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To the Graduate Council:

I am submitting herewith a thesis written by Louis A. Odom entitled "Type and Breed as Factors Effecting Taste Panel and Consumer Preference of Beef." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Dean of the Graduate School

TYPE AND BREED AS FACTORS EFFECTING TASTE PANEL AND CONSUMER PREFERENCE OF BEEF

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

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by

Louis A. Odom

August 1959

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Louis A. Odom

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CHAPTER I

INTRODUCTION

Consumer and organoleptic tests have created much controversy as to the kind of meat that is preferred by American families. Consumer studies have been conducted comparing different federal grades of beef. In addition, similar studies have been made on beef desirability in relation to the amount and color of fat, visual preference of retail cuts, beef versus pork, poultry and cured meats, along with various other factors. Comprehensive studies on what consumers desire in beef and particularly studies on the relation of type and breed to consumer and taste panel preferences have not been conducted. In addition, tests where certain retail cuts were distributed and cooked in the home could furnish valuable information.

Since consumer preference and taste panel studies have been conducted, for the most part, on such a small scale, the information is limited and the results are varied. The differences of opinion that have been reported are such that care should be exercised in making market predictions or establishing production programs.

Indications are that valuable information could be obtained from studies comparing the carcass qualities of animals differing in type. The objectives here would be to form baselines for developing improved evaluation techniques for carcasses of beef animals. In addition, such information could be utilized in a beef breeding program.

Conformation, finish and marbling, as well as other factors of quality, are all important in determining federal grades. The higher grading carcasses are required to possess conformation that is described as blocky, compact and very thickly fleshed throughout. Marbling and finish are not so effectively described. However, the higher grading carcasses must contain large amounts of marbling and usually are highly finished.

Information relating these and other physical and chemical data to organoleptic tests is needed.

The primary objectives of this study were:

1. To determine if type and breed are factors that influence taste panel and consumer preference of beef.
2. To compare consumer preferences to technical taste panel scores of meat from the same animals.
3. To determine whether consumer preference and taste panel scores are influenced by carcass grade, marbling, tenderness, amount of chemical fat, shear and specific gravity.

CHAPTER II

REVIEW OF LITERATURE

Consumer preference studies have presented varied and in some cases contradicting results. Most studies have been somewhat limited due to the small scale on which they were conducted. In addition, these studies were not continued long enough to show whether the homemakers would continue to prefer the initial selection or choice. Also, in some cases conclusions were based on visual preference tests where pictures of meat were shown. Consumer preference studies usually form a basis for supplying the items desired by families. Meat packers, large chain stores and meat promotional organizations have looked into this problem for a long time. Some of these studies indicate that consumers do not prefer the higher grades of beef. This is probably due to the increased amount of fat usually associated with the higher grades. However, the experiences that these particular consumers have had with this higher grading, wasty type beef have probably been with retailers who have not sufficiently trimmed the excess fat as practical, competitive conditions require. Even though most studies were conducted on a small scale, they were designed to give data that is important. Practically no consumer studies relating the effect of type and breed to eating qualities of beef have been conducted.

Branson (1957) found that beef compared with all other meats was preferred by 60 percent of the families in Houston. The study in

Houston was conducted to consider several preference phases. The effect of the following factors as related to consumer preference for beef were considered: federal grades, kind of meat, family income and meat preference, race and meat preference, education and retail cuts. The study showed that chicken was the major competitor of beef. Medium and low income families shifted their preference to chicken instead of veal. U. S. Good grade was preferred by most consumers even if U. S. Choice and Prime were offered for the same price per pound. This study indicated a trend for leaner meat.

It is interesting to note that Seltzer (1955) and Campbell (1956) found in the Phoenix area that preferences among consumers were similar to the Houston study. Stevens et al. (1956) found similar results in the Denver area.

Markedly similar findings have been made by Lasley et al. (1955), and Van Syckle and Brough (1955). Lasley et al. (1955) studied consumer preference in relation to finish. Their findings were the same as those in Houston, Phoenix and Denver in relation to amounts of fat, U. S. grades and ability of consumers to associate visual physical characteristics of beef in terms of eating satisfaction. However, there was no follow-up in the homes to determine the actual preference based on consumption tests.

Rhodes et al. (1956) related consumer preference and beef grades. They found that the eating characteristics of 120 tested loin steaks were not closely related to grade. However, there is a rather high acceptance of federal grading in the market and the differences in prices and actual consumer buying preference of various grades are evidence for the usefulness of the grading system.

Cole and Badenhop (1958) studied the preferences of consumers for broiled loin steaks and braised round steaks. The steaks were from thirty-six beef carcasses of the U. S. Choice, Good, Standard and Commercial grades. Preferences were determined by a group of forty families and by a trained taste panel. All possible combinations of the grades were given to the two taste groups. It was found that the consumers definitely preferred the higher grades in all cases except when Choice and Good were compared. The average differences between Choice and Good were small and inconclusive. Also, there was an overlapping in the preference for the different grades. In addition to the preferences, certain eating qualities were associated with grade. These qualities--tenderness, juiciness and flavor--were scored both by the test families and the taste panel. It was found that all three factors were related to preference. When these factors were taken together, they accounted for 50 percent of the total variation in the preference. Family test groups ranked tenderness as being more important than flavor or juiciness.

