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A STUDY OF PALATABILITY AND
PRICE OF TWO GRADES
OF SIRLOIN BUTTS

Thesis for the Degree of M. S.
MICHIGAN STATE COLLEGE

Jean Hughes Dunnigan
1943

This is to certify that the

thesis entitled

A Study of Palatability and Price of Two Grades
of Sirloin Butts

presented by

Jean Hughes Durnigan

has been accepted towards fulfilment
of the requirements for

Master of Science degree in Institution Administration

Mabelle S. Ehlers
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Date May 28, 1943

A STUDY OF PALATABILITY AND PRICE OF TWO GRADES OF SIRLOIN BUTTS

by

Jean Hughes Dunnigan

A THESIS

Submitted to the Graduate School of Michigan
State College of Agriculture and Applied
Science in partial fulfilment of the
requirements for the degree of

MASTER OF SCIENCE

Department of Institution Administration
Division of Home Economics

1943

THESIS

Acknowledgment

The writer wishes to express her appreciation and thanks to all who assisted in making this study possible.

For the kindly advise and criticisms received during the course of this study, the writer is grateful to Professor Mabelle S. Ehlers under whose supervision the work was directed; to Dr. Marie Dye for helpful suggestions and final review of the subject matter; to Miss Ruth Griswold; to Dr. W. D. Baten; and to Professor G. L. Brown. To the Department of Lunchrooms, Detroit Public Schools, the writer expresses her gratitude and recognition for its cooperation.

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I. Introduction

Since meat absorbs the largest part of the food dollar, food service directors are always interested in data on the most economical way to purchase and prepare meat to obtain the most palatable servings for the lowest cost. This is particularly important in school cafeterias where prices for individual foods must be very low. Food service directors generally agree that one of the most popular kinds of meat in any institution is beef. Clientele tires of it less readily than any other meat, partially because it can be served in more styles than others. For this reason, in many institutions beef, in some form, appears on the menu every day.

Good beef is bright red in color, well marbled and covered with creamy-white fat. This exterior fat should be smooth and brittle. The texture of good lean beef is firm, fine and velvety. The bones are porous and well formed. Not all beef can meet such high standards but can still be edible and palatable. For this reason the United States Department of Agriculture has set up classes and grades to serve as a yardstick for determining quality and to aid in fair price-setting. The price of beef is determined by its classification. These classes and grades are particularly important in beef, since they differ from each other in weight, conformation, finish and sex. These differences are reflected in eating quality and price. The classes of beef are steer, heifer, cow, bull and stag. In each class of beef there are several grades. The common grading arrangement is Prime,* Choice, Good, Commercial, Utility (formerly known as Common), Cutter and Canner. The terms

* Capital letters are used when grade is mentioned to prevent confusion with adjectives.

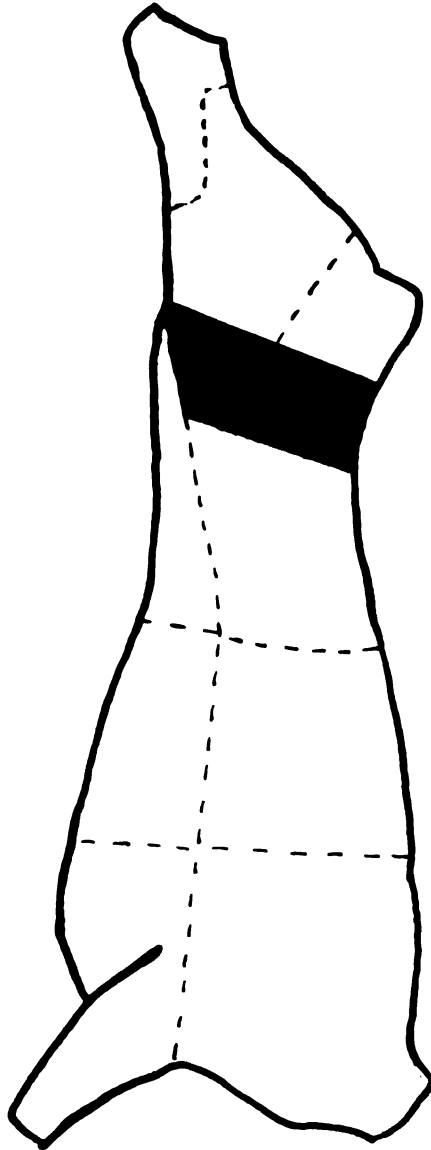
Utility and Commercial are not widely accepted as yet, but will doubtless entirely supercede Common and Medium, since the government so recommends. In this report, the term Utility is used throughout instead of Common.

In beef as in other meats tenderness and toughness depend more upon the cut, the location of the meat on the animal, than upon the grade, although that is a factor too. Tender cuts are more expensive than the tougher ones, but they are not always the most palatable. The tougher cuts of beef come from the so-called "muscles of locomotion;" the legs, the shoulders, the neck, and the flank. These muscles have been exercised more than other parts of the body and so have developed thick cell walls, dense connective tissue and larger amounts of extractives--the factors which make the meat tougher. The more tender cuts of beef come from the parts of the animal which receive the least exercise, the supporting muscles, which lie along the backbone. These muscles have little connective tissue--a factor which makes the meat more tender.

The palatability of meat is affected to some extent by the style of the cut. There are two common styles of cuts: bone-in which means the bones are not removed from the cut; bone-out or boneless which means the bones have been removed from the cut. There is an old folk saying that "the nigher the bone, the sweeter the meat." Objections to boneless cuts have usually been based on that idea and on the fact that they are often more difficult to carve. Whether the bones are left in or not affects the shrinkage of the meat.

It is not only important to choose the class and grade which will best suit the purpose for which the meat is to be used, but it is important to cook it in such a way as to obtain as many portions per pound as

CHART I



A SIDE OF BEEF SHOWING
THE LOCATION OF
SIRLOIN BUTTS

Choice and United States Utility,* were used for the purpose of comparison. These two grades were chosen for three reasons: first, few institutions can afford to serve a grade better than Choice; second, many institutions can not afford better than Utility grade; third, both grades are palatable and have a satisfactory texture. Two styles of cut, bone-in and bone-out, were compared since there has always been a difference of opinion as to the advantages of one style over the other, in flavor, trouble and time in carving, shrinkage loss in cooking, and cooking time.

* A more detailed description of these two grades is given in the Discussion.

II. Review of Literature

There are few studies available concerning beef and its relationship to price; but there are many dealing with palatability and the factors affecting it. As early as 1904 studies were started on this subject, and at the present time the United States Department of Agriculture, in cooperation with many of the State Experiment Stations, is carrying on extensive research. They are attempting to determine the exact cooking conditions which result in the most palatable and nutritious roasts. Most of these United States Department of Agriculture workers agree that palatability is directly related to composition, tenderness, amount of juice, ripening, storage, and cooking. Since all of these factors are interdependent, one on the other, it is difficult to discuss one without mentioning the effect of the others upon it.

A. Palatability

1. Composition:

In a study made by W. H. Tomhave (44) at Pennsylvania State College, it was found that a carcass graded Choice* had 56.90% lean meat and 12.34% bone; and an inferior carcass had 60.98% lean meat and 17.98% bone. Although there was a smaller amount of lean on the Choice carcass, the fact that there was more bone in the inferior carcass is of greater importance. The larger amount of bone denotes age and degree of finish, the younger animal having a smaller bone. Tomhave states that although

* Capital letters are used when grade is mentioned to prevent confusion with adjectives.

age is not a factor considered in grading, it does enter into the composition of the meat which affects palatability. The conformation, quality, and finish (referring to thickness, color, character and distribution of fat) contribute to the composition of the meat.

Even the lean part of beef varies, depending upon the amount and kind of connective tissue. Macleod and Nason of Syracuse University (36) point out, in a discussion on this subject that the protein of the connective tissue consists of two parts,--elastin and collagen. The collagen can be broken down to gelatin by the use of heat, but heat has no affect on the elastin. Therefore, meat with a large amount of elastin will be tougher than meat with a large amount of collagen.

Black, Warner, and Wilson (6) at West Virginia Experiment Station, found that meat from Good supplement-fed steers upon cooking showed less evaporation than meat from thinner cattle. Their meat samples were cooked according to the methods adopted by the National Project Cooperative Meat Investigators (1927). Each roast was seared 20 minutes at an average oven temperature of from 260° to 265°C , and then cooked at 125°C until the thermometer in the meat registered 58°C . The roast was then removed from the oven and allowed to stand until the thermometer in the meat registered its maximum internal temperature which was usually from 62° to 63°C . Meat so cooked would be called rare. There were more drippings from the fatter animals than from the thin cattle. Evaporation losses tended to vary inversely with the fat content; but dripping losses varied directly with the fatness. The finer-grained meats (from Good and Medium grades) had more juice, and, also, scored higher in palatability.

Helser, Nelson, and Lowe (25) at Iowa State College, found a definite relationship between the composition of meat and cooking losses. Fatter roasts had a greater amount of drippings. Lean roasts took more cooking time per pound than the fat roasts. They felt, however, that this evidence could not be used as a basic fact inasmuch as the lean roasts were smaller than the fat roasts. Their studies show that larger roasts take less minutes per pound than smaller roasts. This subject will be discussed in more detail under the topic of weight. The same study showed that a roast with a better finish was better suited for ripening.

Mackintosh and Hall (33) at Kansas State College, concluded from their study on fat and palatability that an increasing degree of finish intensifies the properties of tenderness, juiciness, and flavor. Their evidence seems to justify the old-time belief that fat definitely improves the palatability of meat. They felt, however, that excessive fat could impair the flavor as easily as it could improve it.

As early as 1904, Grindley and Mojonnier (21), of the University of Illinois, found that there were more drippings from fat cuts than from lean ones.

Child and Satorius at (7), University of Minnesota, found that composition affected both palatability and cooking losses. Steer meat rated higher than cow in flavor, aroma, and moisture, and the cow meat showed higher cooking losses. These same authors also compared Medium and Good grades of heifer. Both grades yielded the same amount of press fluid, but the Medium scored higher in total moisture. In the raw state the Medium scored higher in appearance.

Alexander and Clark (2), U.S.D.A. Bureau of Home Economics, concluded from their study that grades did not affect the cooking time, but that bone conformation and fat did. G. M. Redfield, one of Lowe's students at Iowa State, (9), studied the heat penetration in fat. She concluded that fat is a poor conductor of heat in the solid form, but a good conductor in the liquid form. Lowe stated that the proportion of fat and lean in meat affects the time required for cooking, and the time required for cooking in turn affects the palatability.

2. Tenderness

Tenderness, as a factor of palatability, was tested by Sylvia Cover (16) at Texas Experiment Station. Paired slices from paired roasts of beef were used in this study. The result showed that a constant oven of 125°C gave the most tender roast, although the highest possible score was not always given to those samples cooked at 125°C. Cover concluded, therefore, that this presented evidence of the presence of other factors as determinants in judging the tenderness of roasts.

Black, Warner, and Wilson (6) found that the meat next to the bone was always the most tender part of every sample. They reported also that cooked cuts were more tender than raw cuts from Good and Medium (now called Commercial) three-year-old grass fed steers.

Mackintosh, Hall, and Vail, of Kansas State College, have made tenderness studies during the past decade. In 1936 (34), they found that the higher collagen and nitrogen values produced less tender samples of meat. Changes in tenderness likewise seemed to be related to the grade of the carcass, to the marbling in the muscle, and to the increased finish. Later (35), in 1937-38, they reported that aging

increased tenderness in their samples, measured by the Warner-Bratzler shear. They concluded that aging or ripening seemed to be closely related to tenderness.

Tomhave (44) states in his paper that aging the meat causes chemical changes in the muscles. These changes break down some of the connective tissue, make the meat more tender, and develop a higher flavor.

Halliday and Noble (24), University of Chicago, stated that other parts of the carcass, not particularly well suited for roasting, if properly aged, might be used.

Grindley and Emmet (22), at the University of Illinois, compared meat refrigerated over a period of 22 days with that refrigerated over a period of 2 days and found: (a) no water loss; (b) no change in water soluble solids, proteins, nitrogen, or ash; (c) an increase in total soluble inorganic phosphorus and a decrease in the non-nitrogenous organic extractives; (d) the nutritive value unaltered.

Even Stefansson (41) in his book, The Friendly Artic, mentions meat and its quality of tenderness. After spending more than five years in the Artic, he says, "I have never eaten any raw meat that was noticeably tough or stringy--eating unfrozen raw meat cut in small pieces is like eating raw oysters." "Cooking increases the toughness and brings out the stringiness." These comments were made in relation to bear meat. All the men on his expedition learned to prefer raw meat because it was more tender.

Helser, Nelson, and Lowe (25), Iowa State College, cooked roasts with all conditions standardized except the ripening. They found little change in ripening after twenty days, and the juice, flavor, and

tenderness were rated best about the twentieth day. The flavor reached its maximum (a "wild" flavor) somewhere between the twentieth and the fortieth days. They found no consistent correlation between the length of the ripening period and the number of minutes per pound for cooking. They sensed that other factors affected the rate of heat penetration.

Noble, Halliday, and Klaas (40), University of Chicago, found in their study that tenderness was related to cuts: the rib was more tender than the round; and to temperature: the sample at 61°C was more tender than the one heated to 75°C. Lowe (30) stated that meat can be made more tender by: (a) mechanical means, that is, by grinding it; (b) enzyme action (no satisfactory method of injection has yet been found); and (c) peptization; and (d) increased solubility of the proteins, that is, by adding acid--such as tomatoes, sour cream or vinegar (as in the case of sauerbraten).

