasses that graded average Commercial within the needed weight range. All carcasses were measured as prescribed by the Fourth Annual Reciprocal Meat Conference Report (1951). An additional measurement was taken at the division of the round and sirloin and was termed depth of flank. This included the distance from the dorsal portion of the sacral vertebra to the lower tip of the sirloin including the fat.

The carcasses were all evaluated to the nearest one-third of a grade. The color of lean was also determined by subjective evaluation. Rib eye tracings were taken at the 12th rib for measurement of the area of rib eye and thickness of fat covering. A compensating planimeter was used for determining the square inches of lean in the rib eye. The fat covering was measured as outlined by the Fourth Annual Reciprocal Meat Conference Report (1951).

The left side from each carcass was divided into wholesale cuts as prescribed by the Sixth Annual Reciprocal Meat Conference Report (1953). The rib was broken down still further into the 12th rib, 9-10-11 rib and

6-7-8 rib sections. The round was also sub-divided into a shank and a shankless portion by cutting straight through the joint between the femur and tibia-fibula. The portion known as the heel pot roast was left as part of the hind shank.

Each cut from the left side was then divided into separable lean, fat, and bone and weighed to the nearest one-tenth pound. All the fat and lean from the entire left side was thoroughly mixed and ground. The material was mixed again and re-ground through a finer plate. A representative sample was taken and further processed by chopping in a Hobart Food Chopper for approximately five minutes. From this homogeneous mixture a sample was taken, wrapped, and frozen for chemical analysis. Chemical analysis for moisture, crude protein, and fat were accomplished by the standard procedures. All chemical analysis were made in duplicate and any samples which showed more than two percent variation between duplicates were re-run on another representative sample.

The right hind quarter was aged for 14 days in a 36 degrees Fahrenheit cooler at the University of Tennessee meats laboratory. Steaks were then secured and frozen for future organoleptic tests. The short loin was boned and sliced by a power slicer 70 mm. in thickness. Steaks were kept in order as removed and the first ten were numbered from anterior to posterior and saved for taste studies. Each of the ten steaks was divided, individually wrapped, coded, and frozen so that each participating member of the taste test would receive the same cross section of the longissimus dorsi muscle. The next five steaks, from anterior to posterior, were wrapped and frozen for rating purposes by a trained taste panel.

Round steaks for braising were cut and divided in the following

manner. The rump was removed from the round by cutting as closely as possible to the inside edge of the pubis and perpendicular to the femur. A one inch thick steak was then removed before securing slices for future tasting. Five three-quarter inch slices were then removed and numbered from anterior to posterior. All slices were subdivided and numbered in the following manner. The eye of the round was numbered steak one, steak two was the semi-tendinous portion of the bottom round, steak three was a boneless five ounce portion of the most desirable section of the knuckle, steak four was the portion nearer the femur of the inside round, and steak five was the remaining section of the inside round.

The first four slices were used for family taste studies and the fifth steak was used for analysis by the trained taste panel.

Forty families were selected for steak distribution. Twenty were composed of a student group, and twenty were staff members representing several departments in the College of Agriculture. The student families rated steaks taken from nine heifer and three cow carcasses as well as steaks from nine steer and three cow carcasses. Faculty families rated steaks taken only from nine steer and three cow carcasses.

One member of each family drew for the steak position number to be assigned to that family throughout the entire test. Both broiled and braised steaks were distributed weekly to each family in units of two paired grades. All six possible combinations were used and repeated three times during the test period. These combinations were Choice-Good, Choice-Standard, Choice-Commercial, Good-Standard, Good-Commercial, and Standard-Commercial. Each pair of steaks, one of which contained a ring, was placed in a paper bag with the family number and the method of cookery

to be used.

Each family was given two mimeographed forms one each for the husband and wife to fill out independently. The husband and wife were asked to declare a preference and rate each steak on tenderness, juiciness, and flavor. Ratings were scored from one through nine, with nine being the top value. Cooking time and degree of doneness were recorded. Mimeograph instructions were given on cooking methods (broiling and braising) to standardize cookery insofar as possible. The record kept by the families was turned in as soon as possible after the husband and wife finished scoring the paired samples.

Cooking for the trained taste panel was done by the Food Research section of The College of Home Economics. The braising steaks were brought to an internal temperature of 100° C. and then were left in the oven 25 minutes with the oven-thermostat set at 300° F. The broiling steaks were brought to a medium-done stage by cooking until the internal temperature reached 72° C.

The trained taste panel consisted of members of The Animal Husbandry Department and The Home Economics Staff. Both broiled and braised steaks were served in units of four, representing one sample from each of the grades at a tasting. Ratings were scored from one through nine with nine being the top value on odor, appearance, flavor of lean, tenderness, juiciness, and flavor of fat. Dripping and evaporation losses were determined. Samples from all steaks were used for shear values on the Warner Bratzler Shear.

CHAPTER IV

RESULTS AND DISCUSSION

Carcass Characteristics

Average weights of the sides of carcasses chosen were similar, Choice, 239.3 pounds, Good, 242.0 pounds, Standard, 242.4 pounds, and Commercial, 247.5 pounds. Carcasses within the weight range of 480 to 500 pounds yield desirable size retail cuts and are quite popular. Choice and Good carcasses when graded to the nearest one-third of a grade averaged exactly in the middle of the grade. The Standard group of carcasses was slightly below the center of the grade, as seven carcasses were graded average Standard and two low Standard. The cows deviated the most from the mid-point of the grade with five grading average Commercial and four low Commercial. The color of lean was brightest in the Choice carcasses and darkest in the Standard grade. The Good carcasses had a desirable color of lean although somewhat light, and the cow carcasses were slightly dark.

For Choice, Good, and Standard carcasses the fat covering the 12th rib decreased as the grade lowered, 2.1, 1.6, and 1.4 cm. respectively. It was found the Commercial cow carcasses had 1.9 cm. This seemed reasonable as the Commercial grade is composed of carcasses from highly finished cows over four years of age. The amount of lean meat in the rib eye decreased as the grade decreased respectively for all four grades, 9.3, 9.2, 8.9, and 8.3 square inches. There was no apparent difference in thickness of fat over the 12th rib between steers and heifers of the same grade.

