

- PART I. CUSTOMER RESPONSE TO DIFFERENT
PRICING COMBINATIONS FOR U.S. CHOICE
AND U.S. GOOD T-BONE STEAKS
- PART II. THE USE OF AN UNTRAINED TASTE PANEL
TO STUDY ORGANOLEPTIC DIFFERENCES
AMONG U.S. CHOICE, U.S. GOOD AND
U.S. STANDARD GRADES OF BEEF

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PART I. CUSTOMER RESPONSE TO DIFFERENT PRICING
COMBINATIONS FOR U.S. CHOICE AND
U.S. GOOD T-BONE STEAKS

INTRODUCTION

The federal grades for carcass beef are determined by the conformation, finish, age and quality of the carcass. Beef quality is determined by those attributes which are thought to influence the eating characteristics of the meat. In addition to maturity (age), one of the principal indications of quality is the intramuscular fat in the longissimus dorsi known as "marbling". The longissimus dorsi muscle must have moderate to slightly abundant marbling in order to meet the specifications of the Prime and Choice grades. This amount of marbling is often accompanied by an abundance of intermuscular and external fat. Several studies conducted in the western part of the United States have indicated that many consumers discriminate against excessive amounts of external and intermuscular fat.

It appears that the meat industry and in turn the consumers prefer the higher to the lower grades of beef, since beef producers are paid more per pound for higher-grading cattle. If this is true, consumers should be willing to pay a higher price for the grade which they prefer. The question then arises, can consumers recognize differences between the cuts from different grades of beef?

This study was undertaken to determine whether consumers could detect visual differences between steaks of different grades, and to ascertain how much more they would be willing to pay for the grade of their choice. The answers to these and similar questions will be of value to the retailer in helping to bring about a better understanding

of the customers' likes and dislikes, and would enable the retailer to have the maximum advantage in pricing. If the consumers do have a preference for one grade over another and are willing to pay more for that grade, this fact should be reflected back to the producer in the form of increased demand for the preferred grade of cattle.

REVIEW OF LITERATURE

Several studies have been undertaken to determine what factors consumers consider when they make their visual selection of beef. For the most part, these studies have been conducted in the western part of the United States. In most of these studies, price was held constant so that it would not affect the decision of the consumers. The methods employed by the various investigators to determine the physical characteristics desired in beef, and a consideration of the characteristics themselves are discussed in the following paragraphs.

a. Methods

Riley and Kramer (1955) used a mail survey to determine consumer reaction to prepackaged and frozen meat. A questionnaire was mailed to 3,982 families in the Flint-Grand Rapids area of Michigan. This questionnaire was followed by a personal interview of those who did not respond.

The personal home interview was used by Anderson (1956) to determine the effect of income on the type of meat purchased. The personal home interview, supplemented by colored photographs, was used by Stevens et al. (1956) to determine consumer preference for beef in regard to such variables as color of lean, color of fat, marbling, etc. The same method was used by Seltzer (1955).

Ashley et al. (1941), Coles (1956), Meyer and Ensminger (1952),

Farstad et al. (1955), and Rhodes et al. (1955) conducted personal interviews in stores. In most instances the interviews were supplemented by actual cuts of meat in which one variable, such as marbling, color of lean or fat, or amount of external fat was under consideration. The cuts were changed at intervals to insure that all respondents were confronted with essentially the same set of characteristics.

Lasley et al. (1955) at Missouri used a rather unique combination of methods. They selected fifty cooperators and arranged for them to come to the University of Missouri Meats Laboratory to purchase cuts of beef. The three grades, Choice, Good and Commercial, were offered at Commercial prices. After the cooperators had made their purchases, they were interviewed immediately to determine the reasons for their selection. A follow-up interview was conducted in the homes of the cooperators after the meat had been consumed to ascertain the degree of satisfaction or dissatisfaction involved in the eating qualities of the meat.

Schultz (1956) used three-dimensional pictures as substitutes for the cuts of meat. He then conducted a test to determine whether people would select the same cuts of beef from the pictures as they did when confronted with actual cuts of meat. In most cases the respondents selected the same grades of meat from the pictures as they did when confronted by actual cuts. Only a limited number of tests were conducted, but the author indicated that the use of three-dimensional pictures is a good method for determining consumer preference in visual selection of beef.

Miller et al. (1955) found that home preference evaluations and laboratory panel tests were equally effective in ascertaining visual preferences for beef. With both methods, in instances where there was

little difference between the two samples tested, more people wrote "no preference" than when there was a marked difference between samples.

Pilgrim and Wood (1955) demonstrated that the method of rating a particular product by use of a rating scale ("like very much", etc.) was about equally sensitive to differences as a comparison method.

b. Factors Which Influence the Consumers' Selection of Beef

1. Color of Fat

Coles (1956), Seltzer (1955), Stevens et al. (1956) and Lasley et al. (1955) found that white fat was the outstanding first choice of most people, slightly yellow or creamy fat was second, and yellow fat third. Meyer and Ensminger (1952) concluded that although more people preferred white fat, meat with yellow fat sold as readily as meat with white fat when priced alike. While not specifically stating preferences for fat color, Rhodes et al. (1955) indicated that color of fat was a factor considered by many people in their visual selection of beef. This was found to be especially true for the higher grades of beef.

2. Amount of External Fat

Ashley et al. (1941) found that a larger amount of fat was acceptable in beef than has been indicated in more recent studies. This worker concluded that higher income groups preferred more fat in beef than lower income groups. Lasley et al. (1955) found that respondents chose steaks of Commercial grade first, with the Prime grade being the last choice of most people. Coles (1956) and Meyer and Ensminger (1952) stated that a lean Good grade was definitely preferred to a fat Choice grade. Seltzer (1955) and Stevens et al. (1956) reported that the Good grade was preferred to both Commercial and Choice grades, with the preference between

Commercial and Choice grades divided about equally.

3. Marbling

Rhodes et al. (1956) found a greater preference for beef with more marbling than for beef with very little or no marbling when other factors were equal. Seltzer (1955) stated that results of studies in Arizona (using colored pictures) indicated a consumer preference for beef with little marbling. Stevens et al. (1956) obtained somewhat similar results in Wyoming. In this study, Good was selected over Choice, but Choice was selected over Commercial when pictures of the lean area were shown to consumers.

4. Color of Lean

Meyer and Ensminger (1952), and Lasley et al. (1955) stated that the majority of people preferred the medium red color of lean, compared to either a lighter red or dark red color. Seltzer (1955) found that the most desirable color was a bright cherry red. Rhodes et al. (1955, 1956) stated that color of lean was an important consideration with most people in making a selection, but did not state which color was most desired.

Studies conducted by Stevens et al. (1956), Seltzer (1955), and Riley and Kramer (1955) indicated that the majority of consumers purchased most of their meat in self-service stores, although they preferred butcher service to self-service. This was because they preferred to shop at large supermarkets, and only self-service was available in such markets.

Another type of experiment was used by Godwin (1952). The study was concerned with consumer response to different prices for a single commodity, oranges. A Latin square design was used in which the number

of stores equalled the number of treatments, the treatments being the different prices for oranges. He found that as the price continued to increase above the prevailing price for oranges, the volume sold decreased. Conversely, when the price dropped below the prevailing price, the volume sold increased accordingly.

EXPERIMENTAL OBJECTIVES

The objectives of this study were as follows:

- I. To determine whether there was a preference for U.S. Choice over U.S. Good t-bone steaks when both grades were priced the same, at different price levels.
- II. To study the relationship between varying prices for U.S. Choice and U.S. Good grade t-bone steaks from mature beef, and the volume of each grade sold.
- III. To study the effect of average price on the total volume of the two grades sold.
- IV. To determine whether the design used measured Objectives I and II.

EXPERIMENTAL PROCEDURE

a. Source of Data

This study, utilizing nine stores, was conducted in cooperation with a large chain of stores in Tulsa, Oklahoma. Since it was not practical from an economic standpoint to work with the entire beef carcasses, only t-bone steaks were utilized. This cut was chosen because it is one of the more popular higher-priced cuts of beef. It was assumed that consumers would be more discerning in their selection for t-bone steaks than would be the case with a less expensive cut. It was further decided to limit the t-bone steaks to mature beef from Good and Choice grades, in an attempt to control as many of the physical characteristics as possible. Mature beef refers in this instance to beef from carcasses weighing over four-hundred pounds.

The meat buyer for all stores used in this study was instructed to obtain the steaks for the study from one source. All the stores normally carried the Choice grade; however, nearly all of them had to purchase Good grade short loins especially for the study. The packing house supplying the beef for the study agreed to supply beef representing the middle or average part of each grade as determined by a representative of the Federal Grading Service. This was to insure a spread of a full grade between Choice and Good steaks. As it developed, however, the steaks used were not always representative of their respective grades even though they had been previously graded by a federal grader.

b. General Design of the Study

The design of this study was similar to the one used by Godwin (1952) in a study of consumer response to oranges priced at different levels. The design was a 9x9 Latin square, conducted on nine separate days, in nine stores, with nine pricing combinations or treatments. The largest volume of trade in these chain stores occurs during the latter part of the week. For this reason, the days selected for study were Thursday, Friday and Saturday; these days were used for three consecutive weeks beginning Thursday, February 7, 1957.

The treatments were the prices for the two grades of steaks, as shown in Table I.

TABLE I
Treatments Represented by Different Prices per Pound
of Choice and Good Grade T-Bone Steaks

Treatment	Price per Pound	
	Choice	Good
t ₁	\$1.15	\$1.15
t ₂	.95	.95
t ₃	.75	.75
t ₄	1.35	1.15
t ₅	1.15	.95
t ₆	.95	.75
t ₇	.95	1.15
t ₈	.75	.95
t ₉	1.15	.75

Three of the treatments (t_1 , t_2 and t_3) involved identical prices at different levels for the two grades of steaks. This was to learn whether consumers would show a preference for one grade when the prices were the same. It also gave an indication of the total volume of steaks sold at different prices.

Each of the other six treatments had the two grades priced at different levels. In some cases, Choice cuts were priced higher than Good, and in others the opposite was true. The Latin square design is shown in Table II. Every treatment was represented in each store, and once on each of the nine days.

TABLE II
Treatments Applied on Nine Different Days
For the Nine Stores Used

Day	Store Code Number								
	1	2	3	4	5	6	7	8	9
Thursday	t_5	t_8	t_7	t_6	t_4	t_1	t_2	t_3	t_9
Friday	t_1	t_9	t_3	t_7	t_2	t_8	t_5	t_4	t_6
Saturday	t_3	t_7	t_2	t_1	t_8	t_9	t_6	t_5	t_4
Thursday	t_4	t_3	t_8	t_2	t_6	t_5	t_1	t_9	t_7
Friday	t_7	t_1	t_5	t_8	t_3	t_4	t_9	t_6	t_2
Saturday	t_2	t_4	t_6	t_9	t_5	t_3	t_8	t_7	t_1
Thursday	t_8	t_5	t_9	t_4	t_1	t_6	t_7	t_2	t_3
Friday	t_6	t_2	t_4	t_5	t_9	t_7	t_3	t_1	t_8
Saturday	t_9	t_6	t_1	t_3	t_7	t_2	t_4	t_8	t_5

c. Orientation of and Instructions to Store Personnel

The store managers and meat department heads were contacted a week before the study was to begin and given a copy of the prices for the two grades on the different days to be used in their respective stores. The two grades of steaks were exhibited on separate trays, side by side, in the meat counter. The position of the two trays in relation to other displays in the counter was left to the discretion of the manager. The position of the two trays in relation to each other was determined randomly. An example of the schedule of prices for one store and the placing of the trays in the counter for the same store appears in Table III.

TABLE III
Price Schedule and Tray Position
in Store 1

Date	U.S. Choice		U.S. Good	
	Price/Lb.	Tray Position*	Price/Lb.	Tray Position*
Feb. 7	\$1.15	1	.95	2
Feb. 8	1.15	2	1.15	1
Feb. 9	.75	1	.75	2
Feb. 14	1.35	1	1.15	2
Feb. 15	.95	2	1.15	1
Feb. 16	.95	2	.95	1
Feb. 21	.75	2	.95	1
Feb. 22	.95	1	.75	2
Feb. 23	1.15	1	.75	2

*A (1) indicates the left hand position as one would face the counter and (2) the right hand position.

The meat department managers were instructed to cut all steaks approximately three-quarters of an inch in thickness, since this thickness is preferred by most people. All external fat was to be trimmed to a uniform thickness. That is, the thickness of the external fat on the Good steaks was to limit the amount of external fat left on the Choice steaks, since normally the steaks grading Choice would have more external fat than those of the Good grade. It was intended that the visual selection between the grades should be made on the basis of marbling and color of lean, with external fat being held constant.