Hoagland, McBryde, and Powick, (26) of the Biochemic Division of the United States Department of Agriculture in 1917, found that flavor and tenderness were improved by ripening the meat from 15 to 30 days. After 45 days, the meat was apt to taste moldy. In ripening, meats are affected on the surface first. The ripening process tends to penetrate as the acidity decreases.

3. Juice

At the Kansas Experiment Station, Mackintosh, Hall, and Vail (31) found that the cooking losses, both evaporation and drippings, were greater from fresh samples than from ripened samples.

Noble, Halliday, and Klaas (40) studied different cuts of United States graded meats, using the right and left of the animal. They found

that the juiciest meat was the most palatable and that rare meat (61°C interior temperature) had more juice than well done meat (75°C interior temperature).

Grindley and Emmett (22) found that flavor and juice were directly related. The fibrous part of their samples had very little or no flavor, but the juice had a distinct flavor of meat and was very palatable.

The late Alice Child experimented with juices and palatability. Working with Esteros, (8) Child made studies both on standing rib and rolled beef roasts. She found that the standing rib roast was much juicier than the rolled roast, and the quality of the juice of the rib roasts scored higher. She detected, as indicated by a blind-fold test, no distinction in flavor between the boned roasts and the bone-in roasts. Working with Fogarty, (9) Child observed the relationship of interior temperature to press fluid. Eleven per cent more press fluid was obtained at 58°C than at 75°C . She also found more moisture in the heated sample than in the raw.

Cline, Trowbridge, Foster and Fry at the University of Missouri (11) found that an increased shrinkage was accompanied by a decrease in tenderness, juiciness, and flavor of lean meat, and that the loss of flavor might be attributed to the loss of juices.

Bigelow and Cook (5), the United States Department of Agriculture, Bureau of Chemistry, showed that a larger yield of juice could be obtained from meat at 60°C than from raw meat. This tended to increase the palatability of the cooked sample, since juice is so closely related to better flavor.

Mackintosh, Hall, Pittman, and Vail (34) observed that juiciness and palatability are closely related. They found that their ripened samples scored higher and were more juicy than the fresh samples. Press fluid in both the raw and cooked samples increased with the moisture content and decreased with increased fat content. A year later, 1939, press fluid was measured in high-phosphorus and low-phosphorous steers. The largest amounts of press fluid were found in the high-phosphorous steers; the palatability judges committee, however, found no correlation between the amount of phosphorus fed to the steers and to the palatability scores. Ripened steer scored higher in amount of juice and in palatability than did fresh steer.

4. Cooking Time

Factors that affect the cooking time of meat are: cooking temperature, weight, style, surface area, color, and degree of doneness.

Meat being roasted is greatly affected by the oven temperature. The palatability of meat is changed as the roasting progresses; to be more specific! the juice, the flavor, the tenderness, and the aroma are affected. Conclusive evidence of many studies shows that a constant low temperature oven yields the most satisfactory roast. Grindley and Mojonnier (21) found that dry heat caused losses of from 0.25% to 4.55% of the nitrogenous matter and losses of from 2.4% to 27.18% of the fat. At this time (1904), of course, meat was seared and then cooked in a reduced temperature oven. Samples were cooked both covered and uncovered, and though the covered samples shrank more, they were more thoroughly cooked. In another early study on roasting temperatures Grindley and Sprague (23) concluded: (a) that the conditions of the

interior of a roast may be quite accurately determined, and, therefore, the degree of cooking can be controlled by observing the temperature reached in the center; (b) that the number of minutes per pound necessary to produce a certain degree of cooking depends upon: character of cut (size, shape, etc.); the temperature of the oven; that the lower the cooking temperature is the more uniform is the condition of the interior of the meat. In their report, these workers cite Sir Henry Thompson, Food and Feeding. In Thompson's testing, the temperature of the meat thermometer never rose above 187°F (86°C) regardless of the doneness of the roast. Grindley and Sprague also found that if the juice from the pressed cooked meat is clear red, the temperature was probably between 50°C and 60°C . Between 70°C and 75°C the color of the juice changes to brownish red, and between 75°C and 85°C it changes to yellow.

At the University of California, Morgan and Nelson (38) found that to decrease the cooking time of rib roasts also decreased the cooking losses. They found the rib roasts that cooked in a shorter time were more desirable in flavor and appearance. Their experiment was unique inasmuch as they used metal skewers to increase the heat penetration to the center of the roast. More about their work will be discussed under price.

The United States Department of Agriculture with the cooperation of many Experiment Stations has conducted many studies on oven temperatures and the relationship to roasting meats. Esther Latzke's report (27), from the University of North Dakota, is typical of the findings. The total cooking losses were shown to be progressively greater at increased oven temperatures, ranging from 13.52% loss in seared roasts, cooked at

110°C, to a 22.49% loss in ribs, roasted at 175°C. The average total cooking losses for rare roasts were 16.83%; for medium roasts, 18.06%; and for well-done roasts, 22.3%.

Cover at Texas (17) reported that the roasts cooked at 225°C lost 7.1% more than the roasts cooked at 125°C.

Cline and Godfrey (12), University of Missouri, found that loss in weight varied directly with increase in temperature.

Another study by Cline, Trowbridge, Foster, and Fry (11) gave further evidence that a constant oven temperature is best. Over a period of four years, two methods were tested: (a) searing at a high temperature followed by cooking at a low temperature until the desired doneness was attained and, (b) a constant oven. Early in the experiment the authors found the least cooking losses at 110°C (constant heat), but this temperature was too low to be uniformly maintained. The most practical temperature was found to be 125°C. They also found that all roasts ranking low in shrinkage scored high in palatability. The lean meat was especially affected in tenderness, juice, and flavor. The low temperature increased the total cooking time and also the number of minutes per pound. Little, if any, relation was found between the size of the roast and the per cent of the cooking losses. There was a tendency for the cooking time per pound to vary inversely with the size of the roast, and boneless roasts required more time per pound. Doneness could only be determined by a meat thermometer.

Halliday and Noble (24) found the time per pound required to reach any degree of doneness showed a considerable variation, even for roasts of the same weight and approximately the same shape.

Grindley and Sprague (23) concluded that the larger the exposed surface area, the shorter the cooking time will be.

Child and Esteros (8) found that large roasts of the same style took longer to cook than small roasts, but, the larger roasts took less minutes per pound. They also reported that style had its effect on the cooking time. Standing rib roasts, cooked to the rare stage (at 150°C), averaged 23 minutes per pound, and rolled roasts, cooked to the same stage, averaged 35.45 minutes per pound. Relative to styles of cuts and cooking time, Alexander and Clark (2) also found that the boned rib roasts took 10 to 12 minutes longer than the roasts with bones, regardless of the degree of doneness.

Cline, et al. (11) found boned roasts took more minutes per pound to cook than boneless roasts.

Helser, Nelson, and Lowe (25) said that the heavier roasts of meat required a shorter cooking time per pound than the smaller roasts, if all other conditions are standardized. They found also that the greater surface area necessitated a shorter cooking time, if all other conditions are standardized.

Another factor influencing the cooking time and palatability is the degree of doneness. This is linked so closely to the other factors that it has been reviewed in former citations (see Juice).

Bigelow and Cook (5), Child and Fogarty (9), Gridley (21) (22), Cline and associates (11), Noble and associates (40), Child and Esteros (8) all reported that the degree of doneness greatly affected the amount of juice--rare meat contained more juice than well-done meat. The juicier meat scored higher in palatability. Tenderness was also affected

by the degree of doneness. Lowe (30), Halliday and Noble (24), Child (7), Cline (11) et al., have found that less tender cuts of meat, when they are cooked to the proper degree of doneness, are tender.

5. Color

Color in raw meats has often been discussed in its relationship to palatability. Mackintosh and Hall since 1926 have been studying factors relating to the color of meat and the effect of this color upon palatability. In 1934, (32) some of the animals used for the Cooperative Meat Study were of a darker than usual color (from brilliant red through dark red to black.) On all palatability factors these animals graded as high as, or higher than the other carcasses, in their respective lots. The yellow fat received the highest average grade from the Palatability Committee, indicating that at least where good, well-finished cattle are concerned, a yellow fat does not impair the palatability.

B. Price

In reviewing the literature available on price studies in relation to beef, the same factors that were discussed under palatability were present, composition, style, grade, and weight, besides shrinkage and degree of doneness. In most of the meat studies factors definitely affecting the length of the cooking time, affect also the price of the edible portion. Van Arsdale and Monroe (47), at Columbia University, in their study of the relation of the cost of "edible portion" to the "as purchased" portion found that the "edible portion" varied from 21% to 59.61% of the "as purchased." Their study included lamb rib chops, lamb loin chops, pork loin chops, ham, round steak, sirloin steak, porterhouse steak, brisket, pot roast, stuffed heart, and fowl. All samples

were pan broiled, this method requiring only fuel, no additional fat or other materials. They found that the loin chops gave a larger "edible portion" than the rib chops, and that the round steak, "edible portion" cost less per pound than the porterhouse steak. The amount of bone caused most of the increase in price between the "as purchased" meat and the "edible portion." They apparently made no attempt to see if factors, other than style of cut, affected their results. However, the weight of the different samples of one style, rib chops, it was felt, was responsible for the slight variation in the cooking time. This was one of the first if not the first studies on portion costs of meat.

According to Lowe (30) the longer the meat is cooked, the greater the cooking losses. In her experiments, she found, also, that other factors definitely affect the length of time necessary to cook a roast to a desired doneness. This observation is substantiated by the work of Cline, Trowbridge, Foster, and Fry (11), of the University of Missouri. Using a constant oven temperature of 125°C , they found that prime rib roasts lost from 16% to 24%. Only 7.30% was lost in cooking a 7.56 pound, one or two rib chuck roast. The raw edible meat cost was only \$.03 higher than the cost of the whole cut. A rump roast weighing 7.41 pounds had a cooking loss of 9.06% and cost \$.10 more per pound than the raw edible meat. Their results showed that according to the prices paid, the chuck roast was the most economical. In reading the data on this study, the style and composition could have caused the prime rib roast to lose so much more than the rump roast.

McElhinney of Iowa State College (37) studied the shrinkage and

carving waste of several meats: prime ribs, ham, veal leg, lamb leg, and pork loin. These meats with the exception of the ham, were seared and then cooked at 125⁰ C. The degree of doneness was determined by a meat thermometer. She found that 62.4% of the prime ribs, well done, were edible but only 61.2% of the prime ribs medium done, were edible. Other factors, than doneness may have influenced this result. The well done sample was leaner than the medium done cut. McElhinney reported also that beef, well done, cost \$.25 per pound "as purchased," cost \$.404 per pound "edible portion." Beef, medium done costing \$.25 per pound as raw, cost \$.42 per pound "edible portion."

Tests recently conducted by the Southern California Restaurant Association (42) and the National Live Stock and Meat Board showed conclusively that low temperature roasting gave at least eight more servings from every fifty pound roast. In addition to this, it was found that low temperature roasting saved almost 20% in fuel consumption. Every detail of the experiment was scientific. Three tests were run to compare cooking losses and gas consumption in a high and in a moderate oven. In one test, the roast cooked at a high temperature showed 32.8% loss, but the roast cooked at a moderate temperature showed only an 18.3% loss. From this, the investigators concluded that if the roasts had weighed fifty pounds each and had been as near alike as possible, the moderately roasted meat would have lost 9.15 pounds and the high temperature roasted meat would have lost 16.4 pounds. Thus 7.25 pounds would be saved by the difference in roasting; this, of course, means more money to the restaurant operator.

Food and Nutrition News (20) gave the results of some studies on

meats, comparing the number of servings in relation to the oven temperature. Roasts of approximately the same weight were cooked at high or low oven temperatures. All roasts were cooked medium rare. The roasts cooked at the low oven temperature yielded five to seven more servings than corresponding roasts cooked at high temperature. Food and Nutrition News says that food service operators are adopting this slow oven temperature and finding it advantageous in ways other than extra servings: (a) saving in fuel consumption; (b) cooler and more efficient kitchen; (c) less personal attention; (d) roasts cook to a uniform degree of doneness; (e) the non-sliceable portions are more attractive and more usable.

Cline and McLachlan (13) of the Missouri Experiment Station found that an oven heated to 175°C requires less fuel to cook steaks, rare, or pork chops, well done, than an oven of 225°C . The 175°C oven takes a longer time to produce the same degree of doneness. In their study, paired meats were used, club, porterhouse, and pinbone sirloin steaks. United States Good beef was the grade tested. These steaks were two inches thick and were broiled to the rare stage. One member of each pair was cooked at 175°C and the other at 225°C . The steaks broiled at 175°C not only scored higher in palatability, but shrank less than those cooked faster. Rib and loin pork chops were broiled to the well done stage. The same results were shown.

Loughead (29), University of Missouri, found that approximately 40% of the gas used in cooking roasts by the searing method was consumed in preheating the searing oven and in searing the roast for twenty minutes, and that greater fuel consumption was evident with increased

oven temperatures. Loughhead found from her study that cow gave the highest losses regardless of the cut used in comparing heifer, steer, and cow. She used two kinds of ovens, a constant oven and a hot oven for searing that was later reduced in temperature for most of the cooking. Paired cuts of meat were used. Her study indicates that the greater the distance which the heat must penetrate to reach the center of the muscle, the greater the total cooking time. A variety of cuts were cooked. The per cent of bone seemed to bear no relation to the total cooking time. Cooking losses seemed to be influenced by the composition and length of exposure. She also concludes that the lower the temperature at the interior of a roast at the time of cooking, the greater the cooking losses. The fatter the meat, the greater the total cooking losses, the losses being less by evaporation, but greater by drippings.

Cover (17) cooked three-rib roasts at 225°C and 125°C using paired meats and following the methods outlined by Alexander, Clark, and Howe (1). She reported that less gas was needed to roast rib, half ham, and leg of lamb by the constant low temperature than by the constant high temperature, when the meat was cooked to the well-done stage. She found chuck roasts used more gas at the low temperature because of the necessity for an extremely long cooking period.