When analyzed statistically among grades, the fat thickness over the rib eye was significant at the five percent level. The loin eye area was highly significant among grades. Fat thickness over the 12th rib was found to have a highly positive significant correlation to total separable fat (Appendix Table I). The amount of lean in the loin eye area was found to be negatively correlated with total separable lean although not significant.

Carcass Measurements

Large differences existed in carcass conformation between grades (Table I). The length of carcass increased rather uniformly as grade decreased. Carcasses from the Choice group averaged two inches shorter than those from the Good group, the Good carcasses were about two inches shorter than the carcasses from Standard cattle and the Commercial carcasses were approximately two inches longer than those from the Standard group. As would be expected, little difference in length was found when steers and heifers of the same grade and similar weights were compared. Carcass length between grades was significant at the one percent level (Table II).

As the carcass grade decreased, the length of the leg increased from 26.7, 28.4, and 29.2 inches, respectively, for the top three grades (Table I). The cow carcasses averaged about the same length of leg as the Good. Only small differences between steer and heifer carcasses within grades were found and they followed no definite trend. In analysis of variance the differences in length of leg among all four grades were found to be highly significant (Table II).

When measurements of the circumference and width of the round were

taken at 60 percent of the distance between the hock joint and the anterior edge of the pubis it was found that the higher grades tended to be slightly more meaty and bulging at this point (Table I). Although the Good grade circumference was slightly higher than the Choice lot, 30.6 to 30.3 inches, the Standard and Commercial grades decreased as the grade lowered (29.6 to 28.0 inches). The width of the round decreased in sequence as the grade decreased. It was noticed that the heifers had rounds more narrow and smaller in circumference than did the steers. Both of these measurements were found to be highly significant for all grades (Table II).

When the loin was measured with regard to length, it was evident that as grade decreased it became more lengthy. This means that more steaks of equal thickness can be obtained from the lower grades. It was also evident that either the cattle grading higher are more youthful, hence less bone elongation had taken place or a difference in breeding as to skeletal make-up was shown. This measurement was also significant at the one percent level (Table II).

In an attempt to determine whether or not the high-flanked criticism, as evidenced in the show ring or at the market shows up in the carcass, the depth of flank measurement was taken. This measurement decreased as the grade increased in all four grades. The difference in depth of flank between all four grades was found to be significant at the one percent level.

The width of chest tended to decrease as the grade decreased 8.2, 7.7, 7.7, and 7.6 inches respectively (Table I). Although the depth of chest among grades was not significant, the F value was found to approach significant at the five percent level (Table II).

TABLE I

THE MEAN VALUES OF VARIOUS CARCASS MEASUREMENTS WITH REGARD TO GRADE AND SEX

U.S.D.A. Grade	Length of Carcass	Length of Leg	Circumference of Round	Width of Round	Length of Loin	Depth of Flank	Width of Chest	Depth of Chest 5th Rib	Depth of Chest 7th Rib
Choice	43.8	26.7	30.3	8.6	22.7	17.2	8.2	14.7	15.9
Steers	43.8	26.6	30.8	8.7	22.9	17.4	8.2	14.8	16.1
Heifers	43.9	26.9	29.3	8.5	22.3	17.0	8.1	14.5	15.7
Good	45.8	28.4	30.6	8.2	24.0	18.1	7.7	16.0	17.2
Steers	45.8	28.9	31.1	8.8	23.8	17.9	7.8	15.9	17.1
Heifers	45.8	27.8	29.7	7.9	24.2	18.5	7.5	16.2	17.6
Standard	47.4	29.2	29.6	7.8	25.0	18.4	7.7	16.6	18.1
Steers	47.3	29.3	30.1	8.0	24.9	18.5	7.8	16.6	18.1
Heifers	47.7	29.0	28.8	7.6	25.2	18.3	7.5	16.7	18.0
Commercial	50.6	28.3	28.0	7.6	27.6	19.2	7.6	17.4	18.8

TABLE II

ANALYSIS OF VARIANCE OF SELECTED CARCASS MEASUREMENTS

Item	Degrees of Freedom	Mean Square	Error
Carcass Length	3	70.65**	1.46
Length of Leg	3	10.00**	.531
Circumference of Round	3	11.83**	2.65
Width of Round	3	1.92**	.234
Depth of Flank	3	6.04**	.668
Length of Loin	3	37.73**	.642
Width of Chest	3	.577	.204
Depth of Chest 5th Rib	3	10.87**	.68
Depth of Chest 7th Rib	3	13.76**	.62
Loin Eye Area	3	18.6**	.81
Fat Thickness Over 12th Rib	3	.81*	.23
Weight of Tibia and Fibula	3	.450**	.044

* Denotes significance at 5 percent level.

** Denotes significance at 1 percent level.

It was found that the chest was deeper at the 7th rib than the 5th rib. It was also found that the chest depth increased significantly as the grades decreased, indicating larger thoracic cavities in the lower grades.

The Percentage of Wholesale Cuts Among Carcass Grades

Cutting data with regard to the percentages of wholesale cuts from different grades of carcasses are shown in Table III. The chuck, round, and loin end, which certainly are cuts of great economic importance, were shown to increase in percentage of carcass composition as grade decreased from Choice, to Good, to Standard. Both the round and chuck differences were quite linear. The percentages of the plate, brisket, kidney knob, and flank decreased as the grades decreased for the top three grades in question. The rib and short loin showed small differences among grades but no pattern was evident. Highly significant differences existed in the percentages of the chuck, plate, fore shank, round, and flank (Table IV). The kidney knob was significant at the five percent level and the loin end also approached significance at this figure.