All steaks were packaged in the standard manner used in this chain of stores. One or two steaks were placed in a cardboard container and then covered with transparent plastic. The price per pound and the total price of each package were stamped on a label. No indication of the grade was placed on the label or counter. "U.S. Choice" stickers, ordinarily placed on the packages, were not used during this study. If a customer specifically inquired about the grade of the steaks, the counterman would explain why there were no grade labels present. It was made clear to all store managers that any steps necessary should be taken to insure customer satisfaction.

A supply of forms on which to record the data was left with every store each week. Figure 1 shows the form used. Before these forms were given to the store personnel, as many of the items as possible were completed, to facilitate recording of the data. The items completed were: the store number and location; the date on which the form was to be used; the daily rotation schedule of the two grades; and the price for each grade.

The daily customer count was necessary in order to adjust for the

Oklahoma State University

T-Bone Inventory Record

Store No. _____ Location _____

Customer Count _____

Date _____

Display Rotation Schedule 1. _____ 2. _____

Choice _____ Cents/Lb.				Good _____ Cents/Lb.			
Lbs.	No. of Steaks	Lbs.	No. of Steaks	Lbs.	No. of Steaks	Lbs.	No. of Steaks

Figure 1

Form Used By
Store Personnel to Record Data

difference in volume of sales between stores. The number of pounds of steaks sold was converted to a per thousand customer basis without disclosing the volume of business to any competitor who might see the results.

Steak weights were recorded to the nearest ounce. These data were recorded at the beginning of business on each of the study days. If it became necessary to replenish the supply of steaks of either or both grades during the day, the weights of these steaks were added to the list. At the end of the day any unsold steaks were then deleted from the beginning inventory. Thus the total pounds of each grade sold on a particular day could be determined. Some of the stores weighed all the steaks of each grade in the morning, and added the total weights of any steaks added during the day. At the close of the day's business the total weight of all remaining steaks in each grade was entered and the pounds sold determined by the difference.

d. Supervision of Stores

All the store meat department managers were contacted a week prior to the initiation of the study. The purpose of the study, its methodology, and the manner in which the data were to be recorded were explained to them. All of the managers were again contacted the day before each three-day test period, to ascertain that each had enough steaks of the two grades to meet the anticipated demand, and to discuss the prices which were to be used in their stores for the next three days. Forms for recording data were also delivered at this time. Every store was contacted at least once each day during the three-day test period to determine whether the steaks were priced correctly and not labeled; the two grades were in

their proper position in the counter; there was a display of both grades of steaks; and the weights of the steaks had been properly recorded.

RESULTS AND DISCUSSION

I. Effect of Day, Store and Treatment on the Disappearance of Good and Choice T-Bone Steaks

a. Results

Tables IV and V present the data obtained in terms of pounds of Good and Choice t-bone steaks sold per thousand customers. Table VI represents the differences in pounds of steaks sold per thousand customers on the eighty-one occasions, in terms of Good steaks minus Choice steaks. A minus sign indicates that more Choice was sold on that occasion than Good.

Of the eighty-one different instances in which the consumers had an opportunity to register their preference for one grade over the other, more Good than Choice was sold on forty-five occasions and Choice exceeded Good thirty-six times. In six of the forty-five instances in which Good was selected in preference to Choice, the differences in volume were only one half pound or less per thousand customers.

A factor which may have caused consumers to select more Good than Choice steaks was that Good was priced lower than Choice in four treatments, whereas Choice was priced lower than Good in only two treatments. There was a difference in total volume selected for the entire study of 4.01 pounds per thousand customers of Good over Choice steaks.

The total pounds of Good and Choice steaks sold are presented in Table VII. An analysis of variance was performed on these data, and the results appear in Table VIII. An analysis of variance was performed on the difference figures in Table VI; the results of this analysis appear in Table IX.

TABLE IV

Pounds of Choice T-Bone Steaks Sold Per Thousand Customers*

Day	Store									Day Totals
	1	2	3	4	5	6	7	8	9	
Thurs.	28.18	26.65	12.82	11.61	9.22	6.93	3.98	11.08	10.71	121.18
Fri.	12.20	1.04	36.70	11.92	29.28	34.61	7.09	5.63	25.20	163.67
Sat.	9.03	29.73	12.12	20.03	25.36	17.33	5.57	0.00	8.17	127.34
Thurs.	12.14	27.14	41.33	23.62	29.23	6.50	14.37	2.39	19.18	175.90
Fri.	14.83	37.12	16.61	33.30	11.11	4.28	3.41	0.93	17.35	138.94
Sat.	16.98	8.15	7.31	25.48	29.85	30.89	19.04	0.67	11.09	149.46
Thurs.	21.66	8.89	9.05	8.80	8.04	6.87	20.00	3.75	33.12	120.18
Fri.	17.85	10.70	2.95	6.64	7.88	19.89	21.00	1.23	15.08	103.22
Sat.	12.24	0.00	18.49	29.66	15.84	15.86	2.27	5.35	20.90	120.61
Store Totals	145.11	149.42	157.38	171.06	165.81	143.16	96.73	31.03	160.80	1220.50
Treatment Totals	t ₁	t ₂	t ₃	t ₄	t ₅	t ₆	t ₇	t ₈	t ₉	
	129.50	133.64	209.73	61.61	124.66	104.57	144.88	222.38	89.53	

*For treatments applied see Tables I (Page 10) and II (Page 11).

TABLE V

Pounds of Good Grade T-Bone Steaks Sold Per Thousand Customers*

Day	Store									Day Totals
	1	2	3	4	5	6	7	8	9	
Thurs.	18.79	9.27	2.13	33.80	12.99	9.48	10.35	11.68	27.96	136.45
Fri.	15.15	21.51	56.64	12.10	5.76	12.51	15.37	2.81	28.02	169.87
Sat.	13.09	0.00	12.14	9.63	16.17	14.31	22.29	5.37	21.59	114.59
Thurs.	10.41	26.53	20.49	23.89	15.00	7.86	7.58	2.90	4.96	119.62
Fri.	11.98	12.57	16.33	17.15	14.01	3.81	28.22	8.94	10.53	123.54
Sat.	13.94	10.14	34.25	18.33	6.63	34.33	21.04	5.51	16.43	160.60
Thurs.	13.44	26.33	27.13	7.50	14.17	16.25	0.00	2.59	20.15	127.56
Fri.	21.75	13.84	16.65	14.44	16.11	4.72	34.02	1.70	20.74	143.97
Sat.	16.73	35.02	5.31	28.76	0.00	16.62	1.26	3.34	21.27	128.31
Store Totals	135.28	155.21	191.07	165.60	100.84	119.89	140.13	44.84	171.65	1224.51
Treatment Totals	t ₁	t ₂	t ₃	t ₄	t ₅	t ₆	t ₇	t ₈	t ₉	
	92.02	109.66	239.21	87.16	132.39	215.32	41.40	134.15	173.20	

*For treatments applied see Tables I (Page 10) and II (Page 11).

TABLE VI

Difference in Pounds Per Thousand Customers (Good Minus Choice)*

Day	Store									Day Totals
	1	2	3	4	5	6	7	8	9	
Thurs.	- 9.39	-17.38	-10.69	22.19	3.77	2.55	6.37	.60	17.25	15.27
Fri.	2.95	20.47	19.94	.18	-23.52	-22.10	8.28	- 2.82	2.82	6.20
Sat.	4.06	-29.73	.02	-10.40	- 9.19	- 3.02	16.72	5.37	13.43	-12.74
Thurs.	- 1.73	- .61	-20.84	.27	-14.23	1.36	- 6.79	.51	-14.22	-56.28
Fri.	- 2.85	-24.55	- .28	-16.15	2.90	- .47	24.81	8.01	- 6.82	-15.40
Sat.	- 3.04	1.99	26.94	- 7.15	-23.22	3.44	2.00	4.84	5.34	-23.27
Thurs.	- 8.22	17.44	18.08	- 1.30	6.13	9.38	-20.00	- 1.16	-12.97	7.38
Fri.	3.90	3.14	13.70	7.80	8.23	-15.17	13.02	.47	5.66	40.75
Sat.	4.49	35.02	-13.18	- .90	-15.84	.76	- 1.01	- 2.01	.37	7.70
Store Totals	- 9.83	5.79	33.69	- 5.46	-64.97	-23.27	43.40	13.81	10.86	4.02
Treatment Totals	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	t_9	
	-37.48	-23.98	29.48	25.56	7.73	110.75	-103.48	-88.23	83.67	

*A minus sign indicates that more Choice than Good steaks were sold on that occasion. For treatments applied see Tables I. (Page 10) and II. (Page 11).

TABLE VII

Total Pounds of Good and Choice T-Bone Steaks Sold Per Thousand Customers*

Day	Store									Day Totals
	1	2	3	4	5	6	7	8	9	
Thurs.	46.97	35.92	14.95	45.41	22.21	16.41	14.33	22.76	38.67	257.63
Fri.	27.35	22.55	93.34	24.02	35.04	47.12	22.46	8.44	53.22	333.54
Sat.	22.12	29.73	24.26	29.66	41.53	31.64	27.86	5.37	29.76	241.93
Thurs.	22.55	53.67	61.82	47.51	44.23	14.36	21.95	5.29	24.14	295.52
Fri.	26.81	49.69	32.94	50.45	25.12	8.09	31.63	9.87	27.88	262.48
Sat.	30.92	18.29	41.56	43.81	36.48	65.22	40.08	6.18	27.52	310.06
Thurs.	35.10	35.22	36.18	16.30	22.21	23.12	20.00	6.34	53.27	247.74
Fri.	39.60	24.54	19.60	21.08	23.99	24.61	55.02	2.93	35.82	247.19
Sat.	28.97	35.02	23.80	58.42	15.84	32.48	3.53	8.69	42.17	248.92
Store Totals	280.39	304.63	348.45	336.66	266.65	263.05	236.86	75.87	332.45	2445.01
Treatment Totals	t ₁	t ₂	t ₃	t ₄	t ₅	t ₆	t ₇	t ₈	t ₉	
	221.52	243.30	448.94	148.77	257.05	319.89	186.28	356.53	262.73	

*For treatments applied see Tables I (Page 10) and II (Page 11).

TABLE VIII

Analysis of Variance of Total Pounds
of Steak (Good and Choice) Sold
Per Thousand Customers

Source	D/F	SS	MS	F
Total	80	20,724.93		
Stores	8	6,069.37	758.67	6.80**
Days	8	969.56	121.20	1.09
Treatment	8	7,440.05	930.00	8.34**
Error	56	6,245.95	111.53	

**P < .01

TABLE IX

Analysis of Variance of Differences in
Pounds per Thousand Customers
(Good Minus Choice)

Source	D/F	SS	MS	F
Total	80	12,638.88		
Day	8	637.24	79.66	.69
Store	8	916.44	114.56	.99
Treatment	8	4,591.00	573.88	4.95**
Error	56	6,494.20	115.97	

**P < .01

b. Discussion

When the total volume of steaks sold was analyzed, Table VIII, both treatments and stores were significant at the one per cent level. The treatments were the different price combinations applied to the two grades (Choice and Good) of t-bone steaks. The average price for the two grades apparently affected to some degree the total volume of the two grades sold. This, at least in part, helps to account for the significant F value obtained for treatments.

Stores also had a significant effect on total volume sold, while the days on which the sales were made did not. One of the reasons why the stores affected the total volume of steak sold was the income level of the clientele who patronized the particular store. The patrons of stores in a high income area would normally be expected to purchase more of the higher price cuts of beef than would consumers in a low income area.

The analysis of variance of differences, Table IX, indicates that differences between the amounts of the grades sold were not significantly affected by either the store in which the sale was made or the day on which the sale was made. The F value for treatments is significant at the one per cent level. This indicates that the extent of the differences between purchases of the two grades was influenced to a significant degree by treatment. The next step was to attempt to locate the cause of the differences in the rate of purchase of the two grades.

II. Effect of Grade on Consumer Selection of T-Bone Steaks When the Two Grades Were Identically Priced but at Different Levels

a. Results

Table X presents a summary of the data obtained when both grades were priced alike, t_1 , t_2 and t_3 . For these three treatments a total of 472.87 pounds of Choice steaks were sold per thousand customers compared to 440.89 pounds of Good steaks per thousand customers. The analysis of variances of differences (Good minus Choice) in Table XI indicates that the treatment differences among t_1 , t_2 , and t_3 were not significant.

TABLE X
Summary of Treatments t_1 , t_2 , t_3

Treatment Number	Price Per Pound		Differences (Good Minus Choice) ¹		Pounds of Choice Plus Good Sold	
	Choice	Good	Total	Mean	Total	Mean
t_1	\$1.15	\$1.15	-37.48	-4.16	221.52	24.61
t_2	.95	.95	-23.98	-2.66	243.30	27.03
t_3	.75	.75	29.48	3.28	448.94	49.88
Total and Mean for the sum of t_1 , t_2 , t_3 combined			-31.98	-1.18	913.76	33.84

¹A minus sign indicates more Choice than Good sold for that treatment in terms of pounds per thousand customers.

