March 7, 1974

To the Graduate Council:

I am submitting herewith a thesis written by Jesse Ray Ford entitled "The Relationship of Fat Content to the Palatability of Ground Beef." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

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Hilton A. Smith

Vice Chancellor for
Graduate Studies and Research

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THE RELATIONSHIP OF FAT CONTENT TO THE PALATABILITY OF GROUND BEEF

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Jesse Ray Ford

March 1974

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Jesse Ray Ford

ABSTRACT

The objective of this study was to compare ground beef fabricated from two lean sources (domestic and foreign) to contain five levels of fat (16, 25, 30, 35, and 45 percent). USDA Choice grade plates served as the common fat source. Good grade chucks were used for the source of domestic lean, and imported boneless chucks from Managua, Nicargua were the foreign source of lean. The meat was ground and made into patties of five fat levels--16, 25, 30, 35, and 45 percent fat, half of the patties being of the domestic lean source and half being of the foreign lean source. A ten-family taste panel selected from high-income University personnel and low-income University personnel were used to evaluate paired samples and designate a preference. All possible combinations of the five fat levels and two lean sources were compared. A six-member trained taste panel was also used to score flavor, tenderness, and juiciness and declare a preference for all possible comparisons of both broiled and fried samples. Percent moisture, percent fat, percent protein, evaporation loss, drip loss, total loss, and internal temperature were recorded for the cooked samples used for taste panel scoring.

The following observations can be made upon analysis and interpretation of the data presented in this thesis.

It was found that the men of the family panel preferred 25 and 30 percent fat patties over 16, 35, and 45 percent fat levels, with 45 percent fat being preferred least of all. Women showed little difference in preference between 16, 25, 30, and 35 percent fat level patties but did show a sharp decline in preference for the 45 percent fat level patties.

The high-income families were compared to the low-income families for their preference of the five fat levels. There was little difference in the preference between 16, 25, 30, and 35 percent fat levels. A decline in preference was noted at the 45 percent fat level for both high-income and low-income families.

All family panel data were combined for preference of domestic lean source and foreign lean source. At all levels of fat, the domestic lean source was preferred over the foreign lean source (62.1 percent and 37.9 percent, respectively).

There was essentially no difference in high-income families and low-income families and their preference for ground beef from domestic lean source over that from foreign lean source.

A trained taste panel was used to evaluate both broiled and fried samples from all fat levels of both lean sources. For broiled samples, there was a decline in preference from the 16 to 35 percent fat levels, but a sharp increase in preference was shown for the 45 percent fat level patties. Preference for the fried samples followed a somewhat different pattern. There was a high degree of preference for the 45 and 16 percent fat levels. Preference dropped for the 25 percent fat level patties. It was even lower for the 35 percent and the 30 percent fat level patties were preferred least of all.

The trained taste panel's preference was compared for the domestic and foreign source of lean in both fried and broiled samples. It was noted that the domestic source of lean was preferred slightly over the foreign source for fried samples. However, the foreign source of lean was preferred slightly over the domestic source for broiled samples.

When broiled and fried preferences were combined, the total preference for domestic and foreign sources of lean were essentially no different.

Chemical data (percent moisture, percent fat, and percent protein of the cooked patties) was recorded. Broiled samples tended to retain more moisture than the fried samples. However, broiled samples were lower than fried samples for percent fat and percent protein. The domestic lean source for both broiled and fried samples was lower in percent moisture, higher in percent fat, and lower in percent protein than the foreign source of lean.

Organoleptic properties (flavor, tenderness, juiciness, and overall score) were recorded. When means were compared, broiled samples were higher in tenderness, juiciness, and overall score than fried samples but lower in flavor. For broiled samples, domestic lean was higher for tenderness, juiciness, and overall score but lower in flavor than the foreign lean source. The domestic lean source in fried samples was higher for flavor, tenderness, juiciness, and overall score.

Cooking losses (evaporation loss, drip loss, and total loss) were recorded. Means were compared, and the broiled samples were higher for drip loss, but the fried samples were higher for evaporation and total loss, but lower than the domestic lean source in drip loss. In the fried samples, the domestic lean source was higher in evaporation and total loss and lower in drip loss than the foreign lean source.