When the three most valuable cuts (loin, rib, and round) were grouped the percentages comprising these cuts increased as the grade decreased for Choice, Good, and Standard (Table III). This increase is offset by a decrease in percentage of flank, brisket, fore shank, and plate as the grade goes down. These cuts tended to constitute a lower percentage of the total carcass because with lower grades less inedible fat is present. For both the grouped sets of cuts a highly significant difference in percentage was found to exist among grades (Table IV).

TABLE III

COMPARISON OF THE MEAN PERCENTAGE OF BEEF WHOLESALE CUTS AND SELECTED COMBINED WHOLESALE CUTS BETWEEN GRADES AND SEX

U.S.D.A. Grade	Chuck	Rib	Plate	Brisket	Fore Shank	Round	Kidney Knob	Short Loin	Loin End	Flank	Loin, Round and Rib	Flank, Brisket Fore Shank and Plate
Choice	25.6	9.0	8.4	4.4	3.4	22.5	4.4	7.6	8.1	6.7	47.3	22.9
Steers	25.6	9.0	8.4	4.4	3.5	22.9	3.9	7.5	8.0	6.6	47.4	22.9
Heifers	24.9	9.0	8.4	4.5	3.3	21.8	5.3	7.8	8.4	6.8	47.0	23.0
Good	26.3	8.8	7.4	4.1	3.6	24.6	3.8	7.2	9.0	5.4	49.5	20.4
Steers	27.0	8.9	7.2	4.2	3.7	24.8	3.3	7.1	9.0	4.9	49.8	20.0
Heifers	25.0	8.5	7.8	3.9	3.4	24.2	4.8	7.3	9.1	6.2	49.1	21.3
Standard	27.5	9.1	7.0	3.8	3.7	25.2	2.9	7.2	9.2	4.5	50.7	19.0
Steers	27.9	8.9	6.8	3.8	3.8	25.4	2.6	7.2	9.1	4.4	50.6	18.8
Heifers	26.5	9.5	7.3	3.7	3.5	24.8	3.5	7.1	9.5	4.8	50.9	19.3
Commercial	26.9	9.0	7.5	3.9	3.1	22.8	4.0	7.4	10.3	5.2	49.4	19.8

TABLE IV

ANALYSIS OF VARIANCE OF BEEF WHOLESALE CUTS
AND COMBINED WHOLESALE CUTS

Wholesale Cuts	Degrees of Freedom	Mean Square	Error
Chuck	3	5.81**	1.15
Rib	3	.17	.35
Plate	3	3.32**	.39
Brisket	3	.66	.23
Fore Shank	3	6.80**	.54
Round	3	15.49**	1.62
Short Loin	3	.416	.25
Loin End	3	7.19	3.33
Flank	3	7.10**	.46
Kidney Knob	3	3.60*	.98
Loin, Rib, and Round	3	18.08**	1.48
Flank, Brisket, and Fore Shank	3	24.94**	1.26

* Denotes significance at 5 percent level.

** Denotes significance at 1 percent level.

TABLE V

ANALYSIS OF VARIANCE OF SEX EFFECTS ON PHYSICAL COMPOSITION, CHEMICAL ANALYSIS, AND PERCENTAGE OF SELECTED WHOLESALE CUTS

Factors Measured	Degrees of Freedom	Mean Square	Error
Physical Analysis			
Total Separable Lean	2	16.90	8.03
Total Separable Fat	2	49.51*	10.42
Bone and Connective Tissue	2	7.08*	1.40
Chemical Analysis			
Moisture	2	34.24*	6.78
Fat	2	88.65**	10.54
Protein	2	4.3**	.401
Wholesale Cuts			
Chuck	2	12.32**	.395
Loin End	2	.54	.376
Flank	2	2.49**	.407
Kidney Knob	2	8.72**	.608

* Denotes significance at 5 percent level.

** Denotes significance at 1 percent level.

Effect of Sex of the Carcass on the Percentage of Wholesale Cuts

Data in Table III indicate that from the total carcass the percentage of chuck is less in heifer carcasses than in steer carcasses of the same grade. These differences were found to be highly significant (Table V). Also from heifer carcasses, a higher percentage of the total cuts consisted of the flank and kidney knob than did these cuts from steer carcasses (Table III). The udder which remains on the flank would tend to increase the flank percentage of the heifers. Both of these values were found to be highly significant (Table V). Although the loin end made up a higher percentage of the heifer carcass than steer carcass of the same grade, this difference was not significant. When comparing the percentage make-up from all heifer carcasses compared with steer carcasses of similar grades, no definite trends were noticed in the rib, brisket, and short loin. Heifer carcasses, however, tended to have a higher percentage of plate and a lower percentage of round and fore shank than did the steer carcasses.

Physical Analysis Among Grades

With respect to Choice, Good, and Standard grade carcasses, the physical percentage of separable lean increased with a decrease in carcass grade, 49.6, 55.2, and 58.2 percent, respectively. The lean percentage of the Commercial cow carcasses (52.3) fitted in sequence between Choice and Good carcasses. These figures among grades were statistically significant at the one percent level (Table VII). An inverse relationship existed in the mean percentage of separable lean as compared with the

separable fat, with the fat decreasing as the carcass grade decreased (Table VI). The cow carcasses had a higher fat content than the Good grade, but not as high as the Choice grade. The differences in separable fat among all grades were highly significant (Table VII). The percentage of bone and connective tissue in the carcasses showed an increase as the grade decreased except in the case of Commercial cow carcasses. The lower percentage of bone and connective tissue observed in the Commercial cow carcasses as compared to the Standard grade can be attributed largely to the higher percentage of separable fat. Furthermore, since the Standard group of more youthful cattle had a higher percentage of bone, skeletal differences due to breeding may be an additional factor. The bone and connective tissue percentages between carcass grades were significant at the one percent level (Table VII).

Physical Analysis Among Grades With Regard to Sex

In Table VI heifer carcasses were found to have 1.9 percent more separable fat in the Choice grade, 2.4 percent more in the Good grade, and 4 percent more in the Standard grade than the steer carcasses. The heifer carcasses also had less separable lean. The Choice group had 1.2 percent less, while both the Good and Standard group had 2.0 percent less. Also the heifer carcasses had a lower percentage of bone than the steer carcasses in all three grades compared. In Table V, heifer carcasses had significantly more fat than the steer carcasses. In regard to bone and connective tissue a significantly lower percentage in the heifer carcasses was found approaching the one percent level.