Swenson (43) at the University of Missouri found that rib roasts cooked by the searing method required 30% to 40% more gas than did corresponding roasts cooked at a constant-oven temperature of 150°C and that increasing the oven to 175°C increased the gas consumption 9%. In her study she compared classes of beef, as influenced by braising

and roasting. Among her many findings were, that, the time per pound for cooking and the total time were directly proportional to the desired doneness. Cuts without bones required a greater cooking time. There were greater cooking losses in the covered pan method, but the meat cooked faster than the uncovered.

Another study on cooking losses is one by Vail (46) at Kansas State College. She compared cuts of beef desirable for roasting, for institution use. Top clod, rib, and top round cuts weighing from twelve to fifteen pounds were used in each of twenty cooking periods. Ten samples of both United States Good and United States Choice were used in this experiment. The roasts were cooked at a constant oven temperature of 150°C, to an internal temperature of 69°C. The shrinkage was similar for all of the roasts. The greatest shrinkage was found in Choice rib, with a 25.47% loss and the least in Choice clod with a 23.22% loss. The cost price per pound varied from \$.21 to \$.26 for the rib, from \$.25 to \$.29 for the round, and from \$.16 to \$.24 for the clod. Of all the cuts tested, the United States Good clod costing \$.045 per serving (on the basis of 70 gram servings) was found to be the most economical. The United States Choice rib, costing \$.098 for the same size serving was found to be the most expensive.

Cooking losses reported by Cline and Foster (14), University of Missouri, were higher when a high oven temperature was used. In most cases, roasts cooked at a lower oven temperature graded slightly more tender than those cooked at the higher temperature. In their study, thirty-six paired roasts from Good heifers and Good steers were used. Roasts were cooked at a constant temperature of 100°C and at a constant

temperature of 235°C. The roasts were cooked until an internal temperature of 62° was reached.

The study by Latzke (28) at North Dakota, substantiates the work previously reviewed in which it was shown that the degree of doneness is directly related to the cooking time and cooking losses. Paired rib roasts were used for her study and they were cooked by the searing method. Cooked by this method, roasts required 14.19, 16.44, and 22.91 minutes per pound, respectively, to reach the rare, medium, and well-done stages. Total cooking losses increased in proportion to the degree of doneness.

Morgan and Nelson (38) (39), appreciating the fact that longer cooking causes greater losses, roasted ribs with skewers inserted into the center of the flesh--to conduct the heat rapidly. They found a faster cooking roast and less shrinkage than in unskewered roasts. They also obtained greater efficiency when a high oven temperature was maintained throughout the cooking period. The copper, plated with nickel, skewers were plunged hot through the sides of the roasts until the points reached as nearly as possible the centers of the roasts. Six skewers were used in each roast. Standing two rib roasts of beef were the samples used. The skewered roasts averaged a loss of 27.3%, the unskewered roasts, 31.5%. The average decrease in the cooking time by using the skewers was 6.6 minutes per pound.

Child (10), at the University of Minnesota, also used skewers to speed up the roasting period and to study the cooking losses. Her procedure was the same and her results very similar. Rolled ribs of beef were the cuts that she cooked using unskewered roasts as a control. The cooking time was decreased for the skewered roasts by 1.48%.

Approximately four minutes per pound was saved by using the skewers.

In a study by Ayers (4) at the University of Chicago, certain wholesale cuts of beef were compared to find out the effect on yield of roasting by gas and electricity. One of the meats studied was sirloin butts. The right and left side of five animals of Good grade were roasted. The roasts were boned, weighed and cooked in a constant oven temperature of 300°F until the internal thermometer temperature reached 170°F. She found a cooking loss of 32.31% cooking with gas and 31.55% cooking with electricity. From all the five types of roasts cooked, the sirloin butts, the top round, and the bottom round yielded more edible meat than the rib or rib end.

In 1937, the Review Committee of the Cooperative Meat Investigations project (15) published the results of the first ten years of the research in meat cookery. This report summarizes almost all of the data in this review of literature. An outline of this report follows:

Cooking losses:

- 1) increased by high oven temperatures
- 2) increased with degree of doneness
- 3) increased when initial temperature of the meat is low
- 4) decreased by use of skewers
- 5) increased with amount of fat

Cooking time:

- 1) decreased by use of metal skewers
- 2) increased by degree of doneness
- 3) increased by use of low oven temperature
- 4) increased by removing bone
- 5) decreased by larger amount of fat

Cost:

- 1) increased by high temperature because of shrinkage
- 2) United States Choice ribs cost more per serving than United States Good or United States Commercial because of greater original cost of the Choice roasts and because of the smaller amount of sliceable meat in these roasts.

Palatability:

- 1) tenderness decreased by high oven temperature
- 2) quality and quantity of juice of roast decreased by high oven temperature.
- 3) composition directly related to palatability

III Procedure

To test the palatability of the two grades of sirloin butts, the standard method of cooking described by Alexander, Clark, and Howe (1) was followed. This bulletin is generally accepted by State Agricultural Experiment Stations because it is reliable, adaptable, and practical. The work of these people indicates that a constant, low-oven temperature produces a more uniform roast, with less shrinkage, and one that is more palatable than other roasting methods. This procedure was followed throughout this study. The materials and equipment as well as the cooking and serving procedures were in accordance with the methods set forth by these National Cooperative Meat Investigators insofar as it was possible. A description of the materials, equipment, and procedures as used by the author follows.

A. Description of Equipment and Materials

The institution kitchen used as a laboratory in this study was that of a public high school cafeteria in Detroit. The judges were members of the faculty, kitchen, and janitorial help, and students of this high school.

The cuts of meat were purchased from a wholesale distributor. The whole right and left sirloin butts, except the tenderloins of each carcass, were used to check one against the other. The meat was stored in the packing house refrigerators, kept at a temperature of 4°C for nine days after slaughter. Although several of the authorities cited earlier in this paper recommended a longer ripening period than nine days, the nine-day ripening period was used in this study because it was

recommended by Alexander, Clark, and Howe (1). The meat was delivered to the school kitchen on the ninth day and was stored overnight in a mechanical refrigerator in which the temperature was between 6°C and 7°C at all times. Two grades, United States Choice and United States Utility (formerly called Common), and two styles, bone-in and bone-out (or boneless) were used. Eighty samples from forty steers (the right and left cuts from the same animals) were cooked; twenty United States Choice, bone-in; twenty United States Choice, bone-out; twenty United States Utility, bone-in; and twenty United States Utility, bone-out.

The meat was then cooked on the tenth day after slaughter. The insulated ovens used for this study were heated by gas. Each cut, placed on a wire rack, to keep it out of the drippings, was set in an ordinary aluminum pan, twelve inches wide, eighteen inches long and two and a half inches deep. Complete identification of each roast (grade and side---right or left) was scratched on the outside of the pan used for cooking. A scale, calibrated to fifty pounds, was used for all weighing. This scale was regulated and checked before each experiment, by a service man from a national scale company.

Oven thermometers with scale divisions, ranging from 100°C to 300°C, engraved on the stem, were used to maintain a constant oven of 150°C. These oven thermometers were nitrogen-filled, mercury-in-glass type, and calibrated on the basis of total immersion. The meat thermometers, calibrated on the basis of total immersion, were the straight-tube type with, pointed tips, scales etched on glass, two to three calibrations, a total length of six inches, and were of the nitrogen-filled mercury-in-glass type. These meat thermometers were used to indicate the interior

temperature of the meat and to designate the degree of doneness.

Rulers of both the metric and the linear systems, were used to measure the roasts. A stop watch recorded the cooking time lost when the oven doors were opened to check the temperatures. An electric wall clock, which was part of the kitchen equipment, was used for recording the total cooking time.

Charts to record characteristics before and after cooking and to record the judges' reactions on palatability were kept to be incorporated in this report.

B. Cookery

A record was made of the weight, measurements, and physical characteristics (marbling, character of fat, character of lean, firmness of lean) of each meat sample as soon as the sample was delivered to the kitchen; these records are shown on Sheet 1 (see appendix.) The meat was stored in the kitchen's refrigerator, from which it was removed the next day and allowed to reach room temperature (by internal thermometer) before being placed in the oven, at which time its weight was again recorded. The cut was wiped with a clean, damp cloth and the meat thermometer, having also been weighed, was inserted into the middle of the meat. The sample was then placed on the rack in the roasting pan, fat side up, the rack and pan having been weighed previously. The combined weight of the meat, the thermometer, the rack, and the pan was then checked.

The ovens were heated to 150°C for one hour before the cut was placed in it to be cooked. Only one roast was cooked in each oven. The meat was placed in the oven lengthwise, the heavy end to the front. The temperatures of the meat and the oven were checked after two hours of cooking and hourly thereafter until the meat was done. The time taken

Chart II

MEAT COOKING RECORD

Grading Chart for Cooked Meat

U.S. Dept. of Agriculture

Cooking Laboratory No. _____ Sample No. _____ Kind _____ Date _____

Factor	Phase	7	6	5	4	3	2	1	Remarks
Aroma	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What aroma? _____
	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable	Undesirable	Normal or abnormal? _____
Texture (Grain)	Intensity	Very fine	Fine	Moderately fine	Slightly coarse	Coarse	Very coarse	Extr. coarse	_____
	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What flavor? _____
Flavor of fat	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable	Undesirable	Normal or abnormal? _____
	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What flavor? _____
Flavor of lean	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable	Undesirable	Normal or abnormal? _____
	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What flavor? _____
Tenderness	Desirability	Very tender	Tender	Moderately tender	Slightly tough	Tough	Very tough	Extremely tough	Normal or abnormal? _____
	Intensity	Very rich	Rich	Moderately rich	Slightly rich	Perceptible	Slightly perceptible	Imperceptible	_____
Quality of juice	Desirability	Very juicy	Juicy	Moderately juicy	Slightly dry	Dry	Very dry	Extremely dry	_____
	Intensity	Very juicy	Juicy	Moderately juicy	Slightly dry	Dry	Very dry	Extremely dry	_____

Color of Lean

1. Light red
2. Dark pink
3. Light pink
4. Pinkish brown
5. Light brown
6. Dark brown

Color of Fat

1. White
2. Creamy white
3. Grayish cream
4. Yellowish brown
5. Yellow
6. Amber

Note.—Encircle the words which describe intensity; mark desirability and color with a check

(Signature of Judge)

for these readings, during which the oven door was open, was finally subtracted from the total cooking time which was recorded in each case. When the meat thermometer reached 70°C the pan with the roast in it was removed and weighed. The pan, rack, and the drippings were then weighed. This figure was subtracted from the first weight figure to give the weight of the meat. To corroborate this figure, the roast itself was weighed.

The meat, while still hot, was served to the palatability judges. These slices were carved at right angles to the bone, approximately 5 mm. thick, and handled carefully to prevent them from coming into contact with the drippings from the whole roast. Each judge was served but one sample at a time; after this he recorded his opinion on a palatability score card, Chart II; on this chart, there are two phases, intensity and desirability, each having definite factors. Intensity has seven factors: aroma, texture, flavor of fat, flavor of lean, tenderness quality of juice, and quantity of juice. The factors under desirability are aroma, flavor of fat, and flavor of lean. Besides the numerical graduation of one to seven for each of these factors, there are adjectives to describe more accurately the exact condition of each sample. Under aroma, intensity phase, a perfect score of seven would mean the sample was "very pronounced." If it were only "slightly pronounced," the sample would score four. Under aroma, desirability phase, a perfect score of seven would mean the sample was "very desirable." If it were "slightly undesirable" the sample would score only two. Each sample was closely checked by the judges for every factor under each phase. The meat's aroma and the fat content of the sample were scored first because they are so much influenced by temperature that cooling would change

them. Color and texture were scored next and finally the lean meat was scored. These samples were served in a room apart from the kitchen. Between samples each judge ate tart apples and drank water. After each had completed the chart for his sample, all scores were totaled and an average was taken. The same judges were not available throughout the study, but the same procedure was followed for each cooking experiment.

IV Discussion

In the introduction, the purpose of this study was stated thus: to find which grade and which style of sirloin butts scored highest in palatability; lost less weight on cooking; cooked in the shortest time; yielded the largest edible cooked meat at the lowest proportionate cost. In an analysis of the data, there seem to be direct relations and inverse relations of one factor to another.

To present a clearer picture of the grades of beef used in this study, the description of the standards set by the United States Department of Agriculture (45) are given. Choice steer shall be relatively blocky and compact and thickly fleshed throughout. The fat covering shall be fairly smooth and uniform and extend over the entire exterior surface of the carcass. The fat shall be firm, brittle, waxy and may be slightly wavy or rough. The cut surface shall be firm and possess a smooth velvety appearance. It shall be well marbled and uniform and bright in color. Bones are usually soft and red, but some ossification of cartilage and hardening in bone as indicated by tinge of whiteness will not disqualify beef. Utility steer may be decidedly rangy, angular and irregular in conformation. The fleshing is usually thin. The degree of fat covering varies from very thin to very uneven. The fat is usually soft and varies in color from grayish white to decidedly yellow. Cut surfaces of the lean muscle are soft and watery to firm and coarse with very little marbling. The color may be two-toned or shady, from light red to very dark red. The bone is usually hard and white. These standards were developed and formulated in 1916, but it was not until August 1924, that they were published by the department (45).