Malphrus (1957) studied the effect of beef fat color on flavor of steak and roast. The "yellow fat" problem in all levels in the marketing channel has been a prominent one for some time. Buyers have discriminated against carcasses with yellow color. Many people associate yellow color with "cow beef". Certain dairy breeds have more yellow fat covering and usually are discriminated against. It is interesting to note that in this study significant differences were detected in beef steak and roast with yellow fat as compared with white fat. Preferences leaned toward steak and roast with white fat.

Fenton et al. (1956) obtained information about dairy cow beef of Utility grade compared to beef from higher grading animals. The breeds studied were Holstein and Hereford. The particular phases of study between these two breeds were with frozen and unfrozen beef. They found that in most cases the roasts from the Hereford steers were more tender than the Holstein cow beef.

Cover et al. (1956) studied the relationship of fatness in yearling steers to juiciness and tenderness of broiled and braised steaks. They found that juiciness was more closely correlated with fatness in broiled loin than in braised loin or in broiled or braised bottom round. Fatness seemed more closely correlated with tenderness in bottom round than in loin.

Hibbs et al. (1959) studied the possibilities of producing profitable dairy beef. They found that under certain economic conditions dairymen who have the necessary barn space, feed and labor may find it profitable to raise their male calves either for feeders or to be fed out to slaughter weight. They also found that taste panel results showed that the meat from Holstein, Brown Swiss and Jersey steers was acceptably tender. Based on tenderness scores that ranged from 1 to 10 with 1 the lowest and 10 the highest, Holsteins had an average score of 7, Brown Swiss 6.2 and Jerseys 6.5.

Cartwright et al. (1957) studied the heritability of meat tenderness in yearling steers. They tested tenderness of meat from forty-nine steers by use of a taste panel. The breeds represented in the test were Hereford, Brahman and Hereford-Brahman crosses. Earlier results indicated high but variable heritability estimates for shear and tenderness scores based on

small numbers. Work continues to indicate that the heritability of certain eating quality characteristics may be of a magnitude to allow effective selection. Progeny of some Brahman sires equaled or excelled in tenderness those of Hereford sires, but this was not true in all cases.

Harrison et al. (1959) presented a resume of literature related to factors effecting the tenderness of certain beef muscles. They showed that no one factor determines tenderness in meat. Breed, age, sex, grade and muscle fiber diameter may effect tenderness. In addition, tenderness is affected by post-mortem changes in muscle structure and composition, as well as by the location of the muscle in the animal. The manner in which the carcass is handled, such as boning, freezing and the conditions and time of aging also contribute to beef tenderness.

Brady (1957) found that most consumers are adverse to fat and that tenderness is an important factor for complete eating satisfaction. Most consumers had very little knowledge about quality factors of beef. U. S. Good was found very acceptable.

Armsby (1908, 1917), Bull (1916), Barbella et al. (1939) and Helser (1929) believed that fattening of an animal increased the tenderness and juiciness of meat. Black et al. (1931) and Hawkins and Ellis (1939) thought that the degree of finish had little to do with tenderness.

Rhodes et al. (1954) found that although preference was based upon tenderness, juiciness, flavor, color of lean, bone, the amount of external and internal fat and texture, there was a trend to choose the higher grades of meat. People in higher income brackets preferred the top grades. Males showed higher preference for the higher grades than did the females. Also,

as the education level increased, the number of persons choosing the top three grades increased.

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.

In an article that appeared in the magazine, American Cattle Producer, the inconsistencies of the current and past consumer preference studies were mentioned. Strong skepticism was mentioned concerning the fact that these studies indicated that consumers prefer leaner, cheaper grades; i.e., Commercial or Good over Choice. Probably the most important facts established by these studies were that leaner beef is preferred and that consumers do not like to buy excess fat.

The article further mentioned that the most important fact of all to indicate consumer desires was the data on all cattle receipts over the years. Choice steers at Chicago increased from 38 percent of all beef steers thirty years ago to 55 to 60 percent now. The percent below Choice has been cut in half. Further proof of this is borne out by Pierce (1959) who maintained that approximately 50 percent of all beef sold as block beef is U. S. Choice or equivalent.

CHAPTER III

PROCEDURE

Thirty-six bull calves were obtained within two to four months after birth. The following breeds were represented in both years of this study: (1) Dairy animals representing a small dairy breed,[1] (2) Holsteins representing a large dairy breed, (3) Angus and Herefords representing two of the British beef breeds, (4) Purebred Brahman cattle and (5) Brahman-British crossbreds.

All the animals, after the start of the test, were raised under the same feeding and management practices. During the first year's study all animals were individually fed to the limit of appetite. However, during the second year's study the animals were group fed during the earlier period of their feeding regime. The reason for identical management and production practices was to assure that any differences observed after slaughter were those attributed to type, breed and conformation and not environment.

All animals received the same pre-slaughter treatment. Off-feed weights were obtained twenty-four hours prior to slaughter and weights were made at slaughter time giving each animal an equal twenty-four hour shrinkage.

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[1] During the first year of the study representatives of both small dairy breeds were used. However, no Guernseys were used during the second year's work. Hereafter in this study, where reference is made to Jerseys, both small dairy breeds will be included.

The animals were taken off feed for slaughter at approximately 900 pounds or by twenty months of age. University meat laboratory facilities were used for slaughter and the methods used were those outlined in Report of Proceedings, Fourth Annual Reciprocal Meat Conference (1951).