TABLE VI

MEAN PERCENTAGE OF CHEMICAL COMPOSITION OF THE COMBINED SEPARABLE LEAN AND FAT AND THE MEAN PERCENTAGE OF PHYSICAL COMPOSITION OF THE CARCASS WITH REGARD TO GRADE AND SEX

	Chemical Composition			Physical Composition		
U.S.D.A Grade	Moisture	Fat	Protein	Lean	Fat	Bone and Connective Tissue
Choice	49.2	37.1	14.0	49.6	36.3	14.2
Steers	50.0	35.5	14.4	50.0	35.6	14.6
Heifers	47.6	40.2	13.3	48.8	37.7	13.6
Good	57.7	27.8	15.9	55.2	27.3	17.3
Steers	58.3	26.8	16.2	55.8	26.5	17.4
Heifers	56.6	29.8	15.2	53.8	28.9	17.1
Standard	60.1	22.9	17.2	58.2	23.2	18.5
Steers	61.1	21.6	17.3	58.8	21.8	19.1
Heifers	58.0	25.6	16.9	56.8	25.8	17.3
Commercial	53.6	31.5	15.5	52.3	30.3	17.4

TABLE VII

ANALYSIS OF VARIANCE FOR PHYSICAL AND CHEMICAL ANALYSIS

	Degrees of Freedom	Mean Square	Error
Chemical Analysis			
Moisture	3	205.08**	6.87
Fat	3	321.47**	11.00
Protein	3	15.02**	.90
Physical Analysis			
Separable Lean	3	123.50**	6.19
Separable Fat	3	273.86**	9.30
Bone and Connective Tissue	3	30.44**	1.44
6-7-8 Rib			
Separable Lean	3	137.92**	9.29
Separable Fat	3	279.28**	13.20
Bone and Connective Tissue	3	32.13**	5.21
9-10-11 Rib			
Separable Lean	3	146.82**	11.24
Separable Fat	3	308.16**	25.28
Bone and Connective Tissue	3	47.38*	11.92
Short Loin			
Separable Lean	3	144.13**	9.90
Separable Fat	3	281.83**	15.26
12th Rib			
Separable Lean	3	173.00**	21.12
Separable Fat	3	276.65**	32.54

* Denotes significance of 5 percent level.

** Denotes significance of 1 percent level.

Chemical Analysis Among Grades

The results of chemical analysis are shown in Table VI. It was shown that for the top three grades studied that moisture content increased as the grade decreased, 49.2, 57.7, and 60.1 percent, respectively. The cow carcasses had a moisture percentage of 53.6. In a comparison of the top three carcass grades, the percentage moisture increased as the percentage of fat decreased. The percent of protein was highest in those grades with the least fat. The Choice carcasses had the lowest percentage of protein, 14 percent, and the Standard carcasses had the highest, 17.2 percent protein. Table VII shows that all differences between grades were significant at the one percent level for moisture, fat, and protein content. In Appendix Table I, chemical fat was found to have a highly positive significant correlation with total separable fat. Also, moisture and protein were found to have a highly significant positive correlation with total separable lean.

Chemical Analysis Among Grades With Regard to Sex

In Table VI meat from steer and heifer carcasses of the same grades were compared by chemical analysis. Heifer carcasses had less moisture than steer carcasses: 2.4 percent less in the Choice carcasses, 1.7 percent less in the Good carcasses, and 3.1 percent less in the Standard carcasses. Heifer carcasses had a higher percentage of fat in all grades than steer carcasses. The Choice carcasses were 4.7 percent fatter, the Good carcasses were 3.0 percent fatter, and the Standard carcasses were 4.0 percent fatter. The lower percent of protein of heifer carcasses

compared to steer carcasses is due to a higher percent of fat. In Table V, a significant sex difference between heifer and steer carcasses in the percentages of moisture approaches the one percent level. Steer and heifer carcass differences in both fat and protein content were highly significant.

Physicial Analysis of Wholesale Cuts

Data in Table VIII shows the percent of separable lean, fat, and bone in all the wholesale cuts. All cuts follow the same general pattern with respect to these factors as previously shown for the entire carcass. Lean and fat are inversely related throughout.

Various Cuts Used as Indexes of Carcass Composition

Sections of the rib have been used as an index to estimate the percentage of lean, fat, and bone in the entire carcass. Comparisons of the actual percentage of separable fat in the carcass with certain portions of the rib and the whole short loin are shown in Table IX. It was found that the short loin was the most accurate of the cuts investigated for estimating the actual percentage of fat for the whole carcass. Both the 9-10-11 rib section and the 6-7-8 rib section can be used, although the former tends to yield a higher fat value and the latter a lower fat value than the actual separable fat value. The 12th rib was found to be the poorest indicator of the four cuts for estimating the total fat percentage. All these cuts had highly significant positive correlations with separable fat among grades (Appendix Table I). All four cuts also