CHART III

Summary of Palatability Scores in Relation to Composition

Grade	Style	Composition	No. Samples	Intensity					Desirability			Combined Average
				Aroma	Texture	Flavor of fat	Flavor of lean	Tenderness	Juiciness Qual. Quant.	Av. Aroma	Flavor of fat lean	
Choice	Bone-in	Fat Moderate Lean	4	7	6	7	7	6	7	6.7	7	6.8*
			14	6	6	7	6	6	6	6.2	6	6.1
			2	6	6	7	6	6	5	5.9	6	5.8
	Bone-out	Fat Moderate Lean	2	7	6	7	7	6	7	6.7	7	6.8*
			16	6	6	7	6	6	6	6.2	6	6.1
			2	6	6	7	6	6	5	5.9	6	5.8
Utility	Bone-in	Fat Moderate Lean	4	7	4	6	6	5	5	5.4	6	5.6*
			6	6	4	6	5	5	4	5.5	5	4.9
			10	6	4	6	5	5	4	5.5	5	4.9
	Bone-out	Fat Moderate Lean	2	7	4	6	6	5	5	5.4	6	5.6*
			6	6	4	6	5	5	4	5.5	5	4.9
			12	6	4	6	5	5	4	5.5	5	4.9

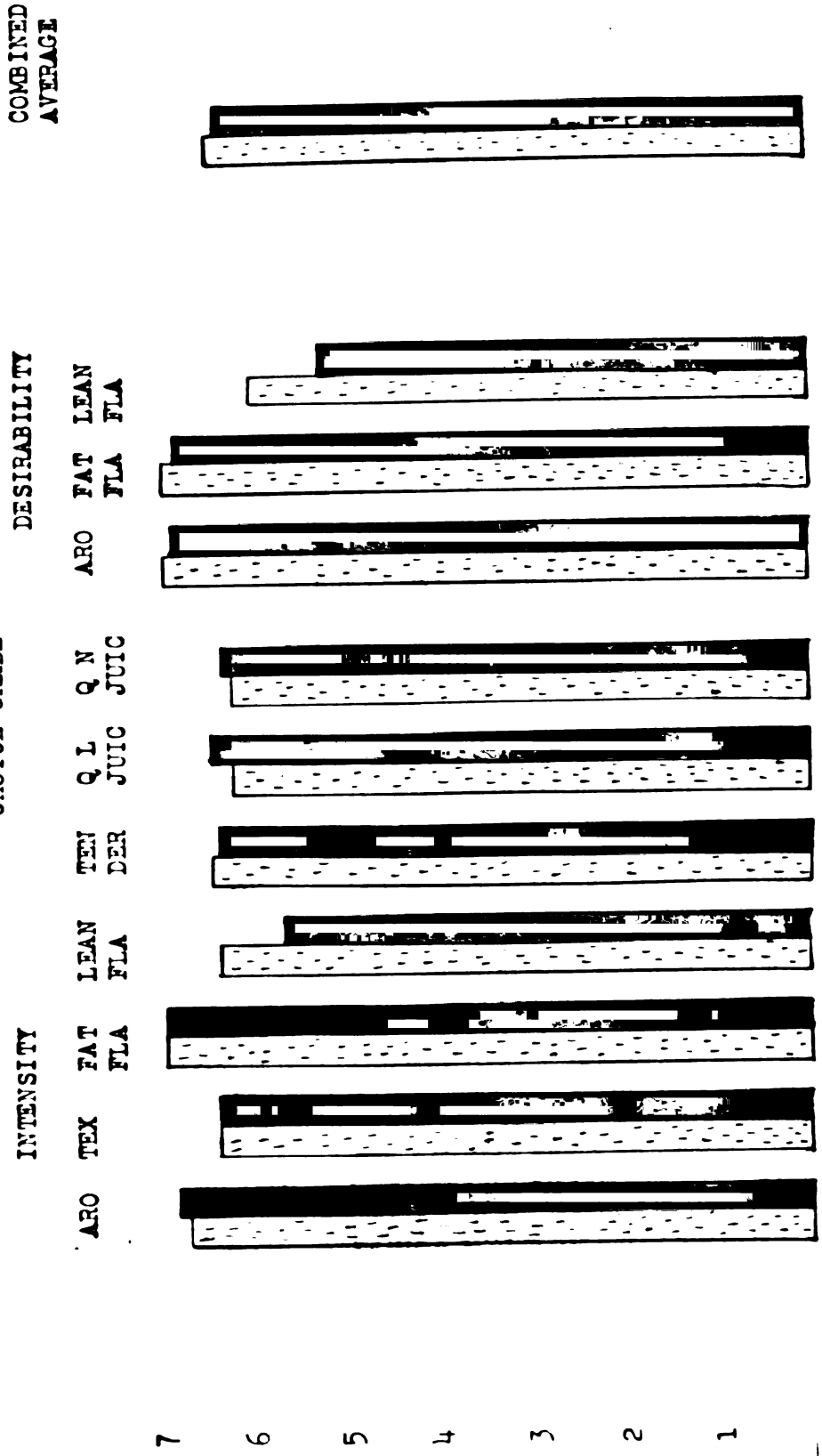
Comment: The nearest whole figure was used for this table.

Knowing the wide variance between Choice and Utility grades, it is easier to understand the results found. First, palatability will be discussed in relation to factors that possibly influence the results. On Chart III, "Summary of Palatability Scores in Relation to Composition," the meats are grouped in the two grades, Choice and Utility, in each style, bone-in and bone-out, and according to composition, fat, moderate, or lean. The number of "fat" samples in each grade and style are recorded as are those of "moderate" and "lean." From this chart, it can be seen that the "fat"* samples in each grade and style scored the highest in their groups. The amount of fat apparently affected the aroma, the flavor, the tenderness, the juiciness, and the desirability of the product. The lean meat seemed to be the least desirable in each grade and style.

In spite of the significance found in the composition, grade seems to play a more important part in palatability. The highest total scores are those of the Choice grade. The judges for the palatability test quickly differentiated between Choice samples and Utility samples. On some occasions, however, when the Utility sample was fat and the Choice sample was lean, the scoring of the two grades was nearer the same, though Choice still received the higher score. To obtain a more accurate opinion about the palatability of the samples, a statistical test of Fisher's (19) was used. His test showed that there was significant difference in the palatability of the samples in relation to composition and to grade.

Another factor that is always mentioned in relation to palatability is the style. The judges, however, reported very little difference in

CHART IV
PALATABILITY SCORES IN RELATION TO STYLES
COMBINED AVERAGE

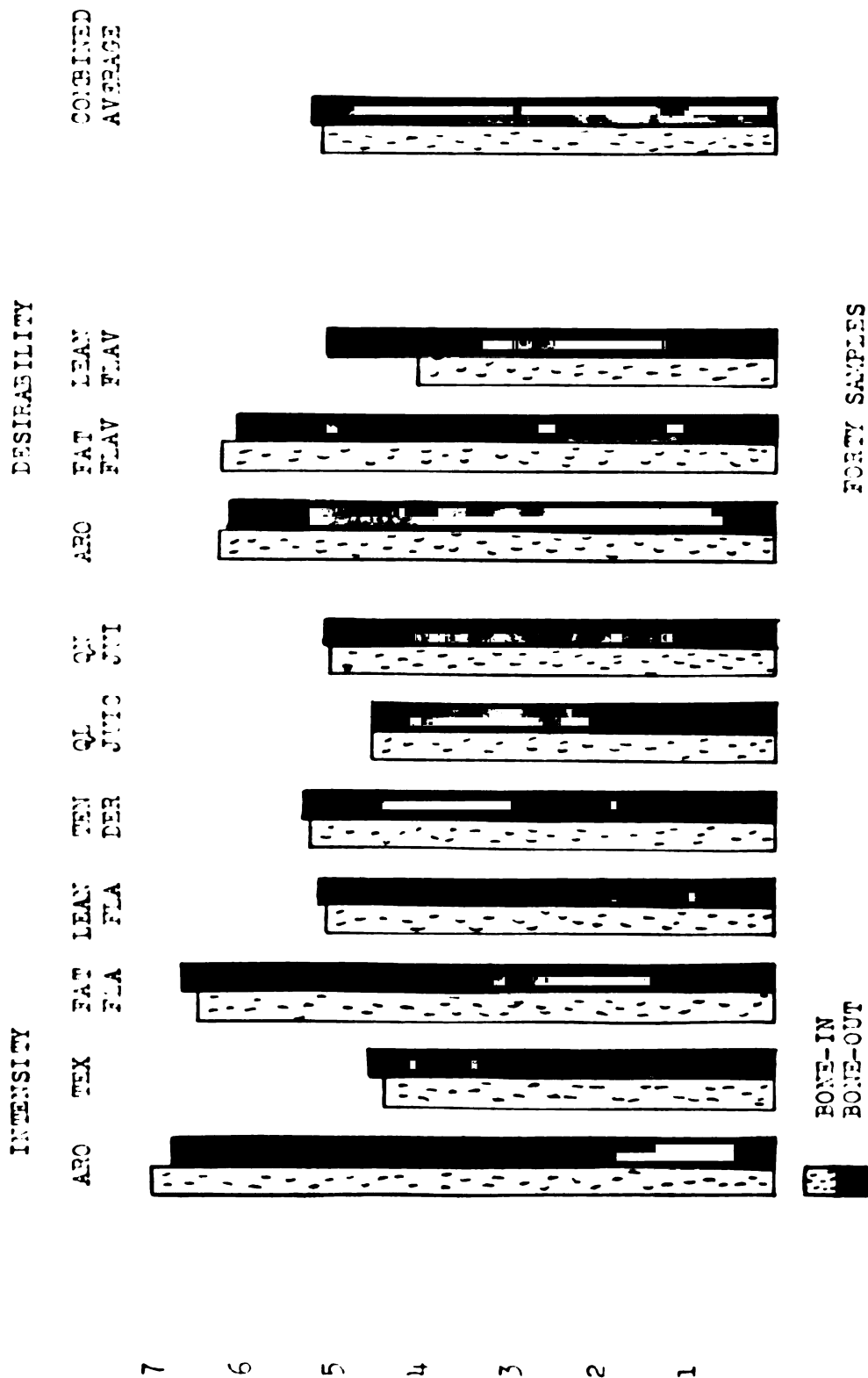


BONE-IN
BONE-OUT
FORTY SAMPLES

CHART V

PALATABILITY SCORES IN RELATION TO STYLES

UTILITY GRADE



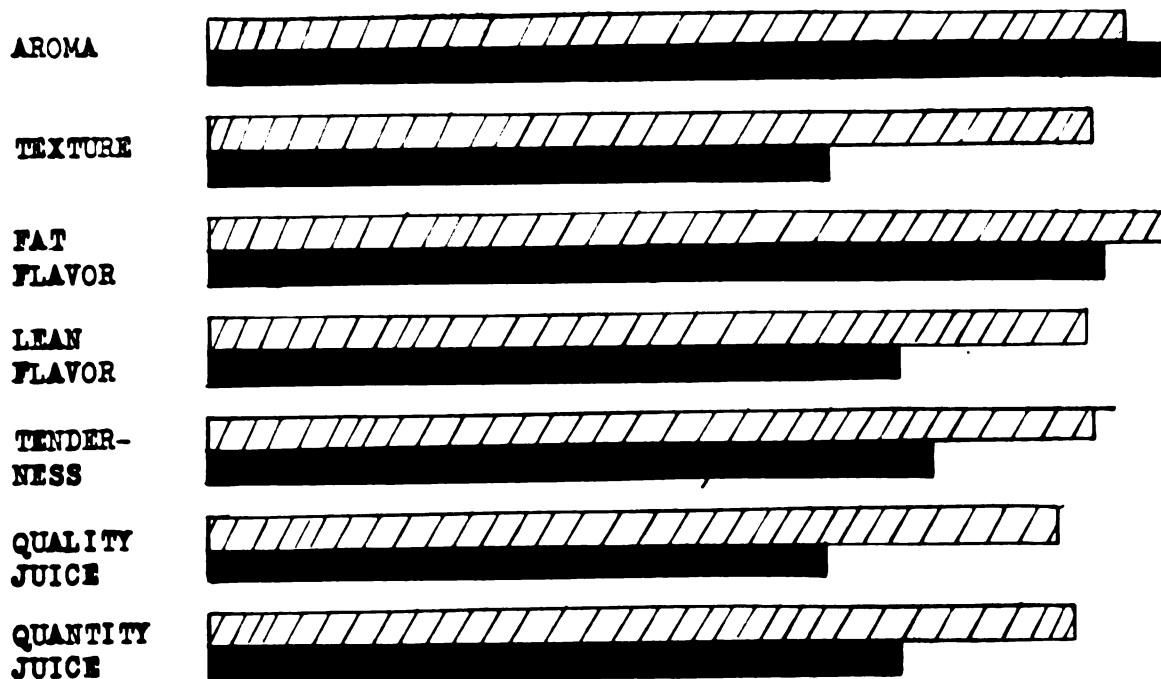
flavor in regard to the style of the sirloin butts. Chart IV graphically shows that among all the Choice samples, style had little effect upon the palatability score of each sample. The factor showing the greatest variance was the intensity of the flavor of the lean meat, the Choice samples, bone-in, scoring 6.41 and the Choice samples, bone-out, 5.73. The combined average of the palatability scores of Choice, bone-in, was 6.57 and the combined average of Choice, bone-out 6.48--a difference of only .09 points. Apparently, whether one prefers bone-in or bone-out cuts depends on other factors than palatability. Chart V, "Palatability Scores in Relation to Styles, Utility Grade," shows the same results. Except for the meat adjacent to the bone, there was very little difference in flavor. Fisher's (19) statistical test showed no significant difference in the palatability in relation to style for either grade.