The left side of the carcass was broken into wholesale cuts in a manner outlined in Proceedings Sixth Annual Reciprocal Meat Conference (1953). Physical separation of lean fat and bone was made on each wholesale cut from the left side. A minimum twenty-four hour chill was obtained prior to the breakdown and physical separation. The right side of each carcass was aged for a period of two weeks in coolers at the temperature of 34° F. ± 2°. After the two weeks aging period, steaks and roasts were cut from this side, packaged and frozen for distribution to the test families and use by the taste panel.

Twenty-four broiling steaks were cut from longissimus dorsi muscle of each steer. All the loin steaks were designated "A", "B", or "C", according to the section of the muscle from which they came. The following cutting procedure was used: Beginning at the tenth rib and working posteriorly, eight steaks were cut eighteen millimeters thick. These were designated "A" steaks. Just posterior to this section another eight steaks were cut similarly and designated "B" steaks. The last eight steaks, designated "C" steaks, were cut from the muscle so as to end approximately between the last two lumbar vertebrae. The first seven steaks of each section were packaged separately for distribution to the test families. The eighth steak of sections "A", "B" and "C" of each animal were packaged together for use by the taste panel. In addition,

sixth and seventh ribs and eighth and ninth ribs were cut for rib roasts and packaged for tests by the taste panel.

There were eight one-half inch full round steaks cut from each steer. All these steaks were designated "X", "Y" and "Z" according to the section of the round steak from which they were taken. The fourth full round steak was packaged whole and frozen for test by the taste panel. Each of the remaining seven steaks was cut into three sections. The tip, or knuckle, was designated "X", the top round was designated "Y", and the bottom round was designated "Z". Each steak was packaged and frozen for distribution to the test families.

To determine consumer preferences for meat produced by various types of steers, a selected group of approximately thirty families was utilized to cook, taste and score the meat in their homes. One half of the families received broiling steaks and one half received braising steaks. The thirty families were selected from experiment station staff members and married students. It was thought that a maximum degree of cooperation could be obtained from such a group.

Each round and loin steak family received from two to eight steaks each week depending upon the pairing and grouping calculated for each week of the test. Two steaks representing two breeds were compared and a selection was made as to a preference. A third steak was rated for tenderness, juiciness and flavor.

Preference cards were issued for each pair of steaks, (Appendix Figure 4), and a separate score card was issued for each steak to be rated. The scoring for the rated steaks was based on a range of scores

from one through nine, with one the lowest value and nine the highest value. Scores were obtained for each palatability factor--tenderness, juiciness and flavor (Appendix Figure 5).

In order to facilitate cooking and enable the families to distinguish between steaks during and after cooking, the following procedure was used: Each of the paired steaks for preference was clamped with either one or two rings. Preference cards called for a choice to be made either for a steak with one ring or a steak with two rings. The only distinguishing feature of the steak to the family was whether it had one or two rings. The additional steak that was to be scored for tenderness, juiciness and flavor received no rings.

In the event that more than three steaks were issued to a family at one time, the following procedure was used: Each pair of steaks to be compared and the steak to be scored were placed in a paper bag with each steak being identified. The bag was marked with a cooking number. The families were instructed to cook their steaks in groups keeping the steaks identified according to the cooking number.

In order to standardize the cooking methods, families were instructed to use no seasoning until after scorings and preferences were made. Each family member was asked to sample the same area of the steak being tasted.

After the first year's results it was found that the moist heat cookery used for the round steaks tended to eliminate most of the tenderness differences between and within breeds. Since tenderness influenced, to such a great extent, preferences, all round steak data has been eliminated from this study.

The animal grouping and pairing was calculated so to allow each animal to be compared with another five times and independently scored for tenderness, juiciness and flavor two times by each family member. Thirty animals were used during the first year of the test and thirty-one the second year. Some substitutions were made, where feasible, to make the proper breed comparisons. It was also necessary to substitute animals within a breed in order to complete five comparisons and two ratings. The following are all possible combinations of the six breeds: (1) Angus x Hereford, (2) Angus x Brahman, (3) Angus x Brahman Cross, (4) Angus x Holstein, (5) Angus x Jersey, (6) Hereford x Brahman, (7) Hereford x Brahman Cross, (8) Hereford x Holstein, (9) Hereford x Jersey, (10)Brahman x Brahman Cross, (11) Brahman x Holstein, (12) Brahman x Jersey, (13) Brahman Cross x Holstein, (14) Brahman Cross x Jersey, and (15) Holstein x Jersey.

Cooking for the trained taste panel was conducted by the Food Research section of The College of Home Economics. The loin steaks were cooked to a medium well done stage by broiling to an internal temperature of 71-72° C. The round steaks were cooked by braising to an internal temperature of 208° F. and were then cooked forty-five additional minutes. The rib roasts were cooked in a Despatch oven to an internal temperature of 68° 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 groups of four, representing one sample from each animal being tested. Steaks were scored for tenderness, juiciness and flavor.

The same scoring system was used for the panel that was used by the test families. Panel preferences were obtained for the rib roasts. Dripping and evaporation losses were determined on steaks and rib roasts, and shear values were determined on the Warner-Bratzler Shear from cores taken from steaks and roasts.