TABLE VIII

MEAN PERCENTAGES OF SEPARABLE LEAN, FAT, AND BONE,
FROM THE WHOLESALE CUTS OF THE CARCASS WITH REGARD TO GRADE AND SEX

U.S.D.A. Grade	Shankless Round Lean-Fat-Bone			Hind Shank Lean-Fat-Bone			Short Loin Lean-Fat-Bone			Loin End Lean-Fat-Bone			Flank Lean-Fat-Bone			Kidney Knob Lean-Fat-Bone		
Choice	63.6	24.2	12.2	45.0	18.2	36.7	52.1	36.4	11.9	56.8	31.6	11.7	30.0	68.1	1.9	6.3	85.1	8.4
Steers	63.0	24.7	12.4	44.8	18.6	36.4	52.3	36.3	12.0	57.0	31.3	11.6	30.8	67.4	1.9	6.5	83.9	9.2
Heifers	64.9	23.3	11.8	45.4	17.5	37.1	51.7	36.7	11.6	56.3	32.1	11.8	28.4	69.5	2.0	5.9	87.4	6.7
Good	65.9	19.8	14.1	47.2	13.2	39.2	57.5	28.6	13.7	61.7	23.4	14.7	36.7	56.9	6.5	8.2	81.7	10.1
Steers	66.1	20.1	13.7	46.3	13.3	40.1	58.3	28.2	13.4	62.2	23.1	14.7	37.5	56.6	5.8	9.2	80.1	10.7
Heifers	65.6	19.4	14.9	49.0	13.1	37.3	55.8	29.3	14.5	60.1	24.2	14.8	35.0	57.4	8.0	6.1	85.0	8.9
Standard	68.3	16.8	14.6	49.1	11.9	38.5	59.9	23.2	16.5	63.5	20.4	66.0	41.9	52.7	5.5	10.4	76.2	13.1
Steers	68.6	16.5	14.8	49.1	11.0	39.5	60.8	21.8	17.0	64.2	19.6	16.0	43.3	49.4	7.3	12.4	73.0	13.9
Heifers	67.7	17.5	14.1	49.1	13.6	36.5	58.2	25.8	15.4	62.0	21.9	15.9	39.2	59.1	6.0	6.3	72.5	11.5
Commercial	64.5	21.0	14.6	48.3	14.2	37.3	51.9	31.9	10.5	58.1	26.3	15.5	34.9	60.6	4.6	4.6	84.4	11.0

TABLE VIII (CONTINUED)

MEAN PERCENTAGES OF SEPARABLE LEAN, FAT, AND BONE,
FROM THE WHOLESALE CUTS OF THE CARCASS WITH REGARD TO GRADE AND SEX

U.S.D.A. Grade	Chuck			Rib			Plate			Shank			Brisket		
	Lean	Fat	Bone	Lean	Fat	Bone	Lean	Fat	Bone	Lean	Fat	Bone	Lean	Fat	Bone
Choice	56.7	28.5	14.8	46.5	37.2	16.7	40.1	48.2	11.8	43.4	14.5	41.1	38.4	50.8	10.5
Steers	56.6	28.1	15.4	47.2	35.9	17.3	41.3	47.0	12.1	44.2	13.3	41.0	37.6	52.1	10.1
Heifers	56.7	29.4	13.8	44.9	39.8	15.6	37.8	50.7	11.1	41.7	17.1	41.2	40.0	48.4	11.3
Good	62.4	20.3	17.0	51.7	28.2	19.3	48.6	36.6	14.6	43.6	9.9	45.9	44.5	41.4	14.1
Steers	62.7	19.7	17.1	52.1	27.6	19.4	49.0	36.4	14.3	41.8	10.8	48.7	44.7	41.5	13.7
Heifers	61.7	21.3	16.9	50.9	29.3	19.2	47.8	36.9	15.3	47.2	8.2	43.7	43.9	41.1	15.0
Standard	64.1	17.7	17.9	54.3	24.0	21.7	51.2	31.5	17.3	44.6	8.1	46.9	47.7	37.8	15.2
Steers	64.6	16.9	18.2	54.9	22.6	22.6	51.4	30.1	18.6	43.4	7.2	48.7	49.4	36.0	15.6
Heifers	63.1	19.5	17.4	53.1	26.8	19.9	51.0	34.3	14.7	46.9	10.0	43.1	44.3	41.2	14.5
Commercial	60.2	22.2	17.4	46.5	32.9	19.3	42.8	42.0	15.2	44.2	8.8	48.0	40.3	44.1	15.7

TABLE IX

A COMPARISON OF THE MEAN PERCENTAGE SEPARABLE FAT OF THE CARCASS WITH THAT OF THE MEAN PERCENTAGE OF SEPARABLE FAT OF SELECTED CUTS OF THE CARCASS

U.S.D.A. Grade	Fat in Carcass	Fat in 9-10-11 Rib	Fat in 6-7-8 Rib	Fat in 12th Rib	Fat in Short Loin
Choice	36.3	39.4	33.7	42.8	36.4
Steers	35.6	37.4	32.7	42.5	36.3
Heifers	37.7	43.3	35.6	43.3	36.7
Good	27.3	30.9	23.9	36.3	28.6
Steers	26.5	29.7	23.7	36.0	28.2
Heifers	28.9	33.2	24.3	36.9	29.3
Standard	23.2	29.9	21.1	29.9	23.2
Steers	21.8	24.0	20.4	27.1	21.8
Heifers	25.8	29.6	22.7	35.6	25.8
Commercial	30.3	35.6	29.1	40.6	31.9

TABLE X

A COMPARISION OF THE MEAN PERCENTAGE OF SEPARABLE LEAN OF THE CARCASS WITH THAT OF THE MEAN PERCENTAGE OF SEPARABLE LEAN OF SELECTED CUTS OF THE CARCASS

U.S.D.A. Grade	Lean of Carcass	Lean of 9-10-11 Rib	Lean of 6-7-8 Rib	Lean of 12th Rib	Lean of Short Loin
Choice	49.6	44.6	48.8	42.3	52.1
Steers	50.0	45.1	49.6	42.6	52.3
Heifers	48.8	43.7	47.1	41.7	51.7
Good	55.2	49.8	55.5	46.7	57.5
Steers	55.8	50.5	56.4	46.4	58.3
Heifers	53.8	48.3	53.8	47.3	55.8
Standard	58.2	51.6	57.1	50.0	59.9
Steers	58.8	51.7	57.8	52.2	60.8
Heifers	56.8	51.5	55.9	45.7	58.2
Commercial	52.3	43.2	50.9	40.3	51.9

had a highly significant positive correlation within grades (Appendix Table II). In analyzing carcass grade differences statistically, the separable fat values among grades for all four cuts were significant at the one percent level (Table VII).