For both broiled and fried samples when flavor, tenderness, and juiciness were compared, tenderness was more highly correlated to overall score, followed by juiciness and then flavor. However, all were highly positive correlations.

Tenderness and juiciness were highly related in both broiled and fried samples. However, flavor for the broiled samples was not significantly associated with tenderness or juiciness, but in the fried samples flavor was highly related to tenderness but not significantly correlated with juiciness.

Percent fat in the broiled samples was highly related to juiciness and tenderness, respectively, but had a high negative correlation to flavor. Percent fat for fried samples was highly related to juiciness but not significantly associated with tenderness, and, like the broiled samples, had a highly negative correlation to flavor.

Thus it appears that a wide range of fat percentage in ground beef is acceptable to the consumer. However, a distinct preference was noted for domestic lean as compared to foreign lean The trained taste panel preference did not parallel the family panel data, but a wide range of fat levels was preferred by the trained panel. There was essentially no difference in the trained panel's preference for foreign lean source or domestic lean source.

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CHAPTER I

INTRODUCTION

Ground beef is one of the most popular items in the retail meat market today. Livestock and meat statistics (1973) indicate that since 1968, total consumption of ground beef has nearly tripled, while total consumption of all beef has increased 11.8 percent.

The present trend is to increase the percent of lean and decrease the percent of fat in beef animals. The reason for this change is the trend toward lower fat levels in the diet and the aversion on the part of many consumers to the consumption of animal fats. Many new breeds of beef cattle have been introduced into the United States which purport to produce leaner carcasses. Traditional beef breeds have been and are being subjected to selection pressure to produce a leaner carcass. The consumer acceptance of American beef is excellent. Per capita consumption is projected to increase to 130 pounds within the next decade. Producers must remain cognizant of the universal acceptance of their product and should not embark upon production programs which may detract from this acceptance. With the trend toward increased leanness, the answer to the question, "How lean is too lean," must be found.

CHAPTER II

REVIEW OF LITERATURE

Research dealing with the degree of fatness and the overall palatability of beef has been extensive. There has been much work done on fat's relationship to tenderness, juiciness, and flavor in the higher priced cuts of beef. However, there has been very little work aimed at finding the optimum fat level for ground beef to satisfy consumer tastes.

I. FAT'S RELATIONSHIP TO PALATABILITY

Mackintosh et al. (1939) found that the degree of finish or fatness of beef appeared to be associated with palatability. An increasing degree of finish rendered more intense the properties of tenderness, juiciness, and flavor. It was noted, however, that exceptions to the general rule appeared among the experimental animals and these will continue to appear. But the evidence seemed to justify the old-time belief that fat improves the palatability of the meat. Without a doubt, there is a point beyond which increased increments of fat will not improve the palatability. This point has not yet been determined, but it is well beyond the degree of finish found in most market cattle. The practice of fattening animals for market, as well as the higher market price paid for fat animals, seemed to be well justified.

Branamon et al. (1939), found that the intensity and desirability of flavor of lean and the quantity and quality of the juice seemed to increase as the degree of fatness increased.

Ashby _et al_. (1941) reported on consumer attitudes obtained from 351 views. Two-thirds wanted a small amount of fat and one-fourth a goodly or considerable amount. There were some indications that higher-income groups preferred a higher degree of finish than the lower-income groups. That is, the high-income group preferred high grading beef perhaps because they could afford it.

Brady, D. E. (1957) found that consumers generally have an aversion to too much fat. This observation was based on actual purchase data collected, not on taste.

Cover _et al_. (1956) found juiciness more closely correlated with ether extract than with fat measured by physical separation or by estimated marbling. Juiciness scores seemed more closely correlated with broiled loin than with braised loin or broiled or braised bottom round Fatness seemed more closely correlated to tenderness scores in bottom round than in loin.

Husaini _et al_. (1950) found in 20 identically fed animals that there was no correlation between tenderness at three days aging or fifteen days aging and carcass grade or intramuscular fat.

Simone _et al_. (1958) found that between 18 and 30 month-old steers, only age affected tenderness significantly. He also observed that a taste panel preferred fatter meat when asked to score tenderness, juiciness and flavor; that is, they preferred USDA Choice over USDA Good.