TABLE XI
Analysis of Variance of Differences (Good Minus Choice)
For Treatments t_1 , t_2 , t_3

Source	D/F	SS	MS	F
Treatment	2	278.66	139.33	1.2
Error	56	6,494.20	115.97	

The amount of each grade sold and the total volume of sales for both grades in treatments t_1 , t_2 and t_3 in terms of pounds per thousand customers are presented in Figure 2. The total volume of steaks sold was related to price in these three treatments, as indicated by the small difference between the grades sold (31.98 pounds more of Choice than Good steaks) and the spread in total volume between t_3 and the other two treatments (210 pounds per thousand customers over t_2 and 225 pounds per thousand customers over t_1). This fact is borne out by the analysis of variance among t_1 , t_2 and t_3 for the volume sold, Choice and Good, in Table XII. The total volume of t_3 at the lowest price is highly significant when compared to t_1 and t_2 at the higher price levels.

TABLE XII

Analysis of Variance of Total Volume
(Choice and Good) for t_1 , t_2 , t_3

Source	D/F	SS	MS	F
Treatments	8	7,440.05	930.00	6.80**
Among t_1 , t_2 , t_3	(2)	3,499.33	1,749.67	15.69**
T_1 and t_2 versus t_3	(2)	6,945.96	3,472.98	31.14**
T_1 versus t_2	(1)	26.60	26.60	.24
Error	56	6,245.95	111.53	

**p < .01

b. Discussion

The normal price for t-bone steaks was approximately 95 cents per pound for the stores cooperating in this study. Assuming that the volume

Lbs./1000 Customers

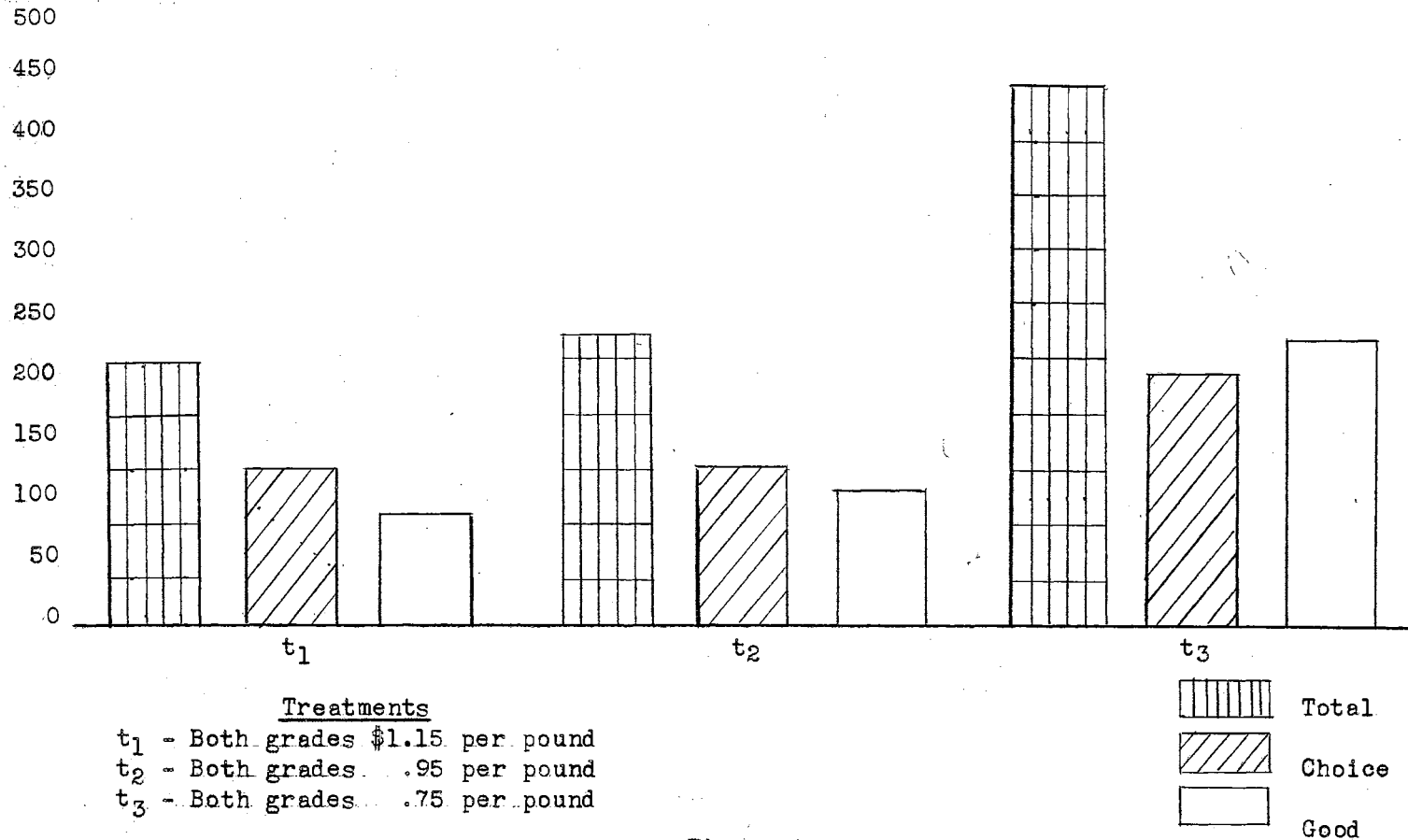


Figure 2

Amounts of Good and Choice T-Bone Steaks
Sold and the Total Volume of Both Grades Sold for
Treatments t₁, t₂ and t₃ in Terms of Pounds per Thousand Customers

of steaks sold under t_2 is the "normal", the data in Figure 2 indicate that an increase in price of twenty cents per pound dropped the total volume of sales nine per cent. There are three factors which may account for this small decrease in volume: first, consumers who normally purchased t-bone steaks may have desired this particular cut of beef to such an extent that the majority of them were willing to pay the twenty cent premium for it. Secondly, the consumers who normally purchase this cut were possibly unaware of the usual price. In this event, they did not realize that they were paying a premium, and so purchased their usual amount. A third possible explanation is that this small decrease in total volume was due to chance. In order to investigate further how much of a premium these people would pay for t-bone steaks, it would be necessary to include one or more treatments at a price per pound greater than \$1.15, since the F value obtained, Table XII, for t_1 versus t_2 was extremely small.

In t_3 , where the price was lowered to 75 cents per pound, there was an increase in total volume of 84.5% over t_2 . This increase may be explained by the fact that consumers who did not ordinarily purchase t-bone steaks became customers for this commodity; or, those consumers who ordinarily purchased at 95 cents per pound may have increased their purchase. One or both of these factors caused an increase in the total volume of t-bone steaks sold at the lower price. The highly significant F value obtained, Table XII, when t_3 was compared to t_1 and t_2 indicates that it is not likely that the large increase in total volume of steaks sold at the lower price was due solely to chance. It may be noted that at the 75 cents per pound level there were slightly more Good steaks purchased than Choice. At the 95 cents and \$1.15 level the reverse situation pre-

vailed. This indicates that while price was a factor in determining the total volume of t-bone steaks purchased, the selection by grade was conducted more or less in an inconsistent manner.

In order to study more fully the relationship which may exist between these two grades and consumer selection of t-bone steaks, it would be well to replicate treatments t_1 , t_2 and t_3 . Also, a price higher than \$1.15 would render more information as to the price level at which the consumer will change from t-bone steak to some other commodity. If a future study adequately demonstrated that at an identical price per pound grades played no significant role in the consumers' selection, the second objective of this study would be of minor importance.

Treatments t_1 , t_2 and t_3 were also compared as a group against t_4 , t_5 , and t_6 , in which the Choice was priced higher than Good at different levels. A summary of the data considered in this analysis is presented in Table XIII, and the analysis of variance is given in Table XIV. The difference between these two groups of treatments was significant at the five per cent level.

In treatments t_4 , t_5 and t_6 , with Choice at a higher level than Good, Good consistently outsold Choice steaks. For treatments t_1 , t_2 and t_3 there was more Choice sold than Good, but when the amount of excess Choice for t_1 , t_2 and t_3 was tested against the excess of Good for t_4 , t_5 and t_6 , an F value significant at the five per cent level was obtained, as in Table XIV.

The significance of the spread between the difference totals for these two groups of treatments indicates that more consumers were basing their selection of t-bone steaks on price than on grade. This spread could also be explained by the fact that Good was the preferred grade,

but this assumption is not supported by the analysis of the differences in volumes of grades sold among treatments t_1 , t_2 and t_3 .

TABLE XIII

Data of Treatments t_1 , t_2 , t_3 Compared
With Data of Treatments t_4 , t_5 , t_6

Treatment Number	Price Per Pound		Differences (Good Minus Choice) ¹	
	Choice	Good	Total	Mean
t_1	\$1.15	\$1.15	-37.48	-4.16
t_2	.95	.95	-23.98	-2.66
t_3	.75	.75	29.48	3.28
Total and Mean for the sum of t_1 , t_2 , t_3 combined			-31.98	-1.18
t_4	\$1.35	\$1.15	25.56	2.84
t_5	1.15	.95	7.73	.86
t_6	.95	.75	110.75	12.34
Total and Mean for the sum of t_4 , t_5 , t_6 combined			144.04	5.35

¹A minus sign indicates more Choice than Good sold for that treatment in terms of pounds per thousand customers.

TABLE XIV

Analysis of Variance of Differences (Good Minus Choice) for Treatments
 t_1 , t_2 , t_3 as Compared with Treatments t_4 , t_5 , t_6

Source	D/F	SS	MS	F
Treatment	1	554.37	554.37	4.95*
Error	56	6,494.20	115.97	

*P < .05

III. The Relationship Between Varying Prices for Two Grades (Choice and Good) of T-Bone Steaks from Mature Beef, and the Volume of Each Grade Sold

a. Results

To study the relationship between the varying prices for the two grades of t-bone steaks (Choice and Good) and the volume of each grade sold, only treatments t_5 , t_6 , t_7 and t_8 were considered. Table XV gives a summary of the data obtained for these four treatments. Figure 3 indicates the volumes sold in treatments t_5 , t_6 , t_7 and t_8 . Table XVI shows the analysis of variance for differences (Good minus Choice) for treatments t_5 , t_6 , t_7 and t_8 .

TABLE XV
Summary of Treatments t_5 , t_6 , t_7 , t_8

Treatment Number	Price Per Pound		Differences (Good Minus Choice) ¹		Pounds of Choice Plus Good Sold	
	Choice	Good	Total	Mean	Total	Mean
t_5	\$1.15	.95	7.73	.86	257.05	28.56
t_6	.95	.75	110.75	12.36	319.89	35.54
t_7	.95	1.15	-103.48	-11.50	186.28	20.70
t_8	.75	.95	- 88.23	- 9.80	356.53	39.61
Total and Mean for the sum of t_5 , t_6 , t_7 , t_8 combined			- 63.23	- 8.08	1,119.75	41.47

¹A minus sign indicates more Choice than Good sold for that treatment in terms of pounds per thousand customers.