Comparisons of the actual separable lean percentage of the carcass with the three sections of the rib and short loin are shown in Table X. The separable lean percentage of the 6-7-8 rib was found to be the best single indicator of total lean in the entire carcass. The short loin is also a good indicator. One might expect, however, from this cut, percentages of total lean to be slightly in excess of the actual value. Lean in the 9-10-11 rib section was lower than actual separable lean figures for the entire carcass. The 12th rib section as a measure of lean value was least accurate. All lean percentages of these cuts have a highly significant positive correlation with total separable lean (Appendix Table I). The short loin and the 6-7-8 rib section have higher correlation values of separable lean than the other two cuts. The correlation within grade shows the percentages of all four lean values to have a highly significant positive correlation with total separable lean (Appendix Table II). In analysis of variance, the lean values for all four cuts were found to be significant at the one percent level.

Actual bone and connective tissue composition with that of other portions of the carcass are compared in Table XI. The chuck provided the most accurate index of total bone and connective tissue of any other cut in the carcass. All rib sections may be used in estimating bone and connective tissue percentages but the values tended to be higher than actual values for the entire carcass. Bone and connective tissue in the

TABLE XI

A COMPARISON OF THE MEAN PERCENTAGE OF BONE AND CONNECTIVE TISSUE OF THE CARCASS WITH THE MEAN BONE AND CONNECTIVE TISSUE PERCENTAGE OF SELECTED CUTS OF THE CARCASS

U.S.D.A. Grade	Bone and Connective Tissue of Carcass	Bone and Connective Tissue of Chuck	Bone and Connective Tissue of 6-7-8 Rib	Bone and Connective Tissue of 9-10-11 Rib	Bone and Connective Tissue of 12th Rib	Percent of Hind Shank Composed of Tibia-Fibula
Choice	14.2	14.8	17.3	16.4	16.2	20.3
Steers	14.6	15.4	17.4	17.5	16.0	19.8
Heifers	13.6	13.8	16.9	14.2	16.6	21.4
Good	17.3	17.0	20.5	18.7	17.4	21.3
Steers	17.4	17.1	20.2	19.2	17.7	21.9
Heifers	17.1	16.9	21.1	17.7	16.8	20.2
Standard	18.5	17.9	21.7	22.0	21.2	21.8
Steers	19.1	18.2	22.0	23.7	20.7	21.7
Heifers	17.3	17.4	21.1	18.6	22.0	22.0
Commercial	17.4	17.4	20.0	19.6	17.9	21.3

tibia-fibula have also been correlated with bone and connective tissue values for the carcass. It was found in this study that the percentage tibia-fibula of the hind shank portion did increase as the percentage of bone increased. The tibia-fibula bone and connective tissue values, however, were higher than that in the actual carcass. A statistical analysis reveals that the bone and connective tissue values are highly significant in the 6-7-8 rib section. In the 9-10-11 rib section, bone percentages were found to be significant at the 5 percent level.

Taste Panel Results for Broiled Steaks

Cooking losses and shear values are shown in Table XII. For the broiling steaks, total cooking losses and evaporation losses tended to increase with a decrease in grade. Dripping losses were quite constant for all grades. The steaks from Good carcasses were most tender according to shear values, the steaks from Standard carcasses were third, and the Commercial grade the least tender.

For the broiling steaks, Table XIII shows the results from the taste panel study. Tenderness and flavor of fat were found to decrease with a decrease in grade. The juiciness and flavor of lean scores decreased with grade for the top three grades studied, but in each case the Commercial grade was rated higher than the Standard grade. Differences between carcass grades in flavor of lean, juiciness, and flavor of fat were found to be statistically significant at the one percent level (Table XIV). The differences in tenderness and shear values were significant at the five percent level. Flavor of lean of the broiling steaks was found to have a highly significant positive correlation when related to

total separable fat (Appendix Table I). Juiciness and tenderness were positively correlated to separable fat among grades but were not significant. The flavor of lean was found to have a negatively significant correlation among grades to total separable lean. It is evident that fat does add flavor to lean meat. Juiciness and tenderness of broiled steaks were also negatively correlated to total separable lean, but these values were not significant. The shear values were positively correlated to separable lean and negatively correlated with separable fat for all grades, however, neither figure was significant.

Taste Panel Results for Braising Steaks

For braising steaks, total cooking losses increased with a decrease in grade (Table XII). The percentage drippings increased as the grade lowered but evaporation losses remained quite even. The shear values of steaks from Choice, Good, and Standard carcasses were quite constant but the Commercial steak scores indicated that the cow meat cuts were decidedly less tender. For braising steaks, tenderness, flavor of lean, and flavor of fat decreased as the carcass grades decreased (Table XIII). Juiciness decreased as the top three carcass grades under consideration lowered but the Commercial steaks were more juicy than the Standard steaks. The differences in flavor of lean, tenderness, juiciness, flavor of fat, shear values, and total cooking losses were found to highly significant between grades (Table XIV). Dripping losses among grades of braising steaks were significant at the 5 percent level. This can be explained by the increased amount of fat in the higher grades thus more grease loss in cooking.

TABLE XII

A COMPARISON OF THE MEAN PERCENTAGE COOKING LOSSES AND SHEAR READINGS ON BROILING AND BRAISING STEAKS BETWEEN GRADES

U.S.D.A. Grade	Broiling Steaks				Braising Steaks			
	Total Cooking Losses	Evaporation Loss	Dripping Loss	Shear Reading*	Total Cooking Losses	Evaporation Loss	Dripping Loss	Shear Reading*
Choice	26.1	16.9	10.3	16.4	35.6	18.3	17.3	14.5
Good	26.1	16.3	9.7	15.4	38.0	18.7	19.3	14.4
Standard	28.4	18.8	11.7	17.8	39.4	18.3	21.2	14.5
Commercial	29.6	18.8	10.0	19.3	40.0	18.0	21.9	20.0

* Shear reading expressed in pounds of shear force required to sever a one inch cooked meat core.