Charts VI and VII show which grade scored higher in each style. Choice grade is by far the more superior. The only factor in Utility grade that scored higher than the same factor in Choice was intensity of aroma. However, the desirability of aroma was more favorable in the Choice grade, regardless of style. The average score for Choice, bone-in was 6.57, while Utility, bone-in scored 5.42, a difference of 1.15 which is significant. Choice, bone-out scored 6.48 in palatability and Utility, bone-out scored 5.58. This difference, .90, proved to be significant, also (19). A summary of all the scores from the grading charts is presented on Chart VIII. These were the results tabulated from the judges' reports regardless of any factors such as composition, weight, cooking time, grade, or style. However, they are recorded under the two grades and the two styles. From this chart, the total score for all

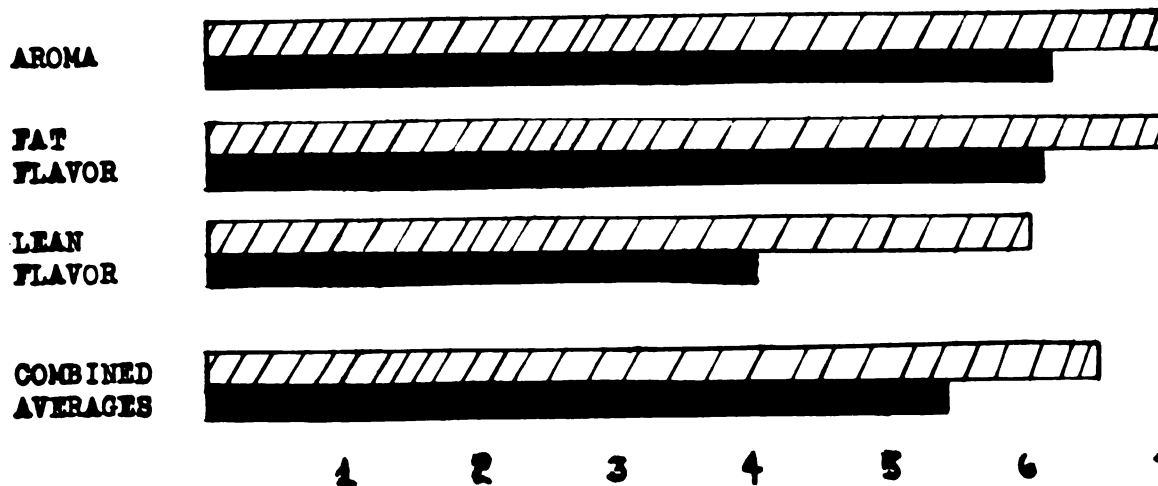
CHART VI

PALATABILITY SCORES COMPARING
CHOICE AND UTILITY GRADES
IN BONE-IN STYLE

INTENSITY



DESIRABILITY



BONE-IN CHOICE



BONE-OUT UTILITY



FORTY SAMPLES

CHART VII

PALATABILITY SCORES COMPARING CHOICE
AND UTILITY GRADES IN BONE-OUT STYLE

INTENSITY



DESIRABILITY



1 2 3 4 5 6 7

BONE-OUT CHOICE
BONE-OUT UTILITY



FORTY SAMPLES

CHART VIII

Summary of all the Scores from the Grading Charts

No. Samples	Grade	Style	Aroma	Texture	Flav. of fat	INTENSITY					DESIRABILITY			Comb. Aver.	
						Flav. of lean	Tender-ness	Qual.	Juiciness	Aroma	Fat	Lean	Flavor of		
20	Choice	Bone in	6.73	6.45	7.	6.41	6.47	6.24	6.31	6.51	7.	7.	6.04	6.68	6.57
20	Choice	Bone out	6.88	6.45	7.	5.73	6.41	6.51	6.37	6.48	6.88	6.93	5.63	6.48	6.48
20	Utility	Bone in	7.	4.37	6.54	5.02	5.26	4.5	5.07	5.39	6.17	6.11	4.06	5.45	5.42
20	Utility	Bone out	6.87	4.53	6.66	5.12	5.29	4.5	5.1	5.44	6.09	6.04	5.07	5.73	5.58
Average			6.87	5.45	6.8	5.57	5.86	5.44	5.71	5.96	6.54	6.52	5.20	6.09	6.03

Choice, bone-in, can be read as well as for Choice, bone-out, Utility, bone-in, and Utility, bone-out. A perfect score was seven points and the lower the number the less palatable was the sample. None of the samples was undesirable in spite of the fact that they were free from seasonings. The juice and the texture of the Utility grade scored the lowest which was around 4.5. In the combined averages of intensity and desirability both styles of Choice scored higher than the Utility styles. It is interesting to note that Utility, bone-out, scored slightly higher than Utility bone-in.

Another comparison made was the relationship of palatability to the weight of the roast. On Chart IX, the sirloin butts are listed according to their weights, heavy, medium, or light. There were, of course, forty samples of each grade and twenty of each style. Of these roasts, the majority fell in the medium weight. The heavy roasts, bone-in, weighed from thirty-three to thirty-six pounds and the heavy, bone-out, weighed from seventeen to nineteen pounds. The medium weight cuts, bone-in, were around thirty pounds and the medium, bone-out, weighed around fifteen pounds. Among the eighty samples, only fourteen were light weight. The bone-in weighed approximately twenty-six pounds. The light, bone-out, weighed thirteen pounds. To compile the information shown in Chart IX, the palatability score sheets of each roast were placed on a large graph along with the weight of each roast. The samples were grouped according to their weights and the average palatability score was checked for each weight group. Again, grade seemed to be more obvious than weight in relation to palatability. In the Choice, bone-in group, all the roasts scored 6.4. In the Choice, bone-out group the

CHART IX

Summary of Palatability Scores in Relation to Weight

Grade	Style	Size	No. Sam- ples	Intensity						Desirability				Combined Average	
				Aroma	Texture	Flavor of fat	Flavor of lean	Tender- ness	Juiciness Qual.	Quant.	Av.	Aroma	Flavor of fat		lean
Choice	Bone-in	Heavy	4	7	6	7	6	6	6	6	6.3	7	7	7	6.4
		Medium	14	7	6	7	6	6	6	6	6.3	7	7	6	6.4
		Light	2	7	6	7	6	6	6	6	6.3	7	7	6	6.4
	Bone- out	Heavy	6	7	6	7	6	6	6	6	6.3	7	7	6	6.4
		Medium	10	7	6	7	5	6	6	6	6.1	7	7	6	6.3
		Light	4	7	6	7	5	6	6	6	6.1	7	7	6	6.3
Utility	Bone-in	Heavy	4	7	4	6	5	5	5	5	5.3	6	6	4	5.3
		Medium	14	7	4	6	4	4	4	4	4.7	6	6	4	4.9
		Light	2	7	4	6	4	4	4	4	4.7	6	6	4	4.9
	Bone- out	Heavy	4	7	4	6	5	5	5	5	5.3	6	6	5	5.4
		Medium	10	7	4	6	4	4	4	4	4.7	6	6	5	5.0
		Light	6	7	4	6	4	4	4	4	4.7	6	6	5	5.0

CHART X
Relation of Composition to Cooking Time

Composition	Choice				Utility				Average
	Bone-in		Bone-out		Bone-in		Bone-out		
	No.	Min. Samples per lb.	No.	Min. Samples per lb.	No.	Min. Samples per lb.	No.	Min. Samples per lb.	
	No.	Min. Samples per lb.	No.	Min. Samples per lb.	No.	Min. Samples per lb.	No.	Min. Samples per lb.	
Fat	4	20	2	29	4	24	2	32	26.25
Moderate	14	21	16	31	6	25	6	37	28.75
Lean	2	22	2	33	10	26	12	39	29.75

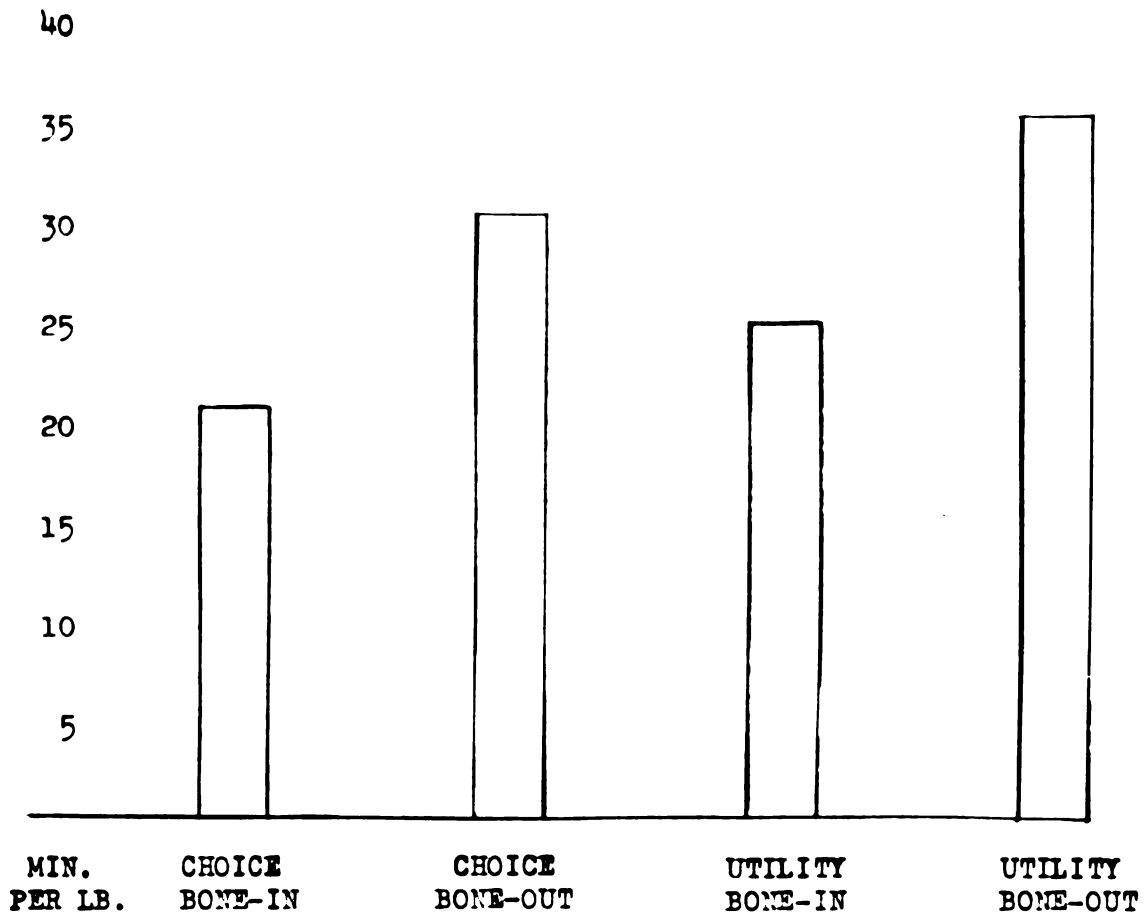
heavy samples scored 0.1 higher than the medium and light weight samples. According to statistical analysis this was not significant. The findings in the Utility grade were similar. Although the heavy roasts scored highest, the differences did not prove significant when tested by Fisher's formula (19). All the Choice samples scored higher than the Utility samples regardless of weight.

In relation to palatability, many investigators have found that the shorter the cooking time the higher the meat scored in palatability. For this reason a comparison is made of the relation of palatability and cooking time to other factors--composition, style, grade, and weight. The figures on Chart X show the relationship between composition and cooking time. The figures under the "average" column show a positive difference in the cooking times. In every instance, the fat roasts cooked in the shortest time. By statistical analysis, a positive significance was found between the cooking time of the moderately fat and the cooking time of the lean. It would seem, therefore, that palatability and cooking time might be related to composition, the fat roasts scored highest in palatability, the moderately fat scored higher than the lean. From Chart X, one can quickly see that the Choice grade tends to be more fat than the Utility grade. Only four samples out of forty, in the Choice grade were lean, while twenty-two samples in the Utility grade were lean. Therefore, Choice apparently is the better grade to buy for palatability and faster cooking, since it is regularly more fat than Utility.

The next factors, style and grade, and their relationship to cooking time and palatability are shown on Chart XI. The grade and style

CHART XI

AVERAGE MINUTES PER POUND USED
FOR EACH GRADE AND EACH STYLE



TWENTY SAMPLES OF EACH

CHART XII
Relation of Weight to Cooking Time

Weight	Choice				Utility				Average
	Bone-in		Bone-out		Bone-in		Bone-out		
	No. Samples	Min. per lb.	No. Samples	Min. per lb.	No. Samples	Min. per lb.	No. Samples	Min. per lb.	
Heavy	4	20	6	31	4	22	4	35	27.
Medium	14	20	10	30	14	25	10	35	27.5
Light	2	23	4	32	2	28	6	38	30.25

that cooked in the shortest time was Choice, bone-in. From this graph, it can be seen that the bone-in roasts cooked faster than the bone-out. The figures used in this chart were the averages of the eighty samples, twenty in each group. In spite of the style, bone-in, cooking in the shortest time, the grade in each style again seems significant. The Choice, bone-in, and the Choice, bone-out, cooked faster than the Utility, bone-in, and the Utility, bone-out, respectively. In reference to the palatability scores discussed previously, the Choice grades scored higher than the Utility grades, regardless of style. With this in mind, there appears to be a relationship between cooking time, palatability, and grade. These results, however, may be affected by composition, since the Choice grades were fatter than the Utility grades. Cooking time, palatability, and style do not seem related. It was found that the bone-in roasts cooked faster than the bone-out, but the palatability scores of the bone-out was not significantly higher than that of the bone-in. (See Chart VIII).

The next factor to compare with cooking time and palatability is weight. On Chart XII, the roasts are listed according to three weights: heavy, medium, and light. From these results, it appears that the light weight roasts take the longest time to cook. In the "average" column, heavy and medium roasts cooked in approximately the same time. To be sure, a statistical test was used to see if there was any significance between the three weights in relation to cooking time. Only a slightly significant difference appeared between medium and light, and a difference of greater significance between heavy and light. No significant difference was found between the heavy and medium weight roasts.