Lbs./1000 Customers

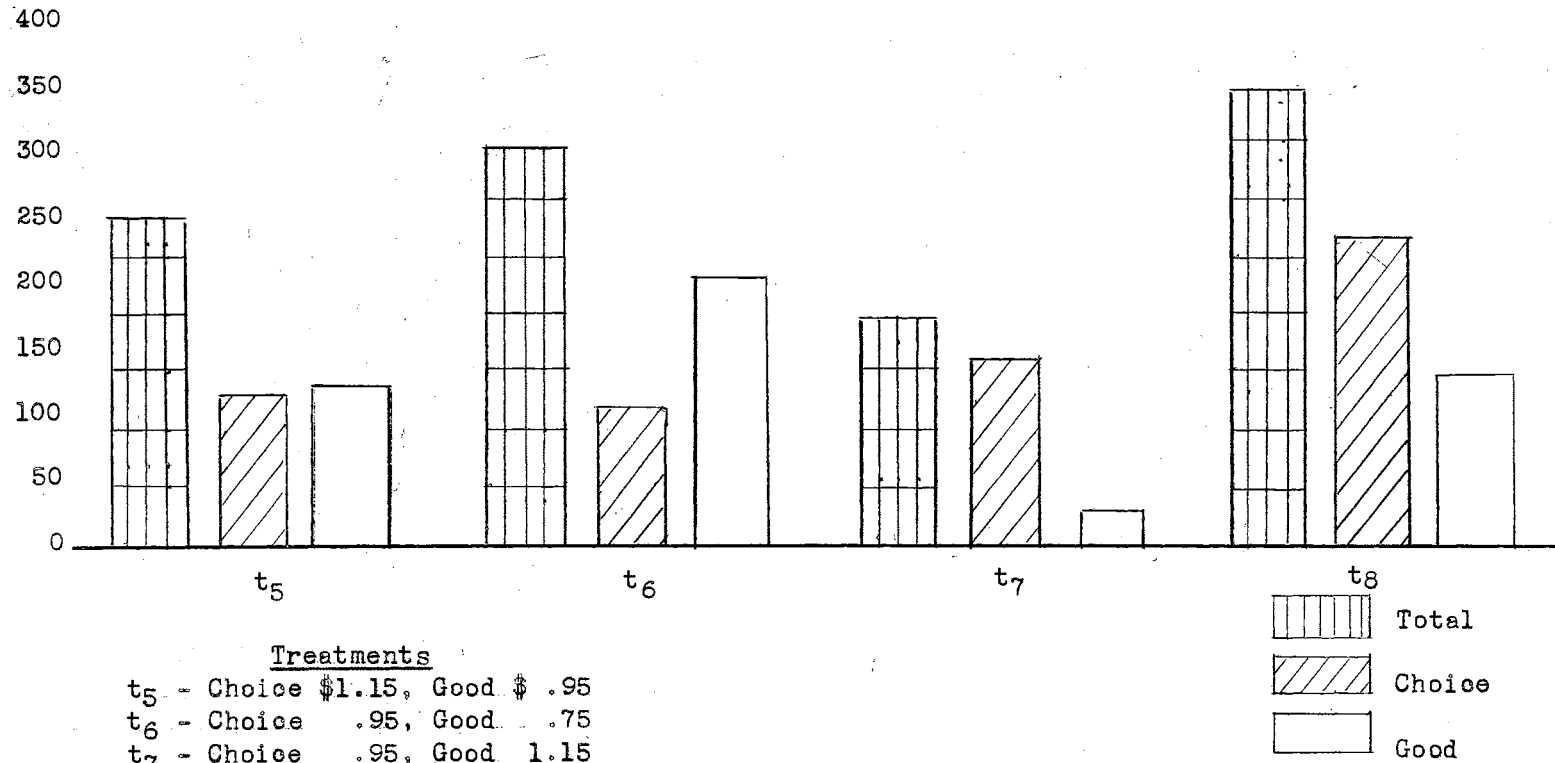


Figure 3

Amounts of Good and Choice T-Bone Steaks
Sold and the Total Volume of Both Grades Sold for
Treatments t₅, t₆, t₇ and t₈ in Terms of Pounds per Thousand Customers

TABLE XVI
 Analysis of Variance of Differences (Good Minus Choice)
 For Treatments t_5 , t_6 , t_7 , t_8

Source	D/F	SS	MS	F
Treatments	8	7,440.05	930.00	6.8**
Among t_5 , t_6 , t_7 , t_8	(3)	3,275.26	1,091.75	9.41**
T_5 versus t_6	(1)	589.62	589.62	5.08*
T_7 versus t_8	(1)	12.92	12.92	.11
Error	56	6,494.20	115.97	

*P < .05

**P < .01

b. Discussion

The analysis of treatments t_5 , t_6 , t_7 and t_8 indicates that differences between the volume of Choice and Good steaks sold were highly significant among these four treatments. The differences as denoted in Figure 3 are in opposite directions, with more of the lower priced grade sold in every instance.

Treatment t_5 , in which Choice is priced at \$1.15 and Good at 95 cents per pound, suggests that at these price levels more people were willing to pay a premium for the Choice grade, since similar amounts of the two grades were sold (Table XVI: t_5 versus t_6). This occurred even though there was a twenty-cent spread in price between the two grades. At the lower levels, treatment t_6 (Choice 95 cents and Good 75 cents) this did not hold true, however, since twice as much Good steak was sold at the lower price. It is possible that the people who normally purchase t-bone steaks have a little more awareness of grade than do the

people who will not purchase this cut until it is below the normal market price. The hypothesis that consumers who purchase t-bone steaks at the higher price are willing to pay a premium for the Choice grade is supported by the analysis of variance in Table XVI in which t_5 was tested against t_6 . The significant F value indicates that some consideration other than chance caused the spread in volume of differences for the two grades at these levels of prices. In this case it can be assumed that the factor considered was the grade.

Treatments t_7 and t_8 , in which Choice was priced twenty cents lower than Good at two levels, again indicate that the price is a more influential factor than grade in determining the amount sold. The extent of the difference between the two grades was not significant (Table XVI: t_7 versus t_8).

The total volume (Good and Choice) sold for these three treatments was analyzed in Table XVII. When the total volume sold at the two higher levels, t_5 and t_7 , was compared with the total volume sold at the two lower levels, the F value obtained was highly significant. When t_7 , a higher level treatment was compared with t_8 , a lower level treatment, the F value was again highly significant. T_5 compared with t_6 was not significant. No apparent reason other than chance can be suggested for the failure of the volume at the lower level in this case to be significantly different from the volume at the higher level.

Treatments t_5 and t_6 , with Choice priced higher than Good, were compared with treatments t_7 and t_8 in which Good was priced higher than Choice. Table XVIII shows the analysis of variance of this comparison.

TABLE XVII

Analysis of Variance of Total Volume (Choice
And Good) for t_5 , t_6 , t_7 , t_8

Source	D/F	SS	MS	F
Treatments	8	7,440.05	930.00	6.80**
T_5 and t_7 versus t_6 and t_8	(1)	1,509.19	1,509.19	13.53**
T_5 versus t_6	(1)	219.38	219.38	1.97
T_7 versus t_8	(1)	1,610.28	1,610.28	14.44**
Error	56	6,245.95	111.53	

**P < .01

TABLE XVIII

Analysis of Variance of Differences (Good Minus Choice) for Treatments
 t_5 , t_6 as Compared With Treatments t_7 , t_8

Source	D/F	SS	MS	F
Treatment	1	2,672.72	2,672.72	23.05**
Error	56	6,494.20	115.97	

**P < .01

The differences between t_5 , t_6 and t_7 , t_8 were highly significant. As noted above, the smallest source of variation among these four treatments occurred in t_5 . This lends further support to the observation that at the higher price levels people may be more conscious of grade and are willing to pay a premium, in this case twenty cents per pound, for the Choice grade t-bone steaks as compared with Good t-bone steaks. It is also recognized that the majority of customers in these stores were accustomed to having only the Choice grade of beef offered to them. This may

have entered into the situation in the form of Choice being selected on the basis of past associations.

IV. Effectiveness of the Design of the Experiment in Measuring the Primary Objectives

The fourth objective of this study was to determine whether the design used would generate the information desired for the first three objectives. The experimental method developed several weaknesses as the study progressed. As has been previously noted, a more exhaustive study is needed to investigate consumer reaction to the grades Good and Choice at the same price over a wider range. The number of treatments used here, three at the same price for the two grades with only a single replication in each store and on each day, is not enough to draw satisfactory conclusions.

The information obtained from the first three treatments hints that there may be a slight preference for the Choice over the Good at the higher price range, but that the Good may be preferred at the lower price level. When t_1 (both grades priced alike at \$1.15) was compared with t_3 (both grades priced alike at 75 cents), the analysis of variance, Table XIX, shows the F value to be significant at the ten per cent level. This study was not extensive enough along those lines to fully investigate that possibility.

TABLE XIX

Analysis of Variance of Differences (Good Minus Choice) for Treatment t_1 Versus t_3

Source	D/F	SS	MS	F
T_1 versus t_3	1	249.09	249.09	2.15 ¹
Error	56	6,494.2	115.97	

¹ $p < .10$

The second objective was studied by the use of four treatments, t_5 , t_6 , t_7 and t_8 . In order to investigate this objective more fully, the design could be improved by having balanced treatments. That is, for every treatment where Choice is priced at a higher level than Good, a similar treatment should be used with Good priced at a higher level than Choice. In this study there were a total of four treatments out of the nine which had Choice priced higher than Good and only two treatments in which Good was priced higher than Choice.

Another aspect of this design is the difficulty in controlling the physical details. One of the major confounding effects in determining consumer preference for the two grades was the fact that all too often visual differences were not apparent. In a few instances the Good grade actually had the appearance of Choice and vice versa. (All the beef used was federally graded, but since much of the grading was performed on the unribbed carcass, there was a chance for considerable variation, particularly in the amount of marbling within a grade.) Another factor which made it difficult to control the quality of the meat used, was that the supplies were not always obtained from the directed source. This also increased the within-grade variation.

Finally, there was the matter of the cooperation of the individual meat managers. In most cases cooperation was excellent, but in one or two instances it was not. The records from one store were felt to be quite unreliable, but there was no way of actually determining the extent or direction of the error. There were also occasions when one or more stores would run short of a supply of a particular grade, thus necessitating an estimate of the missing data.

Further studies should improve the experimental design in the

following ways: (1) The treatments should be devised to study the difference between the two grades at the same price. (2) A balanced set of treatments should be used to study the premium which consumers will pay for their preference. (3) Rigid control must be used in the study to insure that the supplies are properly selected and that the data are properly recorded.

SUMMARY

Consumer preference for U.S. Choice and U.S. Good t-bone steaks was observed in nine chain stores on nine different days. The treatments were the pricing combinations applied to the two grades. No significant difference in volume between the two grades sold due to stores or days is indicated by the analysis of variance for the differences between the two grades sold, in terms of pounds per thousand customers of Good minus Choice steaks. The treatments applied resulted in significant differences in the disappearance of steaks of the two grades.

There were no significant differences among the volumes of the two grades sold when the two grades were priced alike at three different levels (treatments t_1 , t_2 , t_3). There was more Choice than Good sold, however, at the higher price levels (t_1 at \$1.15 per pound and t_2 at 95 cents per pound). At the lower price level (t_3 , 75 cents per pound), more Good was sold than Choice. A decrease of twenty cents per pound in the price of t-bone steaks (t_3) caused a sharp increase in the total volume sold. An increase of twenty cents per pound over t_2 , which is considered to be approximately the normal price of t-bone steak, caused only a small decrease in total volume sold.

The differences in the volumes sold were significant at the five per cent level when treatments t_1 , t_2 and t_3 (in which both grades were priced alike at different levels) were compared as a group to treatments t_4 , t_5 and t_6 (in which Choice was priced twenty cents per pound higher than

Good at three different levels). This indicates that more people base their selection of t-bone steaks on price than on grade.

A highly significant difference among the volumes of the two grades sold was shown by an analysis of t_5 , t_6 , t_7 and t_8 (in which Choice was priced twenty cents per pound higher than Good, t_5 and t_6 , and Good was priced twenty cents per pound higher than Choice, t_7 and t_8). The differences were largely due to the prices applied, since in every instance more of the lower priced grade was sold. The small difference in volume between grades in t_5 suggests that at the higher price range more people were willing to pay a twenty cent premium for Choice steaks. When t_5 and t_6 were compared with t_7 and t_8 , the differences were highly significant, again supporting the observation that at the higher price ranges Choice may be desired by the majority of consumers who purchase t-bone steaks, while at the lower price ranges Good seems to be selected.

A more exhaustive study of these two grades of t-bone steaks, priced at the same level to determine whether there actually is a preference for one grade over the other at different price levels, should be undertaken. If it could be adequately demonstrated that at certain price ranges one grade is preferred to the other, the spread in price which these consumers could pay for the preferred grade could be more fully studied. The experimental design used lacks efficient control of the physical aspects of the study. A scheme is needed which will increase the control of the material used and the method of recording the data.

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PART II. THE USE OF AN UNTRAINED TASTE PANEL TO STUDY
ORGANOLEPTIC DIFFERENCES AMONG U.S. CHOICE,
U.S. GOOD AND U.S. STANDARD GRADES OF BEEF

INTRODUCTION

The federal standards for grading beef are based on visual appraisal of carcass characteristics. The higher Choice grade may be considered more desirable to the consumer than the lower Good or Standard grade, since the monetary values placed upon slaughter cattle are related to the grade of the carcass. The consumer is ultimately interested in the eating qualities of the meat when purchasing beef. It would therefore be logical to assume that there is a relationship between the visual appraisal by which beef is graded, and the eating characteristics of the meat.

Rhodes et al. (1956), in studies conducted at Missouri with a trained taste panel, demonstrated that there was considerable variation in eating characteristics within a grade of beef. If this is true, the question then arises whether or not an untrained panel of consumers can detect differences in eating characteristics among different grades of beef. The present study was initiated in an attempt to help answer this question.

If the consumer can detect eating differences in desirability between grades, it may be concluded that there is a relationship between visual appraisal and eating desirability. If, on the other hand, no differences between grades can be detected or if the lower grades should be more desirable than the higher grades, then the relationship between visual grades and eating desirability may not hold true.