Kidwell _et al_. (1959) found no association between tenderness score and fatness. The flavor of the muscle did show a low correlation with percent fat.

Romans et al. (1965) found that neither maturity, marbling, nor core location had a significant effect on tenderness as determined by the Warner-Bratzler Shear. Steaks from the Longissimus dorsi (L.D.) muscle of the more mature carcasses were considered to be less tender than those from less mature carcasses as scored by a taste panel.

Backus (1968) used 48 weanling Hereford steers to study the effect of three pre-determined subcutaneous fat thickness levels upon the production efficiency and organoleptic properties of beef. He found that acceptable beef can be produced with little waste fat. Also, marbling score, carcass conformation and carcass grade were all significantly increased by increased fat deposition; but tenderness, juiciness, and flavor were not significantly increased by increased fat deposition

Black and Hiner (1946) found no significant differences in palatability of roasted 9-10-11 rib cuts between groups of cattle fed grass alone and those receiving concentrates.

Cover et al. (1957) found that high concentrate rations as opposed to high roughage rations did not significantly improve the eating quality of the loin steaks from yearling steers of the Hereford and Braham X Hereford steers, but it did appear to improve the eating quality of broiled bottom round steaks. It was also noted that breed of sire had a significant effect on juiciness of some of these steaks, but no significant effect on tenderness. Sires within breeds had no significant effect on juiciness, but their effect on tenderness was significant.

King et al. (1958) found that there was no significant difference in eating acceptability from cattle from grazing, growing or fattening rations. Animal age had a significant negative effect on eating acceptability and carcass grade, and Warner-Braztler Shear values increased with increased age.

Cole et al. in a study using Holstein, Jersey, Guernsey, Brahman, Brahman cross bred, Angus, and Hereford steers found that British breeds were more tender than Brahman or Brahman crosses according to shear scores. Dairy breeds' shear scores fell between the scores for the British breeds and the Brahman and Brahman crosses. In paired comparison tests for preference of rib roasts, taste panel preferences indicated considerable variability among steers of the same breed and suggested there may be one or more factors not related to fatness which influence eating quality of beef.

Cover et al., in a study involving 203 steers found that carcass grade, under the present standards, was not satisfactory as an exact indicator of tenderness. It was also noted that there was a wide scattering of tenderness ratings for meat of different carcasses observed with measures of percent separable fat from 9-10-11 rib cut and percent ether extract of the trimmed ribeye in the 9-10-11 rib cut.

Brannan (1957) using beef from the Choice, Good, Standard, and Commercial grades found that data collected from family tasting showed a preference for the higher grades of meat. Palatability scores decreased with a decrease in grade. Percentage wise, when Choice beef was compared to Standard and Commercial beef, it was rated above these grades by wide margins. When Choice was compared to Good, Choice was selected more times when cooked with dry heat, but Good was preferred more if the steaks were braised.

Ramsey et al. (1967) in a study of age effect on carcass composition, meat characteristics, and palatability found that when using heifers from 3 months to 11 months of age, age had little or no effect on meat juiciness and flavor but significantly influenced tenderness.

Breidenstein et al. (1968) used 60 heifer and cow carcasses of the A, B, and E maturity scores and slight, modest, slightly abundant, and abundant marbling scores to study the influence of marbling and maturity on the palatability of beef. They found that maturity score E was less desirable in palatability than either A or B maturities. Marbling degrees did not affect significantly either shear scores or taste panel scores for tenderness, but the abundant level of marbling did have the lowest shear scores and the highest taste panel tenderness scores of any of the marbling levels. Juiciness and flavor were significantly affected by marbling scores but not by maturity.

Zinn et al. (1970) found that tenderness of beef muscle tended to decrease as cattle passed 400 days of age and was lower at 530 days of age. The lowest shear values in this study were recorded at about an average of 430 days.

Wellington and Stouffer (1959) in a study of the effects of marbling on tenderness and juiciness of beef found that marbling only accounted for 7 percent of the variability in tenderness, leaving 93 percent of tenderness variability to factors other than marbling.

Palmer et al. (1958) using short loin steaks from 536 carcasses of known feeding and management backgrounds found that highly significant correlations were obtained between grade and marbling, ether extract in the L. Dorsi, panel tenderness, shear force values and rib eye area.