CHART XIII

Relation of Composition to Palatability, Cooking Losses, and Cooking Time

Grade	Style	No. Samples	Aver. Weight Pounds	Character of fat	Amt. of Fat	Character of lean	Texture	Aver. Cooking Losses-%	Aver. No. Min. per lb.
Ch.	Bone-in	4	30.88	very firm and brittle	very abund.	firm	fine	37.64	20
Ch.	Bone-out	2	13.	very firm and brittle	very abund.	very firm	fine	16.63	29
Ut.	Bone-in	4	25.46	soft	very abund.	mod. firm	sl.c.*	51.34	24
Ut.	Bone-out	2	18.22	mod. soft	very abund.	mod. soft	sl.c.	22.11	32
Ch.	Bone-in	14	33.65	very firm and brittle	mod.	very firm	fine	37.48	21
Ch.	Bone-out	16	15.00	very firm and brittle	mod.	firm	fine	12.68	31
Ut.	Bone-in	6	29.01	soft	mod.	soft	sl.c.	39.73	25
Ut.	Bone-out	6	14.38	soft	mod.	firm	sl.c.	19.75	37
Ch.	Bone-in	2	29.38	very firm and brittle	traces	very firm	fine	33.40	22
Ch.	Bone-out	2	19.2	very firm and brittle	traces	very firm	fine	8.58	33
Ut.	Bone-in	10	27.75	mod. firm	traces	soft	sl.c.	36.73	26
Ut.	Bone-out	12	11.74	soft	traces	mod. firm	sl.c.	15.41	39

* slightly coarse

As shown on Chart IX, the heavy cuts scored slightly higher in palatability but statistically it was not significant. Therefore, it appears that there is no relationship between cooking time, palatability and weight. From the data shown on both Charts IX and XII, grade seems to be more important. The Choice grades in both styles, regardless of weight cooked faster and scored higher in palatability. It should be stated here that composition could have affected the results in Chart XII inasmuch as all the light weight roasts were lean.

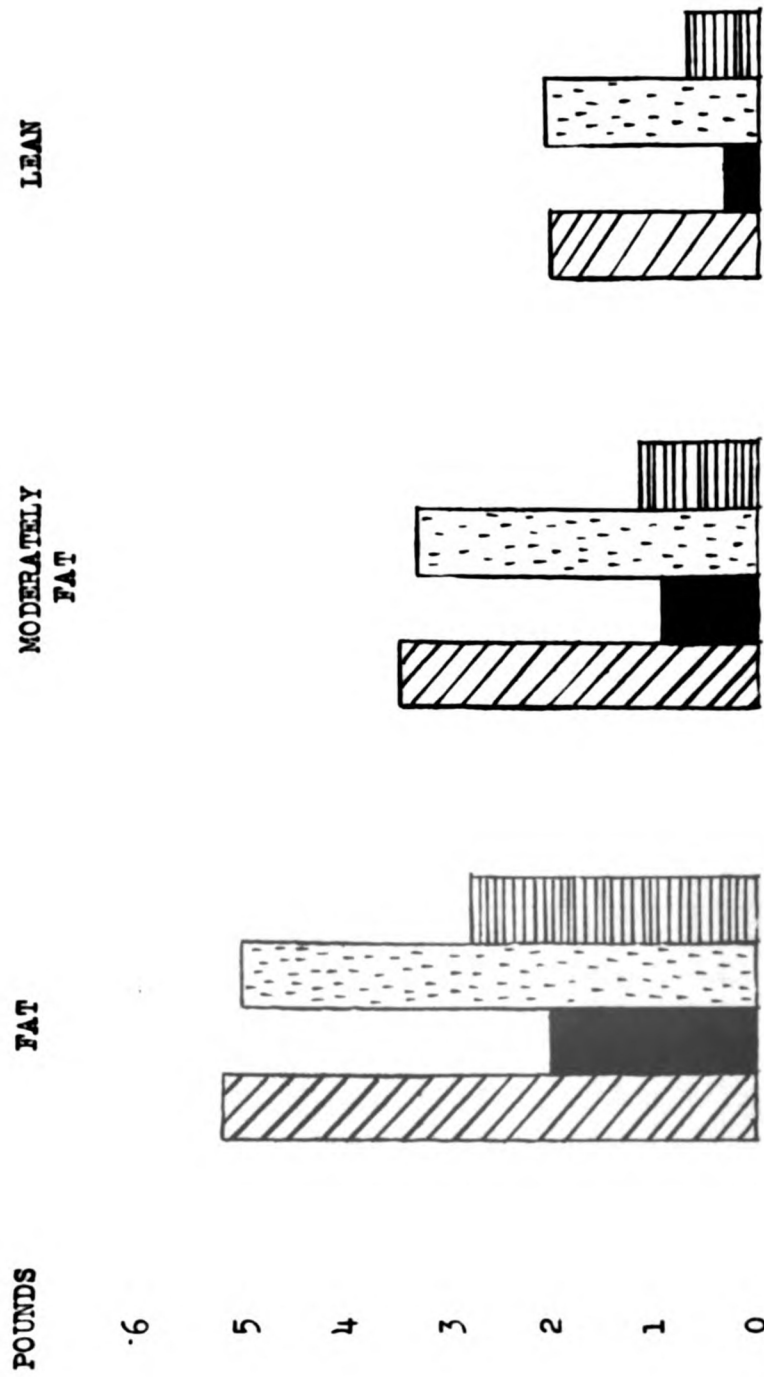
In reporting on price relationships, the same order will be followed as that used in reporting on palatability. The factors, composition, style, grade, and weight will be discussed in relation to price and to cooking time.

To study price and composition, the eighty samples of meat were grouped into three classes, very abundant fat, moderately fat, traces of fat. Chart XIII, "Relation of Composition to Palatability, Cooking Losses, and Cooking Time," shows these three groups and gives other information about the cuts before and after cooking. It includes the amount of fat, the character of the fat, the character of the lean, and the texture. All of these observations were made before the meat was cooked. The cooking losses, the difference between the raw and cooked meat, and the number of minutes per pound that each group took completes the chart. The cooking losses, according to the results of this study were directly related to the composition. The fatter the roasts, the greater were the losses. The moderately fat roasts lost more than the lean roasts, but the largest loss is shown by comparing the abundantly fat roasts with the lean roasts. The Choice, bone-in, abundantly fat,

roast lost 4.24% more than the Choice bone-in, lean, roast. The Utility bone-in fat roast lost 14.61% more than the Utility, bone-in, lean. Another interesting observation is a comparison of the Choice, bone-in, fat roast with the Utility, bone-in, lean roast. The former lost more. If one were interested only in retaining as many portions as possible regardless of palatability it would seem that the lean roasts would be preferred. However, the lean roasts took longer to cook. The Choice, bone-out, fat roasts took twenty-nine minutes per pound while the Choice, bone-out, lean roasts took thirty-three minutes per pound. By keeping all of the other factors constant, that is, the grade, style, and weight of the roasts, the lean meats always cooked slower than the moderately fat and fat meats. The Utility, bone-out, lean, averaged a cooking time of thirty-nine minutes per pound, which was the longest of any cut. The average weight of these Utility, bone-out, lean, roasts was 11.74 pounds which means it took 7.63 hours to roast this cut to the desired doneness (70°C. internal temperature.) The Utility, bone-out, fat, averaged a cooking time of thirty-two minutes per pound, seven minutes less per pound than the Utility, bone-out, lean. The average weight of the Utility, bone-out, fat was 18.22 pounds making the roasting period 9.72 hours. The Choice, bone-in, fat, took only twenty minutes per pound to cook. The average weight for these roasts was 30.88 pounds, making the cooking period 10.13 hours. In other words, the cost of roasting appears to be directly related to the composition of the meat. Other factors affecting the cost and the cooking time, besides composition show up on Chart XIII. For example, the Choice, bone-in, fat, roasts weighing double that of the Utility, bone-out, lean roasts

CHART XIV

AMOUNT OF DRIPPINGS FROM ROASTS



CHOICE BONE-IN
CHOICE BONE-OUT
UTILITY BONE-IN
UTILITY BONE-OUT

EIGHTY SAMPLES

CHART XV

Costs of Roasts in Relation to Composition

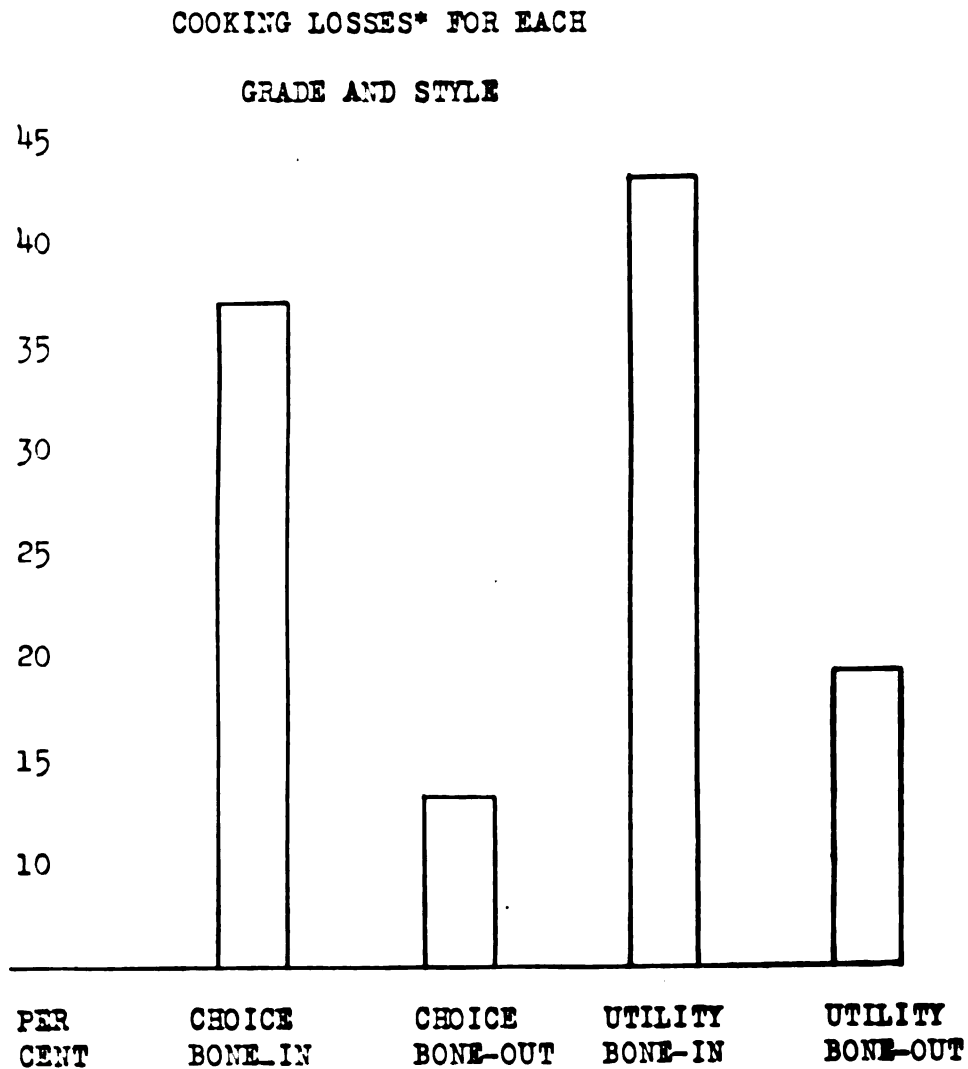
Grade	Style	No. Samples	Composition	Av. Wgt. in lb.		Cost per lb.	
				Raw	Cooked	Raw	Cooked
Choice	Bone-in	4	fat	30.88	19.97	\$.26	\$.42
	Bone-out	2	fat	13.	10.75	.36	.435
Utility	Bone-in	4	fat	25.46	10.31	.22	.54
	Bone-out	2	fat	18.22	11.06	.25	.41
Choice	Bone-in	14	mod. fat	33.65	21.62	.26	.405
	Bone-out	16	mod. fat	15.00	12.95	.36	.42
Utility	Bone-in	6	mod. fat	29.01	11.75	.22	.54
	Bone-out	6	mod. fat	14.38	10.84	.25	.33
Choice	Bone-in	2	lean	29.38	19.13	.26	.38
	Bone-out	2	lean	19.2	17.57	.36	.39
Utility	Bone-in	10	lean	27.75	12.93	.22	.48
	Bone-out	12	lean	11.74	10.03	.25	.29

cooked in approximately the same time.

Along with the shrinkage, and cooking time of these fat, moderately fat, and lean roasts, the amount of drippings from each should be mentioned. The drippings from most meats is saved in institutions according to a study by Disher (18) and are used in various ways. This factor would enter into the total value of the meat. It would not be logical for a food service operator to buy sirloin butts for their drippings, but, if there is an abundance of drippings that can be used, it would reduce the total cost of the edible meat. On Chart XIV, the amounts of drippings from each kind of roast according to its composition are shown. The fat roasts, as it would be expected, yielded the largest amount of drippings. The largest amount of drippings was 5.13 pounds and the least amount was .25 pounds, only four ounces. If a fat roast were preferred because of a more palatable product, the cost would be higher than a lean roast, but the drippings from the fat roast would compensate somewhat for the higher cost. The cooking method used in this study greatly reduced the amount of drippings compared to other methods that had been used by the author.