The consumer is charged more per pound for Choice beef than for Good

or Standard. The cattle producer, in turn, is paid more for those cattle which will grade Choice. If it can be demonstrated that there is little or no difference in the eating desirability between the grades, then some allowance for this should be made in the field of visual grading. The grading system should reflect differences in those qualities which constitute "good eating". If the present grades fail to do this, then some means of improving the grading system would be desirable.

REVIEW OF LITERATURE

Measuring differences in palatability between various products is one of the major problems in the field of meats research. There is at present no objective method for measuring these palatability differences. The use of taste panels to detect organoleptic differences in various food products is the method most widely used.

Crocker (1948), in a study of the source of flavor of raw and boiled beef, stated that in raw beef there is a small amount of blood-like flavor in the juice, but none in muscle fibers. He found no enzyme in the saliva capable of hydrolyzing raw meat fiber to release any taste-producing substances during chewing. This worker also demonstrated that flavor in cooked beef is determined by many chemical components, and consists more of aroma than of taste. Some of the flavor of meat released by low-temperature heating (212° F.) is probably due to the "cracking" of amino acid units of the protein, particularly those of the muscle fiber. Some of the fragments thus released have taste, but the most conspicuous elements present are aromas.

Several investigators have used taste panels to measure such sensory qualities as palatability and tenderness of meats which have been subjected to various treatments. Gaddis et al. (1950) studied ninety-seven beef rib samples to determine the relationship between objective measures of press fluid and subjective panel ratings for juiciness. They found that the percentage of press fluid was not significantly related to the subjective scores for quantity of juice. There was a tendency for the

percentage of press fluid to decrease as the percentage of fat in the press fluid increased due to a larger amount of intramuscular fat. At the same time, the subjective scores for quantity and quality of juice increased. The relationship between percentage of fat in the press fluid and the subjective scores for juiciness was curvilinear, since there was little change in score after approximately two per cent fat content.

Clark et al. (1949) used a five-member trained taste panel to study the differences in tenderness and palatability of beef top-round cooked by oven roasting and pressure cooking. The judges based their ratings on aroma, texture, flavor and juiciness. The panel rated the roasted meat as being more palatable than that cooked in the pressure cooker. The judges preferred the flavor of both the lean and fat of the oven roasted meat and thought that the meat cooked under pressure was too dry. The tenderness of the different muscles in the roasts was tested by means of the Warner-Bratzler shear. No apparent difference in tenderness between the individual muscles of the round was found with either cooking method.

Wanderstock and Miller (1948) used a small panel of trained judges to score the palatability of beef roasts from steers on different levels of feeding. One of the main objectives of this study was to determine the degree of fatness (as represented by carcass grade) necessary to produce beef which was acceptable in palatability. The range in carcass grades was from average Choice to low Commercial. (There was no Standard grade at that time.) It was found that all samples met the minimum level of acceptance for palatability. The beef which had been fed grain and graded low Good to average Choice was higher in palatability than the carcasses which were produced by fattening on pasture alone and which graded low Commercial to low Good.

Many people regard tenderness as the most important eating characteristic of beef. This characteristic may be measured by various objective devices as well as by the use of taste panels. Mackintosh et al. (1936) stated that the Warner-Bratzler shear was a satisfactory test for measuring tenderness as shown by the correlation between shear value, collagen content and a panel rating.

Bratzler (1949) discussed the proper procedure to use with the Warner-Bratzler shear and stated that there are several factors which may affect the values obtained from this machine. The first is the degree of doneness of the cooked sample. In general, the higher the internal temperature of the sample, the more force required to shear it. There may be variation in the readings due to lack of uniformity in thickness among samples. The presence of connective tissue and intermuscular fat in the sample will affect the ratings and should be avoided. Finally, to obtain the most accurate readings, the samples should be taken parallel with the direction of the majority of the muscle fibers.

Hiner and Hankins (1950) compared the relative tenderness of beef samples from nine different locations of the same carcass and from the same location in the carcasses of animals of different ages. They used the Warner-Bratzler shear as the measure of tenderness. At least two one-inch cores per sample were used and each core was sheared three times. The average for all shears on any sample was the figure used in the results. For each of the five age groups used, the samples were classified into four groups ranging from the least to the most tender. These groups were: neck and foreshank; round; chuck at third rib and cross arm, eighth rib, short loin and loin end; and tenderloin. There was a smaller difference in tenderness among samples from the younger animals than from

older animals. As the age of the animals increased, tenderness decreased for each of the nine samples. The difference in tenderness between veal and cow was found to be highly significant, whereas the difference between veal and five-hundred pound slaughter calves was not significant.

Ramsbottom and Strandine (1948) studied differences in tenderness among the muscles of beef carcasses. The Warner-Bratzler shear was used on both raw and cooked samples. Tenderness was also determined by a committee rating using a scale of one (very tough) to seven (very tender). The samples were cooked in deep fat to an internal temperature of 170° F. The shear values were larger for the cooked beef than for the raw samples in thirty-five out of fifty muscles tested. This indicates that most muscles become somewhat less tender when heated quickly to 170° F. The psoas major (tenderloin) was found to be the most tender muscle. There was no indication as to the agreement between the committee ratings and the Warner-Bratzler shear values.

Cover (1937) used the paired-eating method to study the effect of time and temperature on the tenderness of beef roasts. This method involved a panel of judges, each making comparative judgements from paired samples taken from similar positions in paired roasts. One of the paired roasts was cooked in a 257° F. oven to an internal temperature of 176° F., and the other roast was cooked in a 437° F. oven to the same internal temperature. The tenderness was rated on a five-point chart in which number one was "very tough" and number five "very tender". The panel judgements revealed a significant increase in tenderness for beef roasts cooked at the lower temperature as compared to those cooked at the higher temperature. The difference in tenderness appeared to be more related to the longer cooking time needed to reach a given internal temperature than

to the cooking temperature itself.

Ramsbottom et al. (1945) studied the comparative tenderness of twenty-five representative muscles from three U.S. Good beef carcasses. Tenderness was measured by the Warner-Bratzler shear and organoleptically. A positive correlation was found between the shear ratings and the score of the judges.

In most instances where a panel of judges is used to rate samples of meat for such characteristics as flavor, tenderness and desirability, the panel has had some previous training or has been selected on the basis of sensitivity to the characteristic under study. Bennett et al. (1956) conducted a study to determine if the training of taste panel members would increase their ability to detect differences in aroma and flavor of ground beef at different levels of rancidity. The performance of a previously untrained group was observed during fifteen trials. The panel rated twelve samples each day. The panel members had an opportunity to discuss their ratings twice a day. The scorings for both aroma and flavor were inconsistent during the first week of study, but there was more uniformity in ratings among the group as the training period progressed. Some of the judges had only a limited ability to detect small differences, and their discrimination was not improved with training. In general, however, training did increase uniformity among the judges.

Rhodes et al. (1956) worked with both a trained and an untrained panel to determine whether eating differences could be detected among different grades of beef or among different carcasses from the same grade. Carcasses were selected which ranged in weight from 320 to 840 pounds, and which graded Prime, Choice, Good and Commercial. The judges were given five samples from either the short loin or the top-round, three of

the samples from one steak and the remaining two from a similar location on another carcass. The ability of the judges to discriminate was measured by their success or failure to determine which three samples were alike. The results indicated that eating characteristics are not closely related to grade. Differences in eating quality as indicated by the judges' ability to discriminate among samples were about the same within a grade as they were between grades. The panel of inexperienced judges showed greater ability to discriminate among the various samples tested than did the experienced judges. The inexperienced judges were students who expressed an interest in the study. The authors suggested that although experience improves judging ability, perhaps in this case motivation was more important than experience in influencing performance.

There are several different ways in which samples can be presented to taste panels. These different methods of presentation require the use of statistical analyses specifically adapted to them. Bradley (1953) discussed the different types of taste panels and the purposes for which they are designed. There were four types of taste panels considered, those for the detection of differences, quality control, consumer preference, and quality evaluation. It was pointed out that when a rating scale is devised for use by the judges, there is no guarantee that all the members of the panel will utilize the scale in the same manner. The ranking technique may be used by a judge more successfully than the rating scale when treatment differences are very small and difficult to detect. The paired comparison method is merely a special rank order technique. With this method only two treatments are considered at one time.

Terry et al. (1952) presented an experimental technique and analysis for use with the paired comparison method which is adapted to problems

involving the detection of differences among several treatments by sensory means with a small panel of judges. The samples are presented two at a time to the judges who then rank them in order of preference for the attributes under consideration. The statistical analysis is accomplished by the use of tables which detect the degree to which the judges are able to determine differences consistently.

Peryam et al. (1950) described tests designed to measure sensory differences. They stated that the scoring methods most commonly used allow too many variables to operate at once. Each one of these variables is measured subjectively by the judges and then converted into a single score. It can only be assumed that the judges are placing equal weight on the different variables. There is a definite need for objective methods to measure flavor in food products. One such method suggested by these workers is the Duo-Trio test. The panel members are first given a control sample. Next they are given two more samples, one of which is a control and the other a sample of the product being tested. The judges must then state which of the last two samples is different from the first. This same procedure is repeated once more. In another, the Triangular test in which two controls and a variant are used, the observers are asked to state which sample is different. The latter test seems to be more sensitive than the Duo-Trio test.

The meat industry is interested in taste panels, since the reactions of panel members are an indication of consumer response to a given product. Garnatz (1952) discussed the method employed by the Kroger Food Foundation to obtain information regarding consumer preference or acceptance of various meat products. A large consumer panel was established by first dividing the area served by Kroger stores into districts. A

brochure outlining the purposes of the consumer panel was mailed to housewives in these districts. A quota of panel membership was assigned to each district based on the number of stores operated and the size of the population in the area. Full membership for the entire panel was set at seven hundred and fifty. The product to be tested was mailed to the panel members together with a similar item of known acceptance. A letter explaining in a general way what the test involved, a set of directions as to how the samples were to be handled, and a questionnaire accompanied the samples. The housewives who took part in this test received no pay other than the samples sent to them. Despite this fact, there was a high degree of interest and only rarely did the responses fall below eighty per cent. The Kroger Foundation has used such a panel for several years, and found it a valuable guide in product-development work.

EXPERIMENTAL OBJECTIVES

The purposes of this study were as follows:

- I. To determine whether an untrained taste panel can detect differences in over-all desirability, flavor, and tenderness between U.S. Choice, U.S. Good, and U.S. Standard grade rib steaks.
- II. To measure the variation in tenderness in fifteen beef ribs from U.S. Choice, U.S. Good and U.S. Standard grades of beef using the Warner-Bratzler shear.

EXPERIMENTAL PROCEDURE

I. Material Used

Fifteen paired wholesale beef ribs from carcasses grading U.S. Choice, U.S. Good and U.S. Standard were selected for this study. The right rib from each carcass was used for physical separation of fat, lean, and bone, and the left rib furnished the samples for the taste panel.

Animals were selected which had been shipped from the same feed lots and were approximately the same age. It was not always possible to obtain animals of the same weight, age and origin. Therefore, in some instances there was a weight spread between the Standard and the other two grades. The age, which ranged from approximately 14-30 months, was estimated on the live animal by the packing house cattle buyer and from the carcasses by the federal grader.

All carcasses were selected from the middle third of their respective grades, as determined by a federal meat grader. The carcasses were tagged with a code number which remained on the wholesale ribs when shipped to the University meat laboratory. The grade and slaughter weight of the five sets of animals are shown in Table I.