CHAPTER IV

RESULTS AND DISCUSSION

Palatability[2]

Average tenderness scores indicated that the test families and the taste panel were in complete agreement on their ranking of the breeds (Table I). In contrast, there were quite marked differences in their ranking of the breeds for juiciness and flavor. Of these traits, flavor seemed to be more difficult to score. Individual tastes played an important role in scoring flavor, and since it is possible to have so many varied ideas of flavorful meat, it is understandable why this factor was more difficult to score. On the other hand, the measure of tenderness is more universally agreed upon, therefore is easier to distinguish.

When total palatability was considered, the ranking was nearly the same as the tenderness ranking. The Angus and Hereford breeds were switched between the second and third positions and the other breeds were rated the same for palatability as for the tenderness ranking. This would indicate that more importance is placed upon tenderness in determining palatability by both the families and the panel than any other palatability factor.

Jerseys ranked highest, on the average, by both the test families and taste panel as far as total palatability was concerned. There was a

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[2]The term palatability in this study refers to the sum of the scores for tenderness, juiciness and flavor. Palatability factor refers to tenderness, juiciness or flavor.

direct relationship, among all breeds, between tenderness scores, either subjective or from the Warner-Bratzler Shear, to percent preference. In all phases of palatability, Brahman steers ranked lowest. However, Brahman Cross steers were ranked somewhat higher and did rank as high as third in flavor by the taste panel. Appendix Table I shows the average scores for tenderness, juiciness, flavor and total palatability for each year of the test.

Percent Preference

Table II shows the percent preference for all the breeds by the test families and taste panel. It should be pointed out that the percent preference by the taste panel was based on choices of rib roast and that the test families based their preference on loin steaks from the same animals. After the first year's study it was found that the taste panel preferred the Angus first, Jerseys second, Holsteins third and Herefords fourth. On the other hand, the test families varied considerably from the taste panel in their preferences. They preferred Jerseys first, Herefords second, Angus third and Brahman Crosses fourth. There was approximately the same range established between the first and fourth preferred breeds by the panel and families. However, there was inconsistency between the ranking of both taste groups. After the second year's test, it was found that the test families and taste panel were in agreement for their preference of breeds. They both preferred Herefords first, Jerseys second, Angus third and Holsteins fourth. In addition, the range between the first four choices by the families and the first three choices of the

panel was very close. Except for the Jersey and Angus breeds, the families and panel were in agreement for their overall average ranking. Based upon the two year average, the margin of difference among the first three ranked breeds by the taste panel was small. However, there was a slightly greater range established by the families in their first three preferences. The Herefords, which the families and panel both preferred second, were eight percentage points below the first preferred breed by the families, and only five percentage points below the first preferred by the panel. The comparative closeness that both taste groups placed in their first three choices indicated that there were slight differences found in which to base their preference.

Panel Correlations

There was a highly significant relationship between panel tenderness and family tenderness both including and excluding the Jerseys. Table I showed that the taste panel and test families both ranked the breeds in the same order for tenderness and Table III shows that there is a close relationship between these two factors.

The correlation of panel tenderness to federal grade was not significant with the data from the Jersey steers included. However, when this data were not used, the relationship between these two factors was highly significant. This may be explained by the fact that even though the Jerseys in this study had such low federal grades, they were ranked relatively high in tenderness by the taste panel. This inverse relationship eliminated any significance at the 5 percent level. On the other

TABLE I

AVERAGE TENDERNESS, JUICINESS, FLAVOR, TOTAL PALATABILITY AND SHEAR VALUES FOR LOIN STEAKS BY TEST FAMILIES AND TASTE PANEL

	Angus		Hereford		Brahman		Brahman Cross		Holstein		Jersey	
	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel
Average Two Years												
Tenderness	6.70	7.79	6.71	7.93	5.77	6.24	6.40	6.96	6.63	7.19	7.44	8.43
Rank	3	3	2	2	6	6	5	5	4	4	1	1
Juiciness	6.51	7.25	6.45	7.88	5.67	7.14	6.14	7.23	6.20	7.18	6.63	7.62
Rank	2	3	3	1	6	6	5	4	4	5	1	2
Flavor	6.71	7.08	6.52	7.40	5.88	6.58	6.22	7.16	6.41	7.02	6.55	7.34
Rank	1	4	3	1	6	6	5	3	4	5	2	2
Total Palatability	19.92	22.12	19.68	23.21	17.32	19.96	18.76	21.35	19.24	21.39	20.61	23.38
Rank	2	3	3	2	6	6	5	5	4	4	1	1
Shear[a]	13.39		14.92		19.84		16.63		15.70		12.45	

[a] Shear scores were computed on the Warner-Bratzler Shear.