TABLE XIII

A COMPARISON OF THE MEAN TASTE PANEL PALATABILITY SCORES FOR BROILING AND BRAISING STEAKS BETWEEN GRADES

U.S.D.A. Grade	Broiling Steaks				Braising Steaks			
	Tenderness	Juiciness	Flavor of Lean	Flavor of Fat	Tenderness	Juiciness	Flavor of Lean	Flavor of Fat
Choice	7.7	7.1	7.5	7.4	8.1	6.4	7.4	6.8
Good	7.4	7.1	7.1	6.4	7.8	5.8	7.1	6.5
Standard	7.1	6.4	6.6	6.0	7.4	5.3	6.6	6.0
Commercial	6.7	6.5	6.7	5.5	6.0	5.4	6.4	5.6

Score as follows:

1-Extremely Poor
2-Very Poor
3-Poor
4-Fair Minus
5-Fair
6-Fair Plus
7-Good
8-Very Good
9-Excellent

Results of Family Taste Tests

Palatability scores determined by family taste tests for different grades of broiling and braising steaks relative to their tenderness, juiciness, and flavor of lean are indicated in Table XV. The table also shows the number of times a particular grade of meat was preferred over another grade, from the paired-comparisons test. It is readily noticed the braised steak preference scores are lower than broiled steak scores, indicating a preference for loin steaks. Without exception, the trend by grades in tenderness and juiciness for both types of steaks and flavor of lean in the loin steaks is downward with a decrease in grade. The only exception in this linear trend is in the flavor of lean in the round steaks where the Standard grade group was rated slightly higher than the Good grade group.

Data in Table XVI show the percentage of individual family tasters who chose one grade of steak over another. When the Choice and Good grades of steaks were compared for broiled steaks both consumer groups, I and II, chose the Choice steaks more times than the Good steaks. In group III, however, the Good steaks were chosen more often than Choice ones. An inverse pattern exists between the Choice and Good comparisons for the braised steaks. In consumer groups, I and II, the Good steaks were chosen more often than Choice and in group III the Choice was preferred over the Good by quite a large margin. When all loin steaks were combined the Choice steaks were preferred 55 percent of the times tasted as compared to 45 percent for the Good steaks. The braised steaks were ranked with the Good grade over the Choice grade, 54 and 46 percent respectively.

TABLE XIV

ANALYSIS OF VARIANCE FOR BROILING AND BRAISING STEAKS WITH REGARD TO VARIOUS PALATABILITY FACTORS

Factors Considered	Degrees of Freedom	Mean Square	Error
Broiling Steaks			
Flavor of Lean	3	1.59**	.23
Tenderness	3	1.74*	.53
Juiciness	3	1.40**	.25
Flavor of Fat	3	5.47**	.64
Shear Reading	3	26.21*	8.44
Total Cooking Losses	3	28.24	9.94
Evaporation Loss	3	14.92	9.43
Drip Loss	3	6.81	10.15
Braising Steaks			
Flavor of Lean	3	1.72**	.15
Tenderness	3	7.73**	.46
Juiciness	3	2.23**	.32
Flavor of Fat	3	2.55**	.56
Shear Reading	3	84.49**	13.10
Total Cooking Losses	3	34.74**	3.07
Evaporation Loss	3	.55	11.91
Drip Loss	3	39.10*	12.74

* Denotes significance at 5 percent level.

** Denotes significance at 1 percent level.

TABLE XV

SUMMARY OF PREFERENCE, AND RATINGS FROM PAIRED COMPARISONS BETWEEN GRADES BY FORTY FAMILIES

U.S.D.A. Grade	Broiling Steaks				Braising Steaks			
	Total Times Preferred[a]	Average Rating Scores[a] Tenderness[bb]	Juiciness[bb]	Flavor	Total Times Preferred[a]	Average Rating Scores[a] Tenderness[bb]	Juiciness[bb]	Flavor
Choice	258	7.11	6.84	6.92	243	6.07	5.54	6.05
Good	221	6.96	6.75	6.86	211	5.78	5.46	5.89
Standard	111	6.51	6.43	6.42	147	5.73	5.41	5.91
Commercial (Cow)	65	5.94	6.16	6.16	46	4.72	4.83	5.18
No Preference	13				21			

[a]Preference rating obtained only on 668 observations.
[b]Highest rating score = 9.

Score as follows:

1-Extremely Poor
2-Very Poor
3-Poor
4-Fair Minus
5-Fair
6-Fair Plus
7-Good
8-Very Good
9-Excellent

When the Choice steaks were compared with the Standard steaks, the Choice ones were chosen a higher percentage of times in all groups for both the broiled and the braised steaks. When the results of the paired taste comparisons were combined, the Choice loin steaks were preferred over the Standard loin steaks 87 percent of the time. The Choice round steaks followed the same pattern being preferred 79 percent of the time over the Standard grade round steaks.

Good grade steaks were preferred over the Standard and Commercial grade steaks by each consumer group and for each method of cookery. The Good loin steaks were preferred less often when compared with Commercial than with Standard loin steaks but an opposite relationship existed in the case of braised steaks.

Standard grade steaks were preferred decidedly more often than Commercial grade steaks by all consumer groups irrespective of the method of cookery. Commercial grade steaks were preferred by the consumer groups 20 to 30 percent of the time.

Within the limits of these data one may conclude that the higher grades of meat generally are preferred over the lower grades.