TABLE I
Grade, Slaughter Weight and Approximate Age
Of Beef Carcasses

Set	Grade	Hot Carcass Weight (Lbs.)	Approximate Age (Mos.)
1	Choice	450	14-18
	Good	447	14-18
	Standard	329	14-18
2	Choice	760	24-30
	Good	671	24-30
	Standard	534	24-30
3	Choice	721	24-30
	Good	674	24-30
	Standard	529	24-30
4	Choice	489	16-22
	Good	492	16-22
	Standard	467	16-22
5	Choice	474	16-22
	Good	480	16-22
	Standard	458	16-22

II. Methods

a. Physical Separation of Fat, Lean and Bone

The right ribs, after being aged twelve days, were cut according to the procedure set forth in the 1952 Proceedings of the Fourth Annual

Reciprocal Meat Conference. A three-rib cut utilizing the ninth, tenth and eleventh ribs was photographed and weighed. The fat, lean, and bone and eye muscle were physically separated and the weight of each recorded. Plate I shows a representative set of beef ribs.

b. Use of the Warner-Bratzler Shear to Obtain Tenderness Ratings

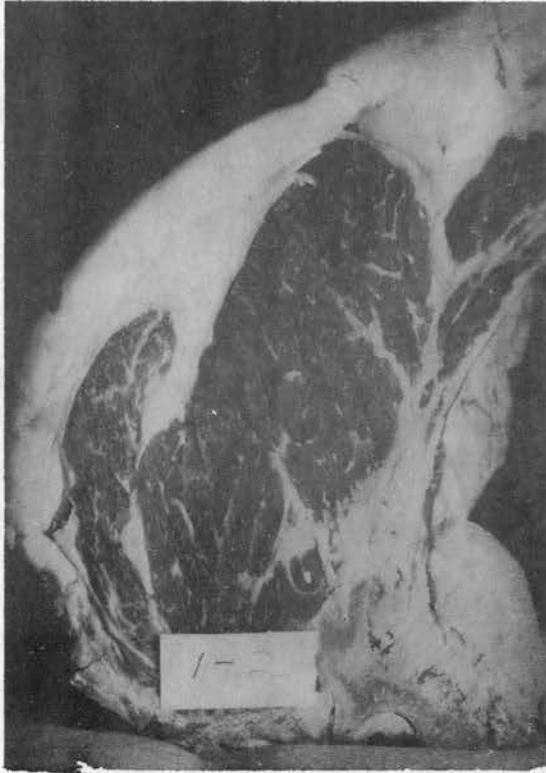
Two-inch steaks were thawed for twenty-four hours at 33° F., and then a dial type meat thermometer was inserted into the center of each steak. The steaks were placed four inches below the flame in a gas broiler which had been pre-heated to 350° F. They were cooked to an internal temperature of 110° F. and then turned and allowed to cook to an internal temperature of 160° F. The steaks were removed from the grill and one-inch cores were taken according to the procedure described by Bratzler (1949). Three cores, dorsal, medial and lateral, were taken from each steak. Two readings on the Warner-Bratzler shear were obtained for each core, making a total of six readings for each steak. The average of these six readings was used as the value for that carcass. An analysis of variance was performed to test for differences in tenderness among the three grades.

c. Initial Preparation of Samples for the Taste Panel

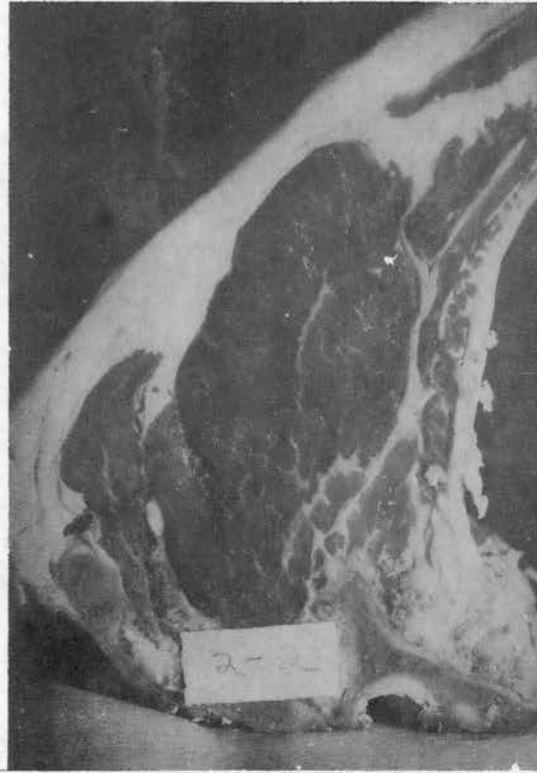
The left ribs, from which the samples for the taste panel were taken, were aged twelve days and trimmed of any dried or discolored surface. The short ribs were removed, and the rib was cut into six one-inch and one two-inch steaks, beginning at the posterior end. The two-inch steaks were used to obtain the Warner-Bratzler shear values. The steaks were prepared boneless and individually wrapped in a laminated freezer paper.

PLATE I

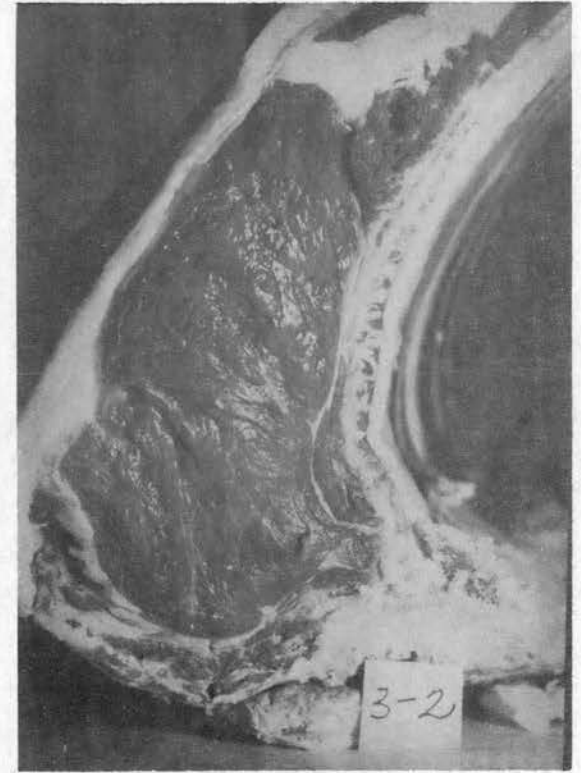
A representative set of Beef Ribs (set #2)



Choice #2



Good #2



Standard #2

Each package was coded to indicate the grade, set, and position of the individual steak in the rib. All steaks were placed in a sharp freeze at -20° F. for twenty-four hours and then stored at 0° F. Twenty-four hours before the steaks were used, they were placed in a cooler at 33° F. for thawing prior to cooking for taste panel evaluation. The length of time the steaks remained frozen varied from five to twenty days.

d. Selection of Panel Members

The taste panel was comprised of seven graduate students. The data for one of the judges were incomplete and were discarded before the final analysis. The panel members were selected from eleven participants on the basis of two preliminary trials using the triangle test, as described by Peryam et al. (1950). The materials for these preliminary tests were Choice and Commercial beef rib steaks.

During the first preliminary trial each judge was asked to indicate which of the samples made up the pair, and which was the odd sample in terms of tenderness and over-all desirability. The second preliminary trial was conducted in a similar manner with one exception. Instead of indicating which sample was the more tender, the judges were to select either the pair or the odd sample as having the more pleasing flavor. The second trial was conducted twenty minutes after completion of the first trial.

Of the eleven initial participants, two failed in at least one of the trials to match up the pairs correctly and were thus eliminated. Two others were inconsistent in their desirability ratings, selecting Choice as more desirable in one trial, and Commercial as more desirable in the other. The remaining seven constituted the taste panel.

e. Conducting the Taste Panel

The trials were conducted weekday afternoons at 4:30 P.M. until a total of fifteen trials had been completed. The steaks were thawed twenty-four hours at 33° F. before each trial. They were then broiled in a manner similar to the one employed to prepare steaks for the shear tests. The surfaces of the steaks, however, were placed three and a half inches from the flame instead of four inches. Also, each steak was tagged with an aluminum tag before cooking to maintain the identity of the sample.

Each trial necessitated the use of six steaks, two from each of the three grades. The steaks were cut from the same relative position on the wholesale rib. A double strip was cut from the center of each eye muscle and from this seven samples were taken. Figure 1 shows the method of cutting the samples. Portion number three was always discarded since it contained a section of intermuscular fat.

The procedure set forth by Terry et al. (1952) was followed in presenting the samples to the judges. The three treatments were the grades of U.S. Choice, U.S. Good and U.S. Standard. The design required all possible paired comparisons among treatments: Choice with Good, Choice with Standard, and Good with Standard. For each trial and for each judge there were thus three sets of comparisons. The judges rated each of these comparisons for three attributes: over-all desirability, flavor and tenderness.

A warm porcelain plate was marked off with a black wax pencil into thirds and the thirds labelled I, II, III. Each third was divided in halves by a red wax pencil and the halves labeled A and B (Figure 2). The position of the comparisons between any two treatments was randomized

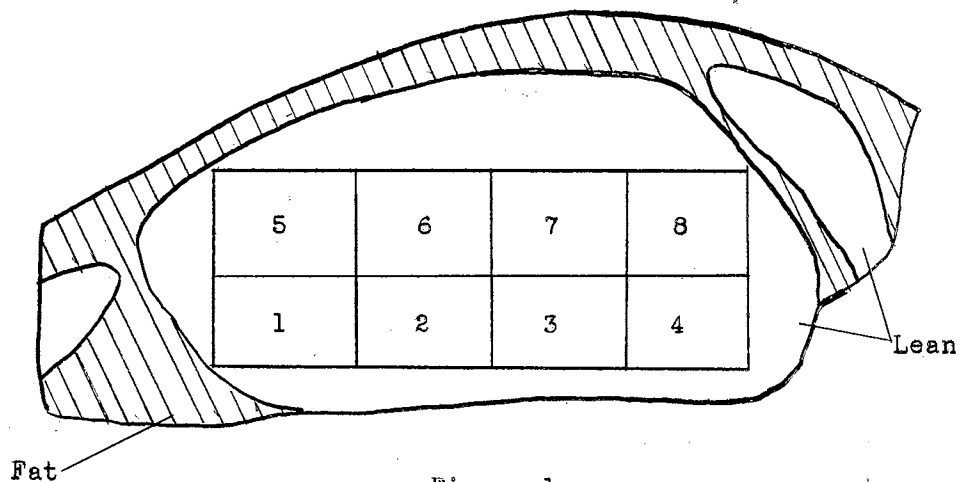


Figure 1

Method of Trimming
and Position of Samples
In Rib Steaks Used in This Study

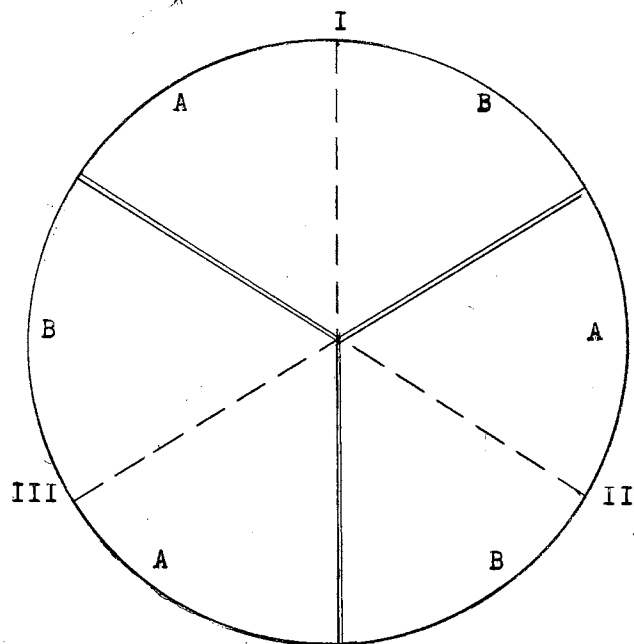


Figure 2

Plate Diagram Showing
the Method in Which the Samples
Were Paired for Presentation to the Judges
(Double lines were black, broken lines were red.)

on the major divisions of the plates (I, II, III) for each judge and for each trial. The treatments were given the following code numbers: (1) for Choice, (2) for Good and (3) for Standard. The position of each treatment on the plates was recorded in advance of each trial so the ratings of the judges could be correctly recorded. When the samples were presented to the panel, portions were taken from the same relative position of the steak in order to hold all variables except grade as constant as possible.

The seven panel members were instructed to make three sets of comparisons for three different factors at each sitting. Each comparison between pairs was made independently of the other comparisons. The members were told only that the samples were beef. This was a forced choice type of situation in which the panel members were required to rate one of each pair as being the "better".

The score card used by the judges is shown in Figure 3. The Roman numerals and letters on the forms corresponded to the same letters and numbers on the plates. The judges recorded a one (1) in the appropriate block for that sample which had most of the attribute under consideration and a two (2) for the remaining sample of the pair. In the case of over-all desirability they were to consider such things as aroma and juiciness, even though they were not specifically rating those characteristics. The over-all desirability rating was used to mean that sample which gave them the greatest eating pleasure. The rating for flavor and tenderness was self-explanatory.

After each trial the rating forms for each of the judges were collected and decoded. The treatment ratings were then recorded on a form as shown in Figure 4. The totals for each treatment were recorded at

TASTE PANEL SCORE CARD

NAME _____

TRIAL _____

DATE _____

1 = more of the attribute

2 = less of the attribute

Over-all Desirability

Flavor

Tenderness

	A	B	A	B	A	B
I						
II						
III						

Figure 3

Taste Panel Score Card

TASTE PANEL DATA SHEET

NAME OF JUDGE _____

TRIAL _____

DATE _____

DESIRABILITY

FLAVOR

TENDERNESS

		T ₁ ¹	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
Pair 1	(T ₁)(T ₂)			X			X			X
Pair 2	(T ₁)(T ₃)		X			X			X	
Pair 3	(T ₂)(T ₃)	X			X			X		
TOTAL ²										

Figure 4

Form Used to Record Ratings of the Judges

¹T₁ indicates Choice, T₂ Good, and T₃ Standard.