TABLE II

PERCENT PREFERENCE BY TEST FAMILIES FOR LOIN STEAKS[a]
AND TASTE PANEL FOR RIB ROAST
BY BREED AND YEAR

	Angus		Hereford		Brahman		Brahman Cross		Holstein		Jersey	
	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel
First Year												
Animal												
1	32	80	63	70	22	20	43	00	57	20	70	20
2	77	85	40	10	25	00	43	15	35	20	80	80
3	53	30	73	90	00	10	47	30	67	70	87	30
4	60	80	52	30	27	10	25	20	28	70	77	90
5	70	100	—		47	00	70	90	33	100	68	80
6	30	70										
Average	54	74	57	50	24	8	46	31	44	56	76	60
Rank	3	1	2	4	6	6	4	5	5	3	1	2

TABLE II (Continued)

PERCENT PREFERENCE BY TEST FAMILIES FOR LOIN STEAKS[a]
AND TASTE PANEL FOR RIB ROAST
BY BREED AND YEAR

	Angus		Hereford		Brahman		Brahman Cross		Holstein		Jersey	
	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel
Second Year												
Animal												
1	80	80	82	80	9	00	38	80	23	20	60	60
2	52	80	67	80	7	40	45	20	55	100	45	80
3	53	100	61	100	30	20	38	60	97	40	83	80
4	50	100	67	100	57	50	24	00	50	00		
5	47	20	47	50	8	00	30	00	46	20		
6	73	40	75	60								
Average	59	70	66	78	22	22	35	32	54	36	62	73
Rank	3	3	1	1	6	6	5	5	4	4	2	2

TABLE II (Continued)

PERCENT PREFERENCE BY TEST FAMILIES FOR LOIN STEAKS[a]
AND TASTE PANEL FOR RIB ROAST
BY BREED AND YEAR

	Angus		Hereford		Brahman		Brahman Cross		Holstein		Jersey	
	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel
Second Year (Continued)												
Two Year Average[b]	56	72	63	67	23	15	40	32	49	46	71	65
Rank	3	1	2	2	6	6	5	5	4	4	1	3

[a]The trained taste panel conducted preference tests on sixth-seventh and eighth-ninth rib roasts of the same animals that test families broiled loin steaks for preference.

[b]Two year average represents sum of preferences divided by total number of animals per breed.

TABLE III

SIMPLE CORRELATIONS OF PANEL TENDERNESS AND FAMILY PREFERENCE TO SELECTED PHYSICAL AND CHEMICAL FACTORS

	Jerseys Included	Jerseys Excluded
	(Computation based on two-year averages)	
Panel Tenderness Correlated With:		
Family Tenderness	.664**	.644**
Federal Grade	.201	.445**
Marbling	-.327**	-.421**
Shear	-.716**	-.682**
Family Preference Correlated With:		
Panel Tenderness	.692**	.686**
Family Tenderness	.743**	.693**
Panel Palatability	.730**	.718**
Federal Grade	.174	.434**
Marbling	-.272*	-.406**
Percent Chemical Fat	.119	.213
Shear	-.644**	-.607**
Specific Gravity	-.255*	-.330**

* Denotes significance at the 5 percent level

** Denotes significance at the 1 percent level

hand, with the Jerseys eliminated, the relationship between the same two factors was highly significant since the best eating steers were also the highest grading. An unusual contrast is shown in this study since the extremes in carcass grades were relatively close in tenderness scores.

Subjective marbling values were given to all the steers. The relation of marbling with panel tenderness was highly significant when including the Jerseys ($r = -.33$), and when they were excluded ($r = -.42$). The increase in significance when the Jerseys were excluded may be explained by the fact that the breeds receiving the scores indicating greater amounts of marbling were also the breeds that received the highest tenderness scores. In addition, the negative correlation may be explained by the fact that as tenderness increased marbling also increased. At the same time there was an inverse relationship between the values given for marbling and their rank. The greater the amount of marbling the smaller the evaluating number.

The Warner-Bratzler Shear is the Standard method, currently used, for objectively measuring meat tenderness. The correlation of panel tenderness with shear values was significant at the 1 percent level including and excluding the Jerseys. There was a negative correlation in both cases due to the fact that high shear scores indicate less tender meat. The high relationship between these two factors indicates that shear values were an accurate measure of panel tenderness. Shear values accounted for 47 to 51 percent of the variation in panel tenderness.

Family Correlations

As was mentioned previously, family preference may be influenced, to a great extent, by various physical and chemical factors. In addition, there are other factors that may influence consumer likes and dislikes.

Table III shows family preference correlated with several factors. When family preference was correlated with panel tenderness there was significance at the 1 percent level. This shows that the families preferred the same animals that the panel found to be the most tender. When the Jerseys were omitted, there was still significance at the 1 percent level, but the relationship was not as high as when they were included. Family preference scores were highly related to family tenderness scores both with and without the Jerseys. Based upon the correlation coefficient r= .743, over 50 percent of the variation in family preference was associated with tenderness.

There was a highly significant relationship between family preference and panel palatability. This was true both with and without the Jerseys. Since total palatability was so closely related to tenderness, the indication is for preference of tender meat.

Federal grading is a system of placing animals into uniform groups according to conformation, finish and quality. It is usually believed that the higher the grade the higher the eating quality. This, of course, is usually true in most cases. However, when family preference was correlated with federal grade there was no significance. This may be explained by the fact that the Jersey steers played such an important role in family preference. Since the Jersey steers graded so low and

were so highly preferred, there was no significant relationship. On the other hand, when the Jerseys were excluded the correlation became highly significant between these two factors. This was due, in part, to the fact that the breeds that were preferred second and third were also the highest grading breeds.

There was a significant relationship between family preference and marbling including the Jerseys (r= -.27). The significance was due to the fact that even though the Jersey steers were low grading they contained considerably more marbling than their grade would suggest. They tied for third in this category (Table IV). Therefore, as preference increased, the amount of marbling increased. When the Jersey steers were omitted, there was a highly significant relationship between these two factors (r= -.42). The Angus and Herefords that were highly preferred also contained the highest amounts of marbling.