TABLE XVI

PERCENTAGE PREFERENCE COMPARISONS OF PAIRED GRADE SAMPLES
BY FORTY SELECTED FAMILIES

Group	Comparison of Choice with Good		Comparison of Choice with Standard		Comparison of Choice with Commercial	
Loin Steaks, Broiled						
I (Students)	58	42	92	8	90	10
II (Faculty)	62	38	82	18	75	25
III (Students)	45	55	87	13	71	29
All Three Groups, Loin Steaks	55	45	87	13	79	21
Round Steaks, Braised						
I (Students)	36	64	88	12	85	15
II (Faculty)	42	58	65	35	86	14
III (Students)	61	39	84	16	71	29
All Three Groups, Round Steaks	46	54	79	21	81	19

TABLE XVI (CONTINUED)

PERCENTAGE PREFERENCE COMPARISONS OF PAIRED GRADE SAMPLES
BY FORTY SELECTED FAMILIES

Group	Comparison of Good with Standard		Comparison of Good with Commercial		Comparison of Standard with Commercial	
Loin Steaks, Broiled						
I (Students)	82	18	——[a]		79	21
II (Faculty)	82	18	69	31	——[a]	
III (Students)	71	29	58	42	84	16
All Three Groups, Loin Steaks	79	21	63	36	81	18
Round Steaks, Braised						
I (Students)	68	32	——[a]		84	16
II (Faculty)	88	12	78	22	——[a]	
III (Students)	57	43	82	18	89	11
All Three Groups, Round Steaks	71	29	80	20	86	13

[a]Due to an error in alloting samples no data are available in Group I for the Good and Commercial comparison or in Group II for the Standard and Commercial comparison.

CHAPTER V

SUMMARY AND CONCLUSIONS

Thirty-six carcasses were selected representing Choice, Good, Standard, and Commercial (cow). The top three grades were composed of six steers and three heifers. The carcasses were measured in detail and the left side was physically separated into lean, fat, and bone. A mixture of the lean and fat from the entire left side was chemically analyzed. The right hind quarter was used for cooking and organoleptic tests with both a trained taste panel and forty families composed of students and staff members in The College of Agriculture.

In analyzing the data presented in this thesis the following observations can be made.

Carcasses grading highest tended to be shorter and more compact than the lower grades. Carcass measurements observed showing a significance between grades were, carcass length, length of leg, circumference of round, width of round, depth of flank, length of loin, depth of chest both at the 5th and 7th rib, loin eye area, and fat thickness over the 12th rib.

As the grade decreased among the top three beef carcass grades considered, the percentage of chuck and round was significantly increased. Also the plate, brisket, kidney knob, and flank decreased as these same three grades decreased. The heifers had a significantly lower percentage of chuck and a significantly higher percentage of flank and kidney knob than the steers.

The percentage of lean increased and the percentage of fat decreased with a decrease in grades for Choice, Good, and Standard carcasses. The

Commercial grade was quite similar to Good in fat and lean proportions. Bone and connective tissue percentage increased as the grade decreased except in the Commercial cow. Heifers were shown to be significantly fatter than steers in the same grade.

Moisture percentage increased as the cattle became leaner. Chemical fat determinations followed the same trend as physical fat values. Heifers had significantly less moisture content than steers and significantly more fat.

The short loin was found to be the best cut for a direct estimate of the fat percentage in the carcass. The 6-7-8 rib section was the best indicator of separable lean. The 9-10-11 rib and 12th rib sections were also valuable for estimating total separable fat and lean. The percentage of bone and connective tissue in the chuck was found to be the closest to the actual percentage in the side.

In taste panel analysis, tenderness and flavor of fat decreased with a decrease of grade in the broiled steaks. In braised steaks tenderness, flavor of lean, and flavor of fat decreased as the grade decreased. Total cooking losses increased with a decrease in grade on both broiling and braising steaks. When these organoleptic tests were analyzed statistically between the four grades, flavor of lean, tenderness, juiciness, flavor of fat and shear reading were significant for the broiling steaks. For the braising steaks flavor of lean, tenderness, juiciness, flavor of fat, shear reading, total cooking loss, and drip loss all were significantly different.

Data obtained from family tasting show a preference for the higher grades of meat. Palatability scores decreased with a decrease in grade.

Percentage-wise, when Choice was compared to Standard and Commercial it was rated above these grades by wide margins. When Choice was compared to Good, Choice was preferred more times as broiled steaks, but Good was preffered more times as braised steaks.

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APPENDIX

APPENDIX TABLE I

SIMPLE CORRELATIONS OF TOTAL SEPARABLE FAT
AND TOTAL SEPARABLE LEAN WITH VARIOUS CARCASS MEASUREMENTS,
CARCASS CUTS AND COOKED BROILED STEAK FACTORS

	Correlations
Total Separable Fat	
6-7-8 Rib Separable Fat	.962**
9-10-11 Rib Separable Fat	.876**
12th Rib Separable Fat	.807**
Short Loin Separable Fat	.922**
Chemical Fat	.956**
Fat Thickness Over 12th Rib	.623**
Tenderness of Broiling Steaks	.214
Juiciness of Broiling Steaks	.249
Flavor of Lean of Broiling Steaks	.445**
Shear Strength of Broiling Steaks	-.103
Total Separable Lean	
6-7-8 Rib Separable Lean	.907**
9-10-11 Rib Separable Lean	.796**
12th Rib Separable Lean	.702**
Short Loin Separable Lean	.918**
Moisture	.870**
Protein	.889**
Loin Eye Area	-.029
Tenderness of Broiling Steaks	-.158
Juiciness of Broiling Steaks	-.206
Flavor of Lean of Broiling Steaks	-.329*
Shear Strength of Broiling Steaks	.033

* Denotes significance at 5 percent level.

** Denotes significance at 1 percent level.

APPENDIX TABLE II

WITHIN GRADE CORRELATIONS OF TOTAL SEPARABLE FAT AND TOTAL SEPARABLE LEAN WITH VARIOUS CARCASS MEASUREMENTS, CARCASS CUTS AND SELECTED CHEMICAL ANALYSIS FACTORS

	Correlations*
Separable Fat	
6-7-8 Rib Separable Fat	.827
9-10-11 Rib Separable Fat	.749
12th Rib Separable Fat	.704
Short Loin Separable Fat	.791
Fat Thickness Over Rib Eye	.448
Chemical Fat Analysis	.844
Separable Lean	
6-7-8 Rib Separable Lean	.796
9-10-11 Rib Separable Lean	.667
12th Rib Separable Lean	.529
Short Loin Separable Lean	.869
Moisture	.618
Protein	.741

* All correlations were significant at the 1 percent level.