²For the actual totals obtained in this study see Appendices A, B, C.

the bottom of the form. A perfect rating, or one in which the judge was able to detect differences in any of the attributes, had totals of 2, 3, 4 for the three trials. Totals of 3, 3, 3 indicated that for a particular trial and attribute the judge was unable to detect any difference.

III. Statistical Analysis

The analysis was conducted according to the procedure outlined by Terry et al. (1952). The judges were rated both as individuals and as a six-member panel. A chi square test for the individual judges and the panel was performed by the method presented by Terry et al. (1952).

RESULTS AND DISCUSSION

I. Physical Separation of the Ninth, Tenth and Eleventh Rib Sections

a. Results

The ninth, tenth and eleventh ribs from the right wholesale rib of each carcass were used for physical separation. The percentages of fat, lean, bone and longissimus dorsi were then computed. The percentage of the longissimus dorsi was computed alone, and then included as part of the total lean. Table II shows the percentages for each carcass. The percentage figures do not necessarily total one hundred, due to rounding errors in recording the weights. Table III presents the average percentage for each of the three grades.

b. Discussion

There was an increase in the percentage of bone in the Standard grade of 1.4% over the Choice grade, as indicated in Table III, while the Standard and Good grades contained almost identical percentages of bone. The percentages of bone for the three grades were not significantly different, as shown by the analysis of variance in Table IV.

There was more variation in percentages of fat than bone among the three grades. The differences in per cent of fat were significant at the one per cent level, as shown in Table V. The average per cent of fat

TABLE II

Percentage of Bone, Fat, Lean and Longissimus Dorsi From
Ninth, Tenth and Eleventh Ribs of Right Wholesale Ribs
Graded U.S. Choice, U.S. Good and U.S. Standard

Animal Number and Grade	% Bone	% Fat	% Lean	% L. Dorsi
Choice 1	17.8	36.7	44.2	19.7
2	13.0	49.6	36.9	16.3
3	14.1	45.0	40.5	16.2
4	13.9	34.4	51.7	28.2
5	13.0	39.9	46.9	22.3
Good 1	17.0	34.5	48.6	21.8
2	17.0	39.0	43.6	16.9
3	16.0	35.5	48.0	19.6
4	12.8	35.9	51.4	25.1
5	14.3	36.2	49.1	19.6
Standard 1	16.1	30.3	53.6	26.3
2	16.7	30.4	52.1	24.6
3	17.9	27.1	55.0	23.7
4	14.1	34.8	50.5	37.7
5	14.3	32.0	53.5	25.5

in each grade was related to the grades themselves (Table III). Choice had the highest average per cent of fat (41.1%), Good had 36.2% and Standard had the lowest percentage of fat, 31.0%.

TABLE III

Average Per Cent of Bone, Fat, Lean and Longissimus Dorsi by Grade

Grade	% Bone	% Fat	% Lean	% L. Dorsi
Choice	14.4	41.1	44.0	20.5
Good	15.4	36.2	48.1	20.6
Standard	15.8	30.9	52.9	27.6

TABLE IV

Analysis of Variance of Per Cent of Bone in Ribs from Choice, Good and Standard Grade Beef Carcasses

Source	D/F	SS	MS	F
Total	14	45.24		
Grade	2	5.74	2.87	.87
Error	12	39.50	3.29	

TABLE V

Analysis of Variance of Per Cent of Fat in Ribs from Choice, Good and Standard Grade Beef Carcasses

Source	D/F	SS	MS	F
Total	14	455.87	32.56	
Grade	2	260.40	130.20	7.99**
Error	12	195.47	16.29	

**P < .01

The percentages of lean for the three grades approached statistical significance at the one per cent level. The analysis of variance is presented in Table VI. The average percentages of lean in each grade were inversely related to the grades, with Standard having 53.0% lean, Good 48.1% and Choice 44.0% lean.

TABLE VI

Analysis of Variance of Per Cent of Lean in Ribs from Choice, Good and Standard Grade Beef Carcasses

Source	D/F	SS	MS	F
Total	14	373.25		
Grade	2	198.91	99.45	6.84*
Error	12	174.34	14.53	

*P < .05

The percentages of longissimus dorsi among the three grades approached significance at the five per cent level, as indicated in Table VII. The average per cent of longissimus dorsi was almost identical for the Choice and Good grades (20.5% and 20.6%), but the average per cent for the Standard grade was 27.6%.

TABLE VII

Analysis of Variance of Per Cent of Longissimus Dorsi in Ribs from Choice, Good and Standard Grade Beef Carcasses

Source	D/F	SS	MS	F
Total	14	433.32		
Grade	2	163.11	81.55	3.62
Error	12	270.21	22.52	

As a result of the analysis of five carcasses from each of the three grades U.S. Good, U.S. Choice and U.S. Standard, several factors are evident. Of the four components studied, the per cent of bone varied the least among the three grades. Since per cent of fat increased with grade, and bone was more or less constant, the percentage of lean automatically decreased with grade. The average percentage of longissimus dorsi was almost identical for Choice and Good, while the Standard grade showed an increase in average per cent of longissimus dorsi of approximately 37% over the other two grades.

II. Values Obtained by Use of the Warner-Bratzler Shear on Samples From U.S. Choice, U.S. Good and U.S. Standard Grades of Beef

a. Results

Three one-inch cores were removed from a two-inch steak from each animal used in the study. On each of the three cores, dorsal, medial and lateral, two readings were obtained in terms of pounds of force necessary to shear the samples by use of the Warner-Bratzler shear. These values were recorded to the nearest one-fourth of a pound. The average of the six readings was used as the value for each animal. Tables VIII, IX and X present the data obtained by grade.

b. Discussion

Both the most tender carcass, as determined by the Warner-Bratzler shear, and the least tender carcass were in the Standard grade. The most tender was Standard #5, which had an average reading of 13.42 pounds, and the least tender was the Standard #2 with a reading of 23.67 pounds. The Standard grade, therefore, had a spread of 10.3 pounds and an over-

all average of 18.97 pounds for the five samples studied. The Good grade samples ranged from 16.04 pounds to 21.50 with a spread of 5.5 pounds and an over-all average for the Good grade of 18.77. The Choice grade ranged from 13.88 to 19.17 pounds, with a spread of 5.3 pounds and an over-all average for the grade of 16.79.

TABLE VIII

Shear Values in Pounds for Samples from Five Choice Carcasses

Carcass Number	<u>Dorsal Core</u>		<u>Medial Core</u>		<u>Lateral Core</u>		Total	Ave.
	1	2	1	2	1	2		
1	13.75	13.75	14.25	18.75	18.25	21.00	99.75	16.63
2	11.50	13.75	12.50	14.00	15.25	16.25	83.25	13.88
3	17.00	17.75	15.00	19.00	21.75	20.25	110.75	18.46
4	15.00	15.75	14.50	17.00	14.50	18.25	95.00	15.83
5	17.50	22.25	18.50	23.00	16.00	17.75	115.00	19.17
							Over-all Average	16.79

TABLE IX

Shear Values in Pounds for Samples from Five Good Carcasses

Carcass Number	<u>Dorsal Core</u>		<u>Medial Core</u>		<u>Lateral Core</u>		Total	Ave.
	1	2	1	2	1	2		
1	14.00	17.25	13.75	19.25	15.00	17.00	96.25	16.04
2	16.75	17.50	24.25	26.25	21.50	22.75	129.00	21.50
3	15.50	16.25	22.75	23.50	19.50	23.25	120.75	20.13
4	16.00	16.50	23.00	15.50	16.00	12.75	99.75	16.63
5	15.50	17.25	18.00	25.25	22.00	19.25	117.25	19.54
							Over-all Average	18.77

TABLE X

Shear Values in Pounds for Samples from Five Standard Carcasses

Carcass Number	Dorsal Core		Medial Core		Lateral Core		Total	Ave.
	1	2	1	2	1	2		
1	20.75	16.00	19.75	24.75	20.00	22.00	123.25	20.54
2	18.00	20.00	18.50	28.75	23.50	33.25	142.00	23.67
3	14.25	19.25	14.00	16.75	16.75	16.25	97.25	16.21
4	17.75	22.75	19.00	24.25	19.25	23.00	126.00	21.00
5	14.00	15.00	14.00	13.50	11.75	12.25	80.50	13.42
Over-all Average								18.97

The Standard grade had approximately twice the spread between carcasses as was found in either the Good or Choice beef. There was only a .2 pound difference between Standard and Good grade averages, whereas there was an over-all spread of approximately two pounds between the Choice average and the averages for the other two grades. This may indicate that while the Standard grade does include carcasses that are as tender or more tender than the grades above it, the chances of repeatedly selecting more tender samples would be higher in the Choice grade.

The analysis of variance shown in Table XI was performed to determine where the differences in tenderness were most prevalent. The core X animals in grade (pooled) mean square was used to test the core X grade mean square and core mean square. The mean square for animals in grade (pooled) was used to test grade mean square.

The differences between the duplicate readings on the same core accounted for only a small part of the total variation in tenderness ratings. The differences between cores were significant at the one per

cent level. When the mean square for animals within grade was used to test grade differences, non-significance was obtained. Variation within grade thus accounted for more of the difference in tenderness ratings than did the differences between grades. This is supported by the actual averages for the three grades and the spread in ranges within the grades.

TABLE XI

Analysis of Variance for Differences in Tenderness of Fifteen Carcasses From U.S. Choice, U.S. Good and U.S. Standard Grades

Source	D/F	SS	MS	F
Total	89	1,439.31		
Grade	2	86.71	43.36	0.8
Animals in Grade (Pooled) ¹	12	641.17	53.43	
Cores	2	110.87	55.43	6.27**
Core X Grade	4	54.78	13.70	1.55
Core X Animals in Grade (Pooled) ²	24	211.96	8.83	
Duplications	45	333.84	7.42	

¹The mean square for animals in grade (pooled) was used to test grade mean square.

²Core X animals in grade (pooled) is used as the error term to test core X grade, cores and animals in grade (pooled).

Careful technique in preparing the samples for the Warner-Bratzler shear eliminates much of the variation between the duplicate readings on any one core. The variations among three cores from one steak constituted the largest single source of variation for all samples used for shear values. The results of the Warner-Bratzler shear test indicate that there is a greater range in tenderness within a grade

than between grades when only Choice, Good and Standard grades are considered.

III. Taste Panel Data

The ratings of six untrained panel members were used to determine whether the panel could detect differences in desirability, flavor and tenderness between samples from fifteen beef carcasses of U.S. Choice, U.S. Good and U.S. Standard grades. The panel made three sets of comparisons at each sitting, rating desirability, flavor and tenderness. Appendices A, B, and C give the total ratings for each of the comparisons for the six judges at fifteen sittings.

a. Desirability

Table XII presents the desirability rating totals for the fifteen trials for each judge and the order of preference for the three grades. The results of each judge were analyzed separately to determine if each individual could detect differences in eating desirability among the three grades. The results of this analysis appear in Table XIII. The ratings on an individual basis were pooled to obtain a rating for the entire panel. This also appears in Table XIII.

The order of preference shows that of the six judges, Judge I scored all three grades exactly the same (Table XII). The probability that he could detect any difference in the over-all eating desirability between the three grades of beef, Choice, Good and Standard was 0.0 (Table XIII). This meant that he could have obtained the same values for his score (45,45,45) had he based his preference between two samples on chance alone. The ratings of Judge VI had a probability of .97, and for all

TABLE XII

Total Desirability Ratings for Six Judges for Fifteen Trials

Judge	Grade			Order of Preference
	Choice	Good	Standard	
I	45	45	45	No Preference
II	43	39	53	Good, Choice, Standard
III	47	44	44	<u>Good, Standard, Choice</u>
IV	46	42	47	Good, Choice, Standard
V	38	42	55	Choice, Good, Standard
VI	46	43	46	Good, <u>Standard, Choice</u>
Total	265	255	290	Good, Choice, Standard

TABLE XIII

Chi Square and Probabilities for the Judges as Individuals and for the Pooled Panel in Detecting Differences in Desirability Among the Grades

Judge	D/F	Chi Square	Probability
I	2	.00	1.0
II	2	9.83	.009**
III	2	.54	.77
IV	2	1.17	.57
V	2	15.39	<.001**
VI	2	.07	.965
Panel	12	27.47	.008**

practical purposes he was no more able to detect differences between the three grades than was Judge I.

Of the four remaining panel members, two were able to detect differences in desirability which were significant at the one per cent level. Judge II had a probability rating of .009 which means that only nine times out of one thousand would he obtain by chance values with a spread as wide or wider than 39,43,53. This is an indication that this judge could detect differences in over-all eating desirability among these three grades. His order of preference was Good, Choice and Standard.