Grade accounted for 8 percent of the variation in panel tenderness. Highly significant correlations were also found between marbling and ether extract in the L. Dorsi, panel and shear force values, and rib eye area. Marbling accounted for 11 percent of the variability in panel tenderness.

Dunsing (1959) found that marbling score and color as determined by a consumer household panel was inadequate to indicate desirable eating qualities of beef. However, eating preferences were significantly related to carcass age but not to grade. Eating preferences of the consumer panel were constantly in favor of the younger carcass steaks.

Cole and Badenhop (1958) found when using paired steaks from the Choice, Good, Standard, and Commercial grades that family taste groups always ranked tenderness over flavor and juiciness, and flavor over juiciness when rating the paired steaks. It was also noted that consumers definitely preferred the higher grades in all cases except when Choice and Good steaks were compared; then, the differences here were small and insignificant.

Cole et al. (1960), in a study involving the effect of fat content of ground beef and palatability found that consumers, as well as a trained taste panel, preferred ground beef with fat levels of 25 percent and above.

It was also noted that regular ground beef from Knoxville, Tennessee area supermarkets ran from 20 to 25 percent fat and that ground chuck ran from 14 to 20 percent fat.

Law et al., in a study using ground beef of three fat levels (15, 25, and 35 percent fat) found that 122 consumer families in Baton

Rouge, Louisiana, consistently preferred the lowest fat level for all six characteristics rated (color before cooking, shrinkage, general cooking qualities, juiciness, flavor, and general acceptability). It was also noted that regular ground beef in eight Baton Rouge stores ran between 14.5 and 35.5 percent fat, and ground chuck from these same stores ran between 7.6 and 24.8 percent fat.

Huffman and Powell (1970) found that Allo Kramer shear values were significantly less for ground beef patties with 35 percent fat than for patties with 25 percent and 15 percent fat. It was also noted that there was an increase in taste panel preference with a decrease in Allo Kramer shear scores.

Irmiter et al., in a study using ground beef found that cooking losses in meat of 10 percent fat or less were due to evaporation of moisture with no loss of fat in the drip. When raw meat with fat levels of 20 percent was cooked, loss of moisture by evaporation decreased significantly, and fat loss in drip increased significantly. When meat with 30 percent was cooked, loss of moisture by evaporation appeared to be significantly retarded by the fat.

Woolsey and Paul (1969) in a study using Choice grade semitendinosus muscles divided into roasts of anterior and posterior portions found that significantly more fat could be extracted from the cooked roasts with external fat covering removed than from the raw roasts. This was explained in terms of the cooking process. It is believed that the heat releases or makes fats present in the muscle tissue more available to extraction technique. Heat may cause denaturation of the protein and lipid complexed with protein, and allow these lipids to go free.

Woolsey and Paul (1969) also found that there were greater drip losses from roasts with external fat than with roasts that had the external fat removed. It was noted, too, that roasts cooked at 218°C had significantly greater losses than did roasts cooked at 163°C although all roasts were cooked to the same internal temperature. This was explained in terms of losses due to greater evaporation at higher oven temperatures.

Garrett and Hinman (1971) used completely trimmed muscle samples from the chuck, rib, loin, and round and found that when cooked, all samples lost fat but also lost moisture at a faster rate than they lost fat; therefore, resulting in an increase in fat content of the cooked muscle over the raw samples.

Blumer (1963) compiled research of many technologists in the Meats and Food Science field and concluded: "The most fruitful research to show the relationship between marbling and panel flavor would appear to be through separation, isolation, and identification of the flavor compounds of beef. Much work has been done on both the volatile and non-volatile fractions of beef and much is known, but more is needed. When the compounds of the flavor complex are all known in their proper proportions, only then may the role of fat be known.

CHAPTER III

EXPERIMENTAL PROCEDURE

I. SOURCE OF DATA

Beef for this experiment was purchased at local packing companies. USDA Choice grade plates were used as a common source of fat. USDA Good grade chucks were used as the source for United States lean beef. Frozen boneless chucks imported from Managua, Nicargua in Central America were used as a source of foreign lean beef.

The Choice plates were boned, and then ground through a coarse, one-quarter-inch plate.