Percent fat was calculated for each steer by ether extract determination. Simple correlation showed no significance at the 5 percent level between family preference and percent chemical fat.

Family preference correlated with shear values was significant at the 1 percent level both with and without the Jersey steers (r= -.64 and -.61 respectively). Thus, shear values accounted for 37 to 41 percent of the variation in family preference.

Specific gravity seems to be an accurate measure of marbling providing that all exterior fat is removed. A significantly negative correlation between family preference and specific gravity of the excised ninth-tenth rib-eye muscle existed including Jerseys. In addition, a

highly significant negative correlation existed without them. Although significant relationships were found, only 6 to 11 percent of the variation in family preference was associated with specific gravity. The increase in significance without the Jerseys was caused by the preference shifting to the Angus and Herefords. These two breeds had much greater amounts of marbling and therefore the specific gravity mean scores were lower. This inverse relationship of greater amounts of marbling and low specific gravity also accounted for the negative correlation that existed.

Mean Squares For Palatability Factors

Up to this point these data show that there were marked differences among breeds when apaltability and percent preference were considered. A computation of analysis of variance for tenderness, juiciness and flavor showed a highly significant difference among breeds for all three of these factors of eating quality (Table V). In addition, it was found that there were highly significant differences between the test families and the taste panel for all palatability factors even though the means appeared to be close. Of the three palatability factors, juiciness and flavor were the most difficult to accurately score, with flavor being the most difficult of all. The trained taste panel, as would be expected, was more discriminating in scoring these factors. There was found a year by method interaction that was significant at the 1 percent level for juiciness and flavor. This could have been due to the incorporation of new families the second year and to the other families scoring the various traits differently each year. This table also shows a highly significant

TABLE IV

BREED AVERAGE FOR GRADE,[a] MARBLING[b] AND PERCENT CHEMICAL FAT[c]

Breed	Grade	Marbling	Percent Chemical Fat
Angus	11.0	4.8	30.11
Hereford	10.8	5.9	26.56
Brahman	7.0	8.3	19.69
Brahman Cross	7.8	7.5	22.27
Holstein	6.8	8.7	20.11
Jersey	5.6	7.6	21.86

[a]Numerical values were given to federal grade where average Good had the value of 10 and the values increase or decrease by one number per one-third of a grade.

[b]Numerical values were given to subjective marbling where 1 was the highest value and 11 the lowest value.

[c]Percent chemical fat was determined by ether extract.

TABLE V

MEAN SQUARES FOR PALATABILITY FACTORS OF LOIN STEAKS
BY TEST FAMILIES AND TASTE PANEL
USING BREED AVERAGES

	Tenderness	Juiciness	Flavor
	(Computation based on two-year averages)		
Breed	2.016**	.478**	.398**
Method[a]	3.930**	5.970**	3.150**
Year	.370	.001	.040
Breed x Year	.146	.030	.036
Breed x Method	.048	.116	.052
Year x Method	.010	.740**	1.690**
Year x Breed x Method	.050	.532**	.064
Within Subclass (Error)	.130	.080	.061

[a]Method denotes taste panel and test families

* Denotes significance at the 5 percent level

** Denotes significance at the 1 percent level

year-breed-method interaction for juiciness.

Variation Within Breed

Thus far, data has been obtained on differences that occur between or among breeds. There are, however, other differences that are important. These are the differences that occur within each breed. Table VI shows the total variation that existed within breeds for tenderness, juiciness and flavor. The values given for each palatability factor are the total sum of squares for each breed by the test families and the taste panel. When the value is small, the range or variation is small.

The total variation in tenderness was greatest for the Brahmans, and to a lesser degree Brahman Crosses, as shown by the families and the panel. The least variation in tenderness appears in the Jersey breed. These data suggest that the greater the tenderness, the less variation there is within a breed.

The greatest variation in juiciness by the taste panel was within the Holstein breed. However, the test families found small juiciness differences in the animals tested within this breed. On the other hand, the test families found a large variation within the Brahman steers, whereas the taste panel found little differences. Thus, the conclusion made at this point, is that differences in juiciness existed within breeds and within methods of testing. However, these differences were inconsistent.

The test families found little differences in flavor within the Jersey and Angus breeds. However, more differences in flavor were found

TABLE VI

SUM OF SQUARES FOR PALATABILITY FACTORS[a]
SHOWING TOTAL VARIATION
WITHIN EACH BREED

	Tenderness		Juiciness		Flavor	
	Family	Panel	Family	Panel	Family	Panel
Two Year Average						
Angus	1.68	.84	1.16	.88	.74	1.38
Hereford	.76	1.19	.79	.36	1.31	.58
Brahman	6.68	9.23	2.62	.43	3.07	1.06
Brahman Cross	2.00	1.07	1.34	1.63	1.15	1.08
Holstein	1.12	1.18	.98	4.26	1.11	.26
Jersey	.69	.36	1.40	.42	.93	.16

[a]Palatability factor values were based on breed averages.

within the other breeds. On the other hand, the taste panel found the lease flavor differences within the Jerseys, Holsteins and Herefords and the greatest differences within the other three breeds. Therefore, there were also flavor differences within breeds, but they too were inconsistent.