From the discussion above, it is quite obvious that fat roasts are more expensive, inasmuch as they lose more in drippings. This seems apparent also from the data on Chart XV. The fat roasts, regardless of grade and style, cost more per cooked pound than the moderate fat roasts or the lean roasts. The raw cost figure is the price charged by the wholesaler for the meats used in this study. Apparently the cost price of the Choice, bone-out was proportionately too high since there was actually less loss in this cut than in the Choice, bone-in. Every Choice,

CHART XVI



TWENTY SAMPLES
OF EACH

*EVAPORATION AND DRIPPINGS

bone-in, cut costs more per cooked pound than the Choice, bone-out cut. This shows that a food service operator should keep daily food records on cooked costs to be sure of the best buy. Theoretically the Choice, bone-out, lean, cut would be the cheaper roast in the Choice grade (cooking loss only 8.58%) but from Chart XV, the actual cost is one cent higher than, Choice, bone-in, lean (cooking loss 33.40%). The cost of the cooked meat in Utility, fat, moderately fat, and lean cuts is consistent with the percentage losses given on Chart XIII. The cheapest cut of all is the Utility, bone-out, lean. This roast costs twenty-nine cents per cooked pound, only four cents higher than the raw cost per pound. This cooked cost figure does not include the cost of fuel. That will be discussed later.

Chart XVI shows the average cooking loss for each style and each grade. The most obvious information on this chart is that style means more in cooking losses than grade. The two boneless styles, regardless of grade, lost less than the cuts with bones. Although the Choice, bone-out, had a 12.63% loss, this was less than the Choice, bone-in, of 36.34%. The Utility grades compared the same way, the bone-in losing 42.60% and the bone-out losing 19.09%. Besides the style definitely showing its relation to the cooking losses, the grades do also. The Choice grade in each style lost less than the Utility grade, respectively. Although the Utility, bone-out, lost less than the Choice, bone-in, the former lost more than the Choice, bone-out. Of all the groups, Choice, bone-out, lost the least and Utility, bone-in, lost the most. In spite of the fact that most of the samples of the Choice grade happened to be fat and moderately fat, the Utility, bone-in, cuts lost the most in

CHART XVII

A COMPARISON OF RAW AND COOKED
WEIGHTS OF ROASTS

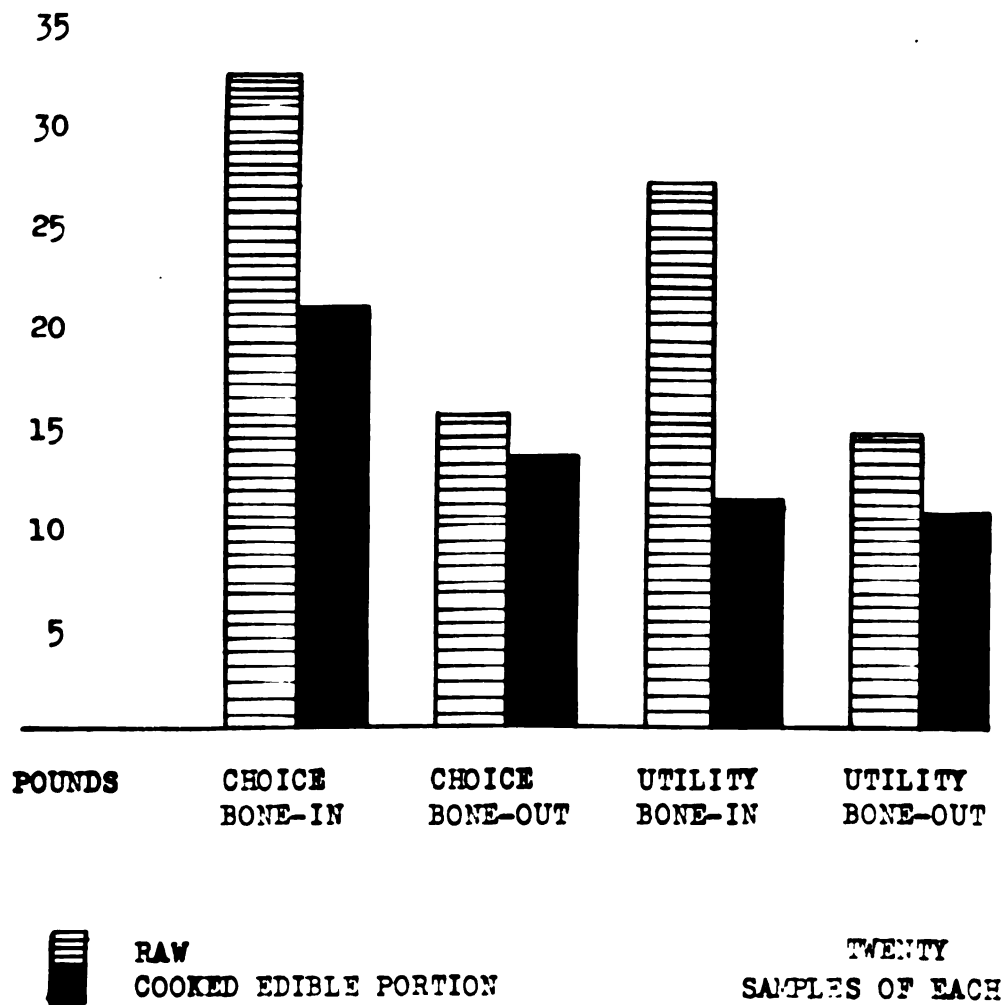
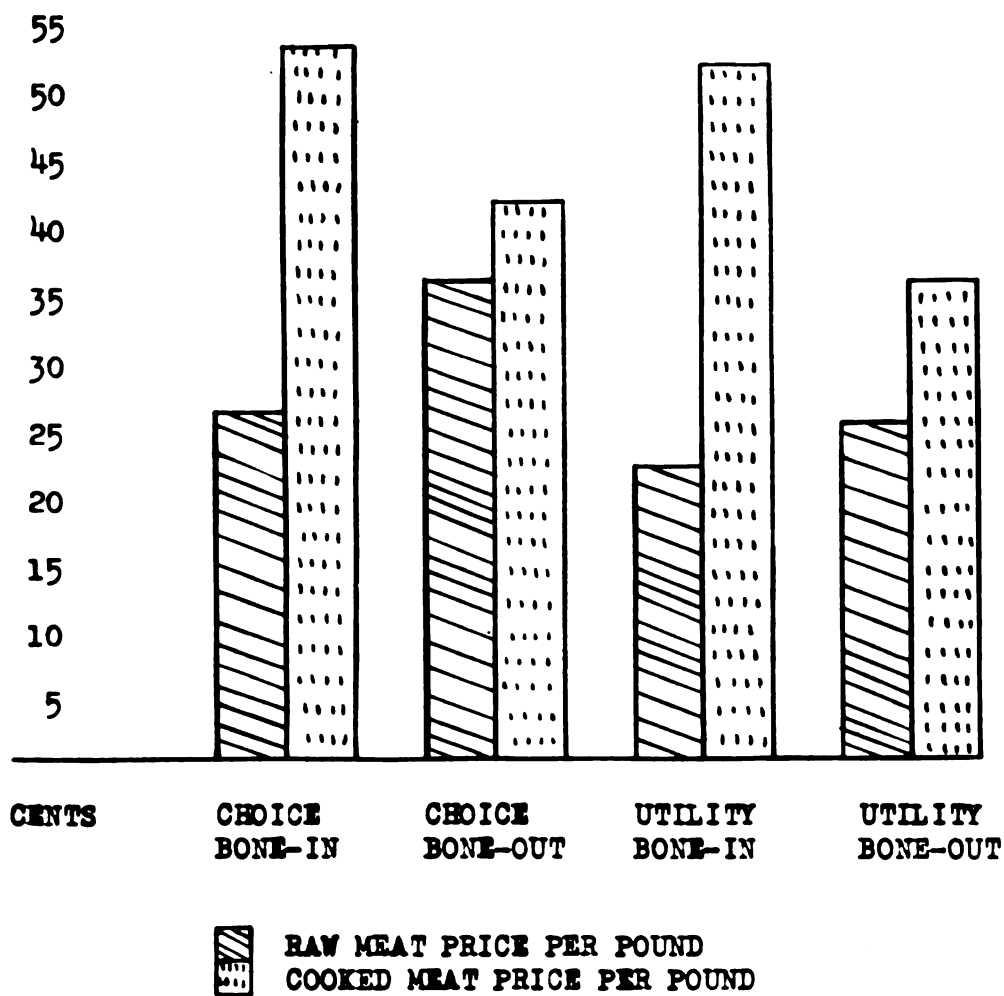


CHART XVIII

PRICE RELATIONSHIP



TWENTY SAMPLES OF EACH

cooking. It appears, therefore, that style and grade are of greater importance than composition as far as cooking losses are concerned. From the data on Chart XVI, style is more important than grade, inasmuch as the bone-out styles had the lowest per cent of losses, the Choice, bone-in, losing more than the Utility, bone-out. A similar picture is presented when the raw and cooked meats are compared. Chart XVII, "A Comparison of Raw and Cooked Weights of Roasts," shows the number of pounds lost by each style and grade. The Utility, bone-in, roast lost fifteen pounds, by the time the bone was removed. This was more than half of its original weight. The Utility, bone-out, roast lost less than five pounds. From this data, if a food service operator were obliged to use Utility grade, it would seem advisable for her to bone her meat before cooking it. Even the Choice, bone-in, lost eleven pounds. The Choice, bone-out, lost only a little over two pounds. This roast appears to be the best of the four since it lost the least number of pounds.

To find out which is the cheapest style and grade to buy, the costs before and after cooking are shown in graph form on Chart XVIII. The Choice, bone-in, cost \$.26 before cooking and \$.531 after cooking, 52% more than the raw cost. The Choice, bone-out, before cooking cost \$.36 and after cooking \$.419. This is only 14% higher than the raw cost. The Utility, bone-in, cost \$.22 raw and \$.526 cooked, an increase of 58%. The Utility, bone-out, cost \$.25 before cooking and \$.352 after cooking. These roasts, cooked, cost 29% more than they cost when raw. The largest increase is found in the Utility, bone-in, roasts. Although they showed the largest percentage increase the edible portion pound price was \$.005

CHART XIX
Average of Results on Cooking Time, Losses, Edible Meat

Grade	Style	No. of Roasts	Weight		Time per lb. min.	Total Time in Oven hour	Cook. Losses %	Bone Waste %	Raw Cost per lb.	Edible Cooked Meat per lb.	Edible Cooked Meat %
			Raw lb.	Cooked lb.							
Choice	Bone-in	20	32.24	21.04	21	11.39	36.34	16.29	\$.26	\$.531	48.88
Choice	Bone-out	20	15.36	13.19	31	7.96	12.63		.36	.419	85.84
Utility	Bone-in	20	27.09	12.04	25	11.48	42.60	16.81	.22	.526	41.82
Utility	Bone-out	20	14.52	10.37	36	8.89	19.09		.25	.352	70.98

less than the Choice bone-in roasts. The cheapest roasts, cooked, are the Utility, bone-out, at \$.352 per pound. The next lowest in edible cooked cost are the Choice, bone-out, roasts. These cost less than the cooked Utility, bone-in, roasts. The difference between the Choice, bone-out, raw cost and the Utility, bone-in, raw cost is \$.14 per pound, but the latter costs \$.107 more per pound cooked than the former. These figures include only the actual cost of the meat. Fuel expense will be discussed later.

The average results on cooking time, losses, costs, and edible portions in relation to grade and style are shown on Chart XIX. Here again, it appears that the style of meat that yields the largest edible portion is the bone-out style. Choice grade also scores higher than Utility grade, each in its respective style. The Choice, bone-out, roasts yielded 85.84% edible cooked meat, the Utility, bone-out, roasts were next with 70.98% edible cooked meat. The bone-in styles were much lower. The Choice, bone-in, roasts gave 48.88% edible cooked meat, and the Utility, bone-in, roasts gave 41.82% edible cooked meat. This chart is a summary of the factors discussed above. It includes the raw weights and cooked weights per pound for the two grades and the two styles, the number of minutes per pound each style and grade required, the total time in the oven for each, the cooking losses, both evaporation and drippings, the bone waste for the two grades, bone-in, the raw cost per pound, the edible cooked meat cost per pound, and the per cent of edible cooked meat from each roast. From this chart it is apparent, that the cheapest meat one could purchase of these two grades would be Utility, bone-out. Choice, bone-out, lost less than the Utility, bone-out but the raw cost

CHART XX

Gas Fuel Costs in Relation to Style and Grade

No. Samples	Grade	Style	Average Raw Wgt. Pounds	Average No. Hr. in oven*	Cooking Cost per Roast	Fuel Cost per Pound	Cooked Cost of Meat per pound	Cooked Cost of Meat plus Fuel Cost per pound
20	Choice	Bone-in	32.24	12.89	\$.2578	\$.0079	\$.531	\$.5389
20	Choice	Bone-out	15.36	9.46	.1892	.0123	.419	.4313
20	Utility	Bone-in	27.09	12.98	.2596	.0096	.526	.5356
20	Utility	Bone-out	14.52	10.39	.2078	.0143	.352	.3663

* These figures include the 1½ hour preheating period.

was so much higher for the Choice, bone-out that the cooked cost is still higher than the Utility, bone-out.