Judge V, who had a probability rating of less than .001, was the most discerning judge on the panel. He would have obtained by chance a spread in ratings as wide or wider than 38,42,55 less than one in one thousand times. His order of preference was Choice, Good, Standard.

Judges III and IV had probability ratings of .77 and .57 respectively. Judge III rated Good and Standard the same, and preferred these grades to Choice. Judge IV preferred Good, Choice and Standard, in that order.

A probability level of .008 was obtained when the ratings were pooled to establish a panel rating. This indicated that the panel as a whole was able to detect differences in eating desirability among the three grades of beef. The order of preference for the panel was Good (255), Choice (265), Standard (290) (Table XII). The panel was more successful in detecting differences in desirability between Standard and the other two grades than between the Choice and Good grades. As a unit the panel preferred the Good to the Choice grade. Even between the two individual panel members who were able to detect successfully differences between grades there was not complete agreement as to order of preference. This indicates that untrained individuals have varying levels of sensitiv-

ity to differences in the eating characteristics of these three grades of beef. There seems to be considerable variation in the order of preference, especially between the Good and Choice grades, even when differences can be detected.

b. Flavor

Table XIV presents the flavor rating totals and order of preference of the six judges during fifteen trials. The analysis followed the same procedure utilized in the desirability ratings. Again, the data for each judge were analyzed on an individual basis and then the ratings for all judges were pooled to obtain the panel rating (Table XV).

The order of preference for flavor was the same as the order of preference for desirability with the exception of Judge I who had no preference for desirability (Tables XII and XIV). Judge I was the only individual whose levels of probability for flavor and desirability showed any great variation. His probability level of .46 for flavor signified that about half the time he would have obtained values as different or more different than 42,45,48 solely by chance.

Judges II and V again demonstrated a distinct ability to detect differences in flavor among the three grades. Judge V in particular exhibited an extreme sensitivity to differences in flavor. Judges III, IV and VI exhibited little ability to detect differences in flavor among the three grades. There was no agreement as to the order of preference among the judges who lacked the ability to distinguish flavor differences. These data indicate that eating preference, especially between Good and Choice grades is not clearly defined, since the two judges who were successful in detecting flavor differences were not in complete agreement

TABLE XIV

Total Flavor Ratings for Six Judges During Fifteen Trials

Judge	Grade			Order of Preference
	Choice	Good	Standard	
I	48	45	42	Standard, Good, Choice
II	43	40	52	Good, Choice, Standard
III	48	44	43	Standard, Good, Choice
IV	45	43	47	Good, Choice, Standard
V	38	42	55	Choice, Good, Standard
VI	46	43	46	Good, <u>Choice</u> , Standard
Total	268	258	285	Good, Choice, Standard

TABLE XV

Chi Square and Probabilities for the Judges as Individuals and for the Pooled Panel in Detecting Differences in Flavor Among the Three Grades

Judge	D/F	Chi Square	Probability
I	2	1.62	.46
II	2	7.23	.03*
III	2	1.25	.54
IV	2	.72	.70
V	2	17.63	<.001**
VI	2	.07	.97
Panel	12	28.97	.005**

as to order of preference. An individual may not necessarily prefer the higher grade even when he can detect a flavor difference.

The pooled ratings for the panel exhibited a definite sensitivity to flavor differences as shown by the probability of .005 (Table XV). The order of preference for the panel was Good (258), Choice (268) and Standard (285) (Table XIV). These figures correspond closely with the panel totals for desirability ratings which could indicate the members of this panel were basing their desirability ratings more on flavor than on tenderness.

c. Tenderness

Table XVI presents the total ratings for tenderness and the order of preference for the six judges during fifteen trials. Table XVII gives the chi square values and the probability levels for each individual judge. A pooled chi square and probability level for the panel is also presented.

The judges were unable either as individuals or as a panel to successfully detect differences in tenderness among the three grades. The ratings of the judges seem to agree with the findings of the Warner-Bratzler shear test in that the greatest differences in tenderness were within grades rather than between grades. The smaller the differences in tenderness, the less likelihood there was that the judges could detect these differences.

The lack of detectable differences in tenderness among the grades did not lessen the discrimination of the judges in regard to desirability. The panel detected differences in over-all eating desirability which were significant at the one per cent level, even though differences in

TABLE XVI

Total Tenderness Ratings for Six Judges During Fifteen Trials

Judge	Grade			Order of Preference
	Choice	Good	Standard	
I	43	47	45	Choice, Standard, Good
II	45	44	46	Good, Choice, Standard
III	45	45	45	No Preference
IV	46	44	45	Good, Standard, Choice
V	43	45	47	Choice, Good, Standard
VI	49	42	44	Good, Standard, Choice
Total	271	267	272	Good, Choice, Standard

TABLE XVII

Chi Square and Probabilities for the Judges as Individuals and for the Pooled Panel in Detecting Differences in Tenderness Among the Grades

Judge	D/F	Chi Square	Probability
I	2	.72	.70
II	2	.18	.91
III	2	.00	1.00
IV	2	.18	.91
V	2	.72	.70
VI	2	2.41	.30
Panel	12	4.22	.96

tenderness among the grades could not be discerned. As long as flavor differences could be detected, then over-all desirability ratings were shown in the same order of preference.

SUMMARY AND CONCLUSIONS

Six graduate students in animal husbandry comprised a taste panel to evaluate differences in eating desirability, flavor and tenderness among three grades of beef: U.S. Choice, U.S. Good and U.S. Standard. As individuals, two of the six judges were able to detect significant desirability and flavor differences among the three grades. None of the individual judges were able to detect differences in tenderness at the ten per cent level of probability.

The panel as a whole was found to be very successful in detecting desirability and flavor differences. For both of these attributes the ability of the panel to detect differences was significant at the one per cent level. The order of preference for the panel was Good, Choice and Standard, for both desirability and flavor. The order of preference was the same for tenderness, but the differences among grades were not significant.

It appears that different individuals have varying levels of sensitivity to flavor and eating desirability. Even when individual panel members were successful in recognizing differences between the three grades there was still not complete agreement as to which grade was the most desirable. The panel members were in general agreement that the Standard was the least desired of the three grades. There was more disagreement between the Choice and Good grades as to which was preferred. The panel rated the Good grade as being more desirable and flavorful than

Choice.

The panel was unable to detect any differences in tenderness among the three grades. This is explained in part by the Warner-Bratzler shear values obtained for the carcasses used, which indicated that differences in tenderness were as large within a grade as they were between grades. The largest variation in tenderness was in the Standard grade.

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APPENDIX A

Ratings by Taste Panel Members for Over-All Desirability of Beef Samples From Grades
U.S. Choice, U.S. Good, U.S. Standard

Date	Set No.	Judge I			Judge II			Judge III			Judge IV			Judge V			Judge VI		
		C	G	S*	C	G	S	C	G	S	C	G	S	C	G	S	C	G	S
June 26	1	4	2	3	3	2	4	4	3	2	4	3	2	2	3	4	4	2	3
June 27	1	2	4	3	2	3	4	3	3	3	3	3	3	3	2	4	4	2	3
July 1	1	3	2	4	3	2	4	4	3	2	3	3	3	2	3	4	4	2	3
July 2	2	3	4	2	3	2	4	3	3	3	2	3	4	2	3	4	4	3	2
July 8	2	4	3	2	3	2	4	3	3	3	3	3	3	2	3	4	3	3	3
July 9	2	2	4	3	3	3	3	3	3	3	3	2	4	2	3	4	2	4	3
July 10	3	2	3	4	4	2	3	3	3	3	2	3	4	3	3	3	4	2	3
July 11	3	4	3	2	3	3	3	3	2	4	3	3	3	2	3	4	3	3	3
July 12	3	3	4	2	3	3	3	4	3	2	4	3	2	2	3	4	2	3	4
July 15	4	2	3	4	3	3	3	2	3	4	3	2	4	3	3	3	2	3	4
July 16	4	2	3	4	2	3	4	2	3	4	3	3	3	2	3	4	3	3	3
July 17	4	3	2	4	4	3	2	3	2	4	2	3	4	3	2	4	2	4	3
July 18	5	4	3	2	3	2	4	4	3	2	4	3	2	3	2	4	4	3	2
July 19	5	4	2	3	2	3	4	3	3	3	4	2	3	4	2	3	2	3	4
July 23	5	3	3	3	2	3	4	3	4	2	3	3	3	3	4	2	3	3	3

*Code: C = U.S. Choice; G = U.S. Good; S = U.S. Standard. For explanation of ratings see page 60.

APPENDIX B

Ratings by Taste Panel Members for Flavor of Beef Samples From Grades U.S. Choice, U.S. Good, U.S. Standard

Date	Set No.	Judge I			Judge II			Judge III			Judge IV			Judge V			Judge VI		
		C	G	S*	C	G	S	C	G	S	C	G	S	C	G	S	C	G	S
June 26	1	4	2	3	3	2	4	4	3	2	4	3	2	2	3	4	4	2	3
June 27	1	2	4	3	2	3	4	3	3	3	3	3	3	3	2	4	4	2	3
July 1	1	2	3	4	3	2	4	4	3	2	3	3	3	2	3	4	4	2	3
July 2	2	4	3	2	3	2	4	3	3	3	2	3	4	2	3	4	4	3	2
July 8	2	4	3	2	3	2	4	3	3	3	3	3	3	2	3	4	3	3	3
July 9	2	2	4	3	3	3	3	3	3	3	3	2	4	2	3	4	2	4	3
July 10	3	3	3	3	4	2	3	3	3	3	2	3	4	3	3	3	4	2	3
July 11	3	4	3	2	3	3	3	3	2	4	4	3	2	2	3	4	3	3	3
July 12	3	2	4	3	3	3	3	4	3	2	3	4	2	2	3	4	2	3	4
July 15	4	3	3	3	3	3	3	2	3	4	3	2	4	3	3	3	2	3	4
July 16	4	3	4	2	2	3	4	2	3	4	3	3	3	2	3	4	3	3	3
July 17	4	4	2	3	4	3	2	3	2	4	2	3	4	3	2	4	2	4	3
July 18	5	4	3	2	3	3	3	4	3	2	4	3	2	3	2	4	4	3	2
July 19	5	3	2	4	2	3	4	4	3	2	3	2	4	4	2	3	2	3	4
July 23	5	4	2	3	2	3	4	3	4	2	3	3	3	3	4	2	3	3	3

*Code: C = U.S. Choice; G = U.S. Good; S = U.S. Standard. For explanation of ratings see page 60.

APPENDIX C

Ratings by Taste Panel Members for Tenderness of Beef Samples From Grades
U.S. Choice, U.S. Good, U.S. Standard

Date	Set No.	Judge I			Judge II			Judge III			Judge IV			Judge V			Judge VI		
		C	G	S*	C	G	S	C	G	S	C	G	S	C	G	S	C	G	S
June 26	1	4	2	3	3	3	3	4	3	2	4	3	2	3	3	3	4	3	2
June 27	1	2	4	3	2	4	3	3	2	4	3	3	3	3	2	4	3	4	2
July 1	1	3	3	3	2	4	3	4	3	2	3	3	3	3	3	3	4	2	3
July 2	2	2	4	3	2	4	3	2	4	3	2	4	3	2	3	4	4	2	3
July 8	2	4	2	3	3	2	4	3	4	2	2	4	3	3	4	2	4	3	2
July 9	2	2	4	3	3	2	4	2	3	4	3	3	3	2	3	4	2	3	4
July 10	3	2	3	4	4	3	2	2	3	4	2	3	4	3	3	3	4	3	2
July 11	3	4	3	2	4	3	2	3	2	4	3	3	3	3	4	2	3	3	3
July 12	3	3	4	2	3	3	3	4	3	2	4	3	2	3	2	4	2	3	4
July 15	4	2	3	4	3	2	4	2	4	3	3	2	4	3	3	3	3	2	4
July 16	4	2	3	4	2	3	4	2	3	4	3	3	3	2	3	4	3	3	3
July 17	4	2	3	4	4	3	2	3	2	4	3	2	4	2	3	4	3	2	4
July 18	5	4	3	2	4	2	3	4	3	2	4	3	2	4	2	3	4	3	2
July 19	5	4	3	2	4	3	2	3	3	3	4	2	3	4	3	2	3	3	3
July 23	5	3	3	3	2	3	4	4	3	2	3	3	3	3	4	2	3	3	3

*Code: C = U.S. Choice; G = U.S. Good; S = U.S. Standard. For explanation of ratings see page 60.

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- II. THE USE OF AN UNTRAINED TASTE PANEL TO STUDY ORGANOLEPTIC DIFFERENCES AMONG U.S. CHOICE, U.S. GOOD AND U.S. STANDARD GRADES OF BEEF

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II. THE USE OF AN UNTRAINED TASTE PANEL TO STUDY
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AND U.S. STANDARD GRADES OF BEEF

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