The data presented thus far show that there were various differences between and among breeds as well as within breeds for the various organoleptic traits tested by both taste groups.

Visual Contrast of Carcasses

Visual carcass characteristics, such as conformation and finish are illustrated in Figures 1., 2. and 3. These animals were among those studied during the first year of the test. Table VII lists the data that was collected on each of these animals.

CRANESHOT CREST



Figure 1

Angus Carcass No. 31



Figure 2

Brahman Carcass No. 8



Figure 3

Jersey Carcass No. 6

TABLE VII

INDIVIDUAL DATA ON THE CARCASSES PICTURED
IN FIGURES 1., 2., AND 3.

Breed	Family Preference	Family Tenderness	Panel Tenderness	Grade	Marbling	Shear	Percent Chemical Fat	Specific Gravity
Angus 31	77	7.8	8.1	12	4	13.9	36.2	1.05801
Brahman 8	00	3.6	4.5	7	9	25.3	13.4	1.07132
Jersey 6	77	7.8	8.5	5	9	12.5	20.6	1.06412

CHAPTER V

SUMMARY AND CONCLUSIONS

Detailed physical, chemical and organoleptic data were obtained from sixty-one Angus, Hereford, Jersey, Guernsey, Holstein, Brahman and Brahman Cross steers over a period of two years.

These animals all received identical treatment from the time they were put on feed until they were slaughtered and processed for distribution to test families and to a trained taste panel.

Loin and round steaks were distributed to thirty families the first year of the study and thirty-two families the second year. Information was gathered on family preferences which included scores for tenderness, juiciness and flavor. Also, identical information was obtained from a trained taste panel. Carcass data, such as federal grade, marbling and specific gravity of the excised ninth-tenth rib-eye muscle were collected. In addition, percent chemical fat, shear values and percent cooking losses were determined.

In analyzing the data collected, the following observations were made.

The average taste panel scores for the three palatability factors ranked the breeds in the following order: Jerseys first in tenderness and second in juiciness and flavor; Herefords first in juiciness and flavor and second in tenderness; Angus third in tenderness and third and fourth respectively in juiciness and flavor. The other breeds--Holstein, Brahman Cross and Brahman--were ranked in the following manner:

Holsteins fourth in tenderness and fifth in juiciness and flavor; Brahman Crosses third, fourth and fifth respectively in flavor, juiciness and tenderness; Brahmans sixth for all three factors.

According to average scores by the test families for the three palatability factors, Jersey steers ranked first in tenderness and juiciness and second in flavor. Hereford steers ranked either second or third in tenderness, juiciness and flavor. Angus steers ranked first in flavor and either second or third in tenderness and juiciness. The other three breeds--Holstein, Brahman Cross and Brahman--ranked fourth, fifth and sixth respectively in all three palatability factors.

Both the taste panel and test families ranked the breeds similarly for total palatability except that the Angus and Herefords were switched in the second and third positions. The other breeds were ranked in the following order by both taste groups: Jerseys first and Holsteins, Brahman Crosses and Brahmans fourth, fifth and sixth respectively.

The results of each year of this study showed that the trained taste panel preferred the Angus or Herefords first and the Jerseys second. However, the test families preferred the Jerseys first and the Herefords second the first year, and then switched their preferences for these two the next year. An average of both years showed that the taste panel preferences placed Angus first, Herefords second and Jerseys third. On the other hand, the test families preferred Jerseys first, Herefords second and Angus third, based on two averages. Also, two year averages showed that both the families and the panel preferred Holsteins, Brahman Crosses and Brahmans fourth, fifth and sixth respectively.

Family preference was significantly related, and in some cases highly significantly related, to panel tenderness (r= .69), total palatability (r = .73), shear values (r =-.64), marbling (r = -.27) and specific gravity of the excised ninth-tenth rib-eye muscle (r = -.26). When these same comparisons were made with the data on the Jersey steers omitted, there was also a highly significant correlation with federal grade (r = .41).

The Jersey steers had the lowest average carcass grades, less percent chemical fat and a higher specific gravity. These traits would normally be associated with lower preference. However, in this study this group of steers were the most tender and were ranked high in preference. This would indicate that there are factors other than those mentioned that would affect meat tenderness and beef eating quality in general.

Analysis of variance for average tenderness, juiciness and flavor showed that there were highly significant differences among breeds for all of these factors. In addition, there were highly significant differences between the test families and the trained taste panel.

Based on the data presented, the following conclusions were made:

1. Type or breed may well influence preference and eating qualities of beef.
2. Tenderness plays an important, if not the most important role in overall eating satisfaction.
3. Variation existed among breeds as far as tenderness, juiciness and flavor are concerned.
4. In addition, variation existed between animals within a breed. However, when tenderness was considered, the variation was less prevalent within the three most tender breeds.

5. Consumer preference was influenced to a more or less degree by tenderness, grade and marbling, but not percent chemical fat.