The cuts in this study were roasted by gas. The ovens had three burners with an orifice size 46 which has a maximum discharge of 20,400 British Thermo Units per hour. The three burners were opened one-fourth of the maximum using 5100 B.T.U. per hour per burner, or 15,300 B.T.U. per hour per oven. This was the amount of fuel necessary to maintain the oven at 150°C. Since there is an average of 1000 B.T.U. per cubic foot and 100 cubic feet of gas cost \$.132, the calculated cost for heating an oven 150°C for one hour is \$.02. At the time that the meats were cooked for this study, no equipment was available for an accurate measurement of the gas consumed. This cost method used is similar to the one used by the company that supplied the gas and it has been found to be the best method for calculating fuel costs. Each oven was heated one and one-half hours before the meat was placed in it. The gas fuel costs are shown on Chart XX in relation to style and grade. The cooking costs for the Utility and Choice, bone-in, roasts are higher than the bone-out roasts. The Choice, bone-in, roasts averaged \$.2578 per roast, the Utility, bone-in, averaged \$.2596 per roast. The other style roasts cost less in total cooking, the Choice, bone-out, was \$.1892 and the Utility, bone-out, \$.2078. The fuel cost per pound presents a different picture. The style, bone-in, took less fuel per pound than the style, bone-out, inasmuch as these roasts cooked faster. It takes less money per pound to roast a Choice, bone-in cut than a Choice, bone-out, cut but the total fuel cost is greater for the Choice, bone-in, cut because they are so much heavier. The bones tend to speed up the cooking period, but they

do not justify themselves because of the additional weight that they add to the roast. The Choice, bone-in, sample averaged only twenty-one minutes to the pound for cooking time and the Choice, bone-out, sample averages thirty-one minutes to the pound. The weight of the bones makes the total cooking time for the Choice, bone-in roasts longer than the Choice, bone-out roasts. The Utility styles show the same results. The Utility, bone-in, cuts cook faster per pound and therefore cost less to cook per pound, but because of the extra weight of the bones, the total cooking and total fuel cost is greater than with the Utility, bone-out cuts. Since the bone-out style is more economical in spite of it taking more minutes per pound to roast, a comparison of the two grades, should indicate which is more economical. The Choice grade cooked faster than the Utility grade and the fuel cost per pound was lower in the Choice grades in each respective style. The Choice, bone-in, fuel cost of \$.0079 per pound is slightly lower than the Utility, bone-in, fuel cost of .0096 per pound. The cooked cost per pound of the Choice, bone-in, meat plus the fuel cost per pound, however, is slightly higher than the Utility, bone-in, meat cost per pound, plus the fuel cost per pound. In spite of the higher cooking losses and the larger amount of bone waste, the Utility, bone-in grade appears to be the cheaper of the two grades. The Choice, bone-in costs \$.5389 per cooked pound plus fuel cost per pound and the Utility, bone-in, costs \$.5356 per cooked pound plus fuel cost per pound. Upon Statistical analysis (19) there is no significant difference between these two costs but there is a positive significant difference between the Choice, bone-out costs and the Utility, bone-out costs. The Choice, bone-out, roasts cooked for this study averaged

\$.1892 total fuel cost, the Utility, bone-out, averaged \$.2078 total fuel cost. The Choice, bone-out, cuts took thirty-one minutes per pound to roast and the Utility, bone-out, cuts took thirty-six minutes per pound. According to the data presented on Chart XX, the fuel cost per pound for the Choice, bone-out, is \$.0123 and for the Utility, bone-out, \$.0143. Upon adding the cooked cost of meat per pound, respectively, to each of these grades, the Utility, bone-out, appears to be by far the cheapest. Its total cost per pound is \$.3663 and the Choice bone-out \$.4313. Although the Utility grade in both styles took longer to cook per pound and showed greater cooking losses, the wholesale price of the meat was so much less than the Choice grade that it appears to be the cheaper grade.

Had electric ovens been used in this study, the electricity would have been furnished by the Detroit Edison Company. From statistics supplied by this company, 2700 watt would be required to preheat the lower unit for a 150°C oven. Since there are 1000 watt in 1 kilowatt hour, it would take 4.7 kilowatts to preheat the electric ovens. To maintain an oven temperature of 150°C, it takes 2200 watts or 2.2 kilowatts operating one-fifth of the time. Tests by the Detroit Edison Company have shown that the heat of an oven is actually "on" only one-fifth of the time. The combination of 4.7 kilowatt for preheating plus the 2.2 kilowatt for operation would give an oven with a connected load of 3 kilowatts according to L. F. Marston of the Detroit Edison Company. A large institution would receive a rate of \$.015 per kilowatt hour, therefore, the following formula can be used: $3KW \times \text{number of hours roast was in oven} \times \frac{1}{5} \times \$.015 = \text{cooking cost.}$

CHART XXI
Electric Fuel Costs in Relation to Style and Grade

No. Samples	Grade	Style	Average Raw Wgt. Pounds	Average No. Hr. in oven	Cooking Cost per Roast	Fuel Cost per Pound	Cooked Cost of Meat per pound	Cooked Cost of Meat plus Fuel Cost per pound
20	Choice	Bone-in	32.24	11.39	\$.1025	\$.0032	\$.531	\$.5342
20	Choice	Bone-out	15.36	7.96	.0716	.0046	.419	.4236
20	Utility	Bone-in	27.09	11.48	.1033	.0038	.526	.5298
20	Utility	Bone-out	14.52	8.89	.0800	.0055	.352	.3575

On Chart XXI, the total cooking cost for each group of roasts is given according to this formula. The bone-in cuts cost the most to roast inasmuch as they were the heaviest. The Utility, bone-in, cut cost more than the Choice, bone-in, cut although the latter weighed more. The average fuel cost per pound for the Choice, bone-in is \$.0052 and for the Choice, bone-out, \$.0046. The results shown on this chart are similar to those on Chart XX. The type and grade that proves to be lowest in cost is the Utility, bone-out, roast. The fuel cost per pound is highest because it took so long to cook, but the wholesale price was low enough to offset this expenditure. The Utility, bone-out, roasts averaged \$.0055 fuel cost per pound, the Utility, bone-in, roasts, \$.0038. The total cost per pound of the meat plus the fuel for the Utility, bone-out, was only \$.3575 and for the Utility, bone-in, \$.5298. These figures showed a greater variance between the two styles than was shown by the Choice grade. The Choice, bone-in, roast cost \$.5342 per pound per cooked meat cost plus fuel cost. The Choice, bone-out, roast cost \$.419. These results speak well for boning meat before roasting it. Both the Choice, bone-out, and Utility, bone-out, cooked in a shorter time and lost less in evaporation and drippings than the bone-in style, respectively. The Choice, bone-out, cooked in the shortest period of all the roasts and had the least cooking losses.

In relation to the cooking costs of roasts and their weights, it has been mentioned above that the light roasts take more minutes per pound in cooking. It also appears that the fuel cost per pound is higher for the light weight roasts as shown on Chart XXII. Naturally, the fuel cost per roast is proportionate to its weight, the heavy roasts

CHART XXII

Relation of Weights of Roast to Cooking Costs

Grade	Style	No. Samples	Weight	Min. per lb.	Raw Weight pound	Fuel Cost per roast	Fuel Cost per pound	Cooked Cost of Meat plus fuel cost per lb.
Choice	Bone-in	4	Heavy	20	34.5	\$.26	\$.0075	\$.5385
		14	Medium	20	30.8	.234	.0076	.5386
		2	Light	23	26.3	.23	.008	.539
	Bone-out	6	Heavy	31	18.9	.226	.012	.431
		10	Medium	30	15.7	.187	.012	.431
		4	Light	32	13.	.168	.013	.432
Utility	Bone-in	4	Heavy	22	32.3	.266	.0082	.5342
		14	Medium	25	28.5	.266	.0093	.5353
		2	Light	28	23.4	.248	.0106	.5366
	Bone-	4	Heavy	35	18.5	.246	.0133	.3653
		10	Medium	35	15.7	.213	.0135	.3695
		6	Light	38	12.0	.182	.0151	.3671

using the most fuel per roast. There seems to be no correlation between the weight of the roast and its cooking cost. In the Choice, bone-in, group, the heavy, medium, and light averaged about the same in fuel cost per pound, and in total food cost. The same is true in the other groups. In the total food cost column, the light roasts cost slightly more than the medium and heavy roasts but by statistical analysis (19) there was no significant difference. If a person bought a large roast, and cooked it at a constant oven temperature of 150°C, she would not have any more cooked meat in proportion than if she bought a small roast, according to the findings of this study.

In trying to find which grade and which style of sirloin butts scored highest in palatability and yielded the largest edible cooked meat at the lowest proportionate cost, it has been necessary to discuss other factors which could affect the results. Chart XXIII includes the summary of these factors in relation to palatability and price. First, composition was discussed. The average roast in the Choice grade is moderately fat and in the Utility grade, lean. The palatability score of the Choice, bone-in, is highest, Choice, bone-out rated second, Utility, bone-out, third, and Utility, bone-in, lowest. The Choice grades are heavier than the Utility grades in their respective styles. The bone-in style loses more in weight upon cooking than the bone-out style. The Choice, bone-in, averages less minutes per pound for cooking than any other grade or style, the Utility, bone-in, being second. The cheapest cooked roasts are the bone-out style and Utility grade is cheaper than Choice.

For the most part, the results above agree with the findings of

CHART XXIII

Summary of Factors in Relation to Palatability and Price

Grade	Style	Aver. Comp.	Palat. Score*	Raw Wgt. lb.	Cooked Wgt. lb.	Min. per lb.	Raw Cost per lb.	Total Cook- ed cost per pound	Cost per 4 oz. Serv.
Choice	Bone-in	Moderately fat	6.57	32.24	21.04	21.	\$.26	\$.5389	\$.1347
Choice	Bone-out	Moderately	6.48	15.36	13.19	31.	.36	.4313	.1078
Utility	Bone-in	lean	5.42	27.09	12.04	25.	.22	.5356	.1339
Utility	Bone-out	lean	5.58	14.52	10.37	36.	.25	.3663	.0916

* A perfect score is 7.0

other meat investigators. There was an opportunity, in this study, to compare style in large roasts. Other reports have been made (2), (3), (11), on style and cooking time but smaller roasts were used. The forty paired roasts cooked for this study showed very consistent results as far as the effect of style on palatability and price were concerned.

V Summary and Conclusion

The palatability and price of sirloin butts in two grades, Choice and Utility, and in two styles, bone-in and bone-out, were tested and compared in this study. Approximately ninety samples were cooked, the results of eighty used to form the basis for the following:

A. Palatability

- 1) Composition affected palatability, because the fatter roasts scored higher.
- 2) Styles apparently had no affect on the palatability of a large roast, except that the meat adjacent to the bone scored higher.
- 3) Grade and palatability showed a positive correlation, Choice grade scoring higher than Utility, all other factors being constant.
- 4) Weight showed no relationship to palatability.
- 5) Palatability scoring in relation to intensity included six factors.
 - a) Aroma--was influenced by composition but not by grade or style.
 - b) Texture--was influenced by grade.
 - c) Flavor of fat--was influenced by grade.
 - d) Flavor of lean--was influenced by composition.
 - e) Tenderness--was influenced by grade.
 - f) Juiciness--was influenced by grade and composition.
- 6) Palatability scoring in relation to desirability included three factors.

- a) Aroma--was influenced by fat.
 - b) Flavor of fat--was influenced by amount and grade.
 - c) Flavor of lean--was influenced by fat and grade.
- 7) In relation to cooking time, fat roasts cooked faster and scored higher than other roasts.

Bone-in roasts cooked faster and scored approximately the same as the bone-out roasts.

Choice grades cooked faster and scored higher, respectively, There was no relationship between weight, palatability, and cooking time.

- 8) The scraps from both grades were palatable when used at a later date.

B. Price

- 1) Composition affected price, the fat roasts losing more in drippings and consequently not yielding as many edible portions as the lean roasts.

The lean roasts lost more in evaporation but this did not offset the higher loss of the fat roasts in drippings.

The lean roasts required longer cooking, but the fuel cost was nominal compared with the higher cooking loss of the fat roasts.

- 2) Style affected price, the bone-out roasts requiring a longer time to cook, however the fuel cost was not a large expenditure.

The bone-out roasts had the smallest cooking losses and yielded the largest amount of edible cooked meat.

Utility, bone-out, cost less both raw and cooked.

Choice, bone-out, cooked, cost less than the Utility,
bone-in, cooked, per pound.

- 3) Grade affected price. The Choice grades cooked faster, had the least cooking losses, and yielded the most edible cooked meat, in their respective styles.

The Utility grades cost less, raw and cooked, in their respective styles.

- 4) Weight had little affect on price.

The light weight roasts required more minutes per pound than the medium or heavy roasts.

There were no more servings in one large roast than in two small roasts, equal to the weight of the large one.

As it seems to indicate that Choice, bone-out, cuts have the lowest cooking losses, and score very high in palatability, they would be a good buy. If one were only interested in the cheapest roast with a large yield of edible meat, Utility, bone-out, cuts would be the best buy. The outstanding yield of edible meat from the bone-out cuts is probably due, to some extent, to the use of the low constant oven temperature.

VI Appendix

Description of Sirloin Butts before Cooking

Cooking laboratory serial number								
Animal number								
Weight of cut, pounds								
Texture								
Very fine								
Fine								
Slightly coarse								
Coarse								
Very coarse								
Marbling								
Very abundant and extensive								
Abundant and extensive								
Moderate, limited distribution								
Traces								
None visible								
Character of fat, external and internal								
Very firm and very brittle								
Firm and brittle								
Moderately firm								
Soft								
Very soft								
Firmness of Lean								
Very firm								
Firm								
Moderately firm								
Soft								
Very soft								

Calculations of Cooking Losses

	Per cent	Per cent	Per cent	Per cent
A. Losses as per cent of weight of uncooked roast				
1) Total loss during cooking D + A3				
2) Per cent of edible portion F + A3				
B. Time-weight relations				
1) Total time in oven, min.				
2) Weight of uncooked roast lbs.				
3) Minutes per pound				

Oven Chart

Cooking laboratory serial number _____

Pan number

Kind and number of animal

Oven number

[illegible]

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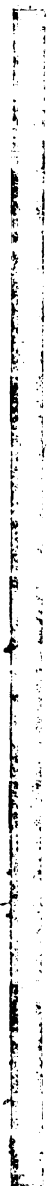
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