CRANES CREST

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APPENDIX

APPENDIX TABLE I

AVERAGE TENDERNESS, JUICINESS, FLAVOR, TOTAL PALATABILITY AND SHEAR VALUES FOR LOIN STEAKS BY TEST FAMILIES AND TASTE PANEL

	Angus		Hereford		Brahman		Brahman Cross		Holstein		Jersey	
	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel
First Year												
Tenderness	6.98	8.10	6.48	7.98	5.96	6.32	6.96	7.38	6.46	7.30	7.52	8.22
Rank	2	2	4	3	6	6	3	4	5	5	1	1
Juiciness	6.51	6.88	6.38	7.93	5.74	7.12	6.36	7.10	6.26	6.78	6.62	7.40
Rank	2	5	3	1	6	3	4	4	5	6	1	2
Flavor	6.87	6.90	6.53	7.25	6.32	6.22	6.76	7.04	6.64	6.80	7.02	7.00
Rank	2	4	5	1	6	6	3	2	4	5	1	3
Total Palatability	20.36	21.88	19.39	23.16	18.02	19.66	20.08	21.52	19.36	20.88	21.16	22.62
Rank	2	3	4	1	6	6	3	4	5	5	1	2
Shear[a]	14.08		16.60		21.94		15.46		16.54		13.16	

APPENDIX TABLE I (Continued)

AVERAGE TENDERNESS, JUICINESS, FLAVOR, TOTAL PALATABILITY AND SHEAR VALUES FOR LOIN STEAKS BY TEST FAMILIES AND TASTE PANEL

	Angus		Hereford		Brahman		Brahman Cross		Holstein		Jersey	
	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel	Family	Panel
Second Year												
Tenderness	6.43	7.48	6.95	7.88	5.58	6.16	5.84	6.54	6.80	7.08	7.36	8.63
Rank	4	3	2	2	6	6	5	5	3	4	1	1
Juiciness	6.50	7.62	6.51	7.83	5.60	7.16	5.92	7.36	6.14	7.58	6.63	7.83
Rank	3	3	2	1	6	6	5	5	4	4	1	1
Flavor	6.54	7.25	6.50	7.55	5.44	6.94	5.68	7.28	6.18	7.24	6.07	7.67
Rank	1	4	2	2	6	6	5	3	3	5	4	1
Total Palatability	19.47	22.35	19.96	23.26	16.62	20.26	17.44	21.18	19.12	21.90	20.06	24.13
Rank	3	3	2	2	6	6	5	5	4	4	1	1
Shear[a]	12.70		13.23		17.74		17.80		14.86		11.73	

[a]Shear values were computed on the Warner-Bratzler Shear

APPENDIX TABLE II

SUM OF SQUARES FOR PALATABILITY FACTORS[a] SHOWING TOTAL VARIATION WITHIN EACH BREED

	Tenderness		Juiciness		Flavor	
	Family	Panel	Family	Panel	Family	Panel
First Year						
Angus	.69	.96	.57	1.30	.28	2.10
Hereford	.09	.79	.05	.27	.71	.51
Brahman	4.57	14.47	1.75	.83	1.81	.87
Brahman Cross	2.51	1.67	1.41	2.58	.53	1.91
Holstein	1.97	2.10	1.57	8.09	1.55	.26
Jersey	.35	.47	1.45	.70	1.35	.26
Second Year						
Angus	2.66	.72	1.74	.46	1.19	.65
Hereford	.73	1.58	1.53	.45	1.90	.65
Brahman	8.79	3.99	3.48	.03	4.33	1.25
Brahman Cross	1.49	.47	1.27	.67	1.77	.25
Holstein	.26	.25	.39	.23	.67	.25
Jersey	1.03	.25	1.35	.13	1.35	.26

[a]Palatability factor values were based on breed averages.

APPENDIX TABLE III

AVERAGE GRADE,[a] MARBLING[b] AND PERCENT CHEMICAL FAT[c] BY BREED AND YEAR

	Grade	Marbling	Percent Chemical Fat
First Year			
Angus	10.8	5.5	30.28
Hereford	11.0	6.0	28.25
Brahman	7.2	8.4	21.00
Brahman Cross	6.4	8.4	21.98
Holstein	7.4	8.6	20.03
Jersey	5.2	8.8	20.12
Second Year			
Angus	11.2	4.0	29.93
Hereford	10.5	5.7	24.87
Brahman	6.8	8.2	18.38
Brahman Cross	9.2	6.6	22.56
Holstein	6.2	8.8	20.18
Jersey	6.0	6.3	23.60

[a]Numerical values were given to federal grade where average Good has the value of 10 and the values increase or decrease by one number per one-third of a grade.

[b]Numerical values were given to subjective marbling where 1 is the highest value and 11 is the lowest value.

[c]Chemical fat was determined by ether extract.

Mr.
NAME Mrs. DATE_____

Family No. (LOIN)

BROILED STEAKS

CONSUMER PREFERENCE CARD

1. What steak do you prefer? (check one)

   Steak with 1 Ring _____

   Steak with 2 Rings _____

2. Did you like the one preferred? (check one)

   1. Very much better _____

   2. Much better _____

   3. Slightly better _____

COOKING TIME _____ MINUTES

Degree of Doneness: (check one)
RARE_____ MEDIUM _____ WELL DONE____

COMMENTS:

Figure 4

Consumer Preference Card

NAME Mr. Mrs. _____ DATE _____

Family No. (LOIN)

BROILED STEAKS

CONSUMER
RATING CARD

Score the steak with no ring.*

- Tenderness _____
- Juiciness _____
- Flavor _____

*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

COMMENTS

Figure 5

Consumer Rating Card