The USDA Good chucks were boned, some of the easily separated fat was removed, and then ground through a one-quarter-inch plate.

The foreign source of lean, the boneless chucks from Nicargua, were sawed into strips 1-1/2 inches square and allowed to thaw. They were then ground through a one-quarter-inch plate.

Three random samples were taken from each source--U. S. fat, U. S. lean, and foreign lean. Ether extract was determined on these samples so the fat percent in each source could be used to formulate the desired fat-lean mixture. Once the fat percentages were known, the proper ratios of fat to lean for U. S. and foreign beef at 16, 25, 30, 35, and 45 percent fat were calculated using the Pearson square. A separate batch was mixed for each level. Care was taken to mix each fat level thoroughly and grind through a one-eighth-inch plate; then mix again and grind through the one-eighth-inch plate. This was done to insure a thorough and even mixture.

After mixing each batch, three samples were taken from each fat level and percent ether extract, percent moisture, and percent protein determined by laboratory analysis to confirm the calculation of the Pearson square and insure that the correct fat level was attained for each batch.

A Hollymatic patty-forming machine was used to make eight-ounce uniform patties, one-half inch thick. The patties were sealed in plastic freezer bags, marked as to fat levels and quick frozen at minus 20°F in a blast freezer.

II. FAMILY TASTE PANEL

A family taste panel was selected. The husband and wife from five high income families made up of The University of Tennessee personnel and the husband and wife from five low income families made up of The University of Tennessee labor force were used.

All combinations of the ten fat level-source samples (five fat levels with U. S. beef and the five fat levels with foreign beef) were paired for testing. Only one pair at a time was tested. Pairs were assigned to testing time at random (see Appendix A).

The ten husband and wife teams compared all samples. Forty-five pairs of patty samples were tasted over a period of approximately 23 weeks. Thus, an average of two pairs of patties per family per week were evaluated. All patties were paired according to the sequence in which they were to be eaten by the family panel. A hole was bored in one patty of the pair so the panel members could identify the two samples during the process of cooking and tasting.

The patties were packaged in pairs, marked, packed in boxes of ten like pairs, and stored at 0°F until they could be evaluated.

Two instructional data sheets, one for the husband and one for the wife, accompanied each pair (see Appendix B). As the new pair of patties was delivered, the data sheets for the previous pair were picked up, the data recorded, and the sheets filed under the family name but separated by husband and wife.

The instructional data sheet allowed the families to select either frying or broiling as a method of cooking but requested that the method selected be used throughout the experiment. If frying were selected, the families were asked to fry the patties separately, not allowing the drippings from one to come in contact with the other. They were asked to cook the patties to the degree of doneness which they normally used in their home. The individual family panel member was asked to mark which sample he preferred and to what degree he preferred this sample over the other sample. The degrees of preference were slightly, moderately, or strongly. Each data sheet allowed for comments on factors which may have affected their preference. The husband and wife of each family were asked not to discuss their preferences before making a decision.

III. TRAINED TASTE PANEL

A six member trained taste panel was used to score flavor, juiciness, tenderness, preference, and degree of preference on the same pairs of patties as the family taste panel was given. Panels were held for the paired comparisons cooked by broiling and also by pan frying. All broiled comparisons were made before making the fried comparisons.

Flavor and juiciness were scored on a scale of one to nine, nine being excellent and one being extremely poor. Tenderness was scored on a scale from zero to ten, ten being extremely tender and zero being a rejected sample. Preference for the pair being sampled was marked and degree of preference was divided into slight, moderate, or strong (see Appendix C).

Training of the taste panel and cookery for panel evaluation was done by the Food Science Department of The University of Tennessee.

For the first phase, a triangle test was used. This test involved three samples, two being of the same fat level and one being different. The panelists were asked to distinguish the odd sample. The order of testing was designed so the first samples tested had the greatest difference in fat levels (29 percent), and the last pair the least difference in fat levels (5 percent). Two tests were done per session (see Appendix D, Table XV). The panel tests were scheduled between 2 p.m. and 3 p.m. on Monday and Friday for a three week period. Before beginning the training, two practice sessions were held in which the score card, terminology, and items to be scored were discussed. Additional discussion periods were held after half the tests had been run to discuss any problems and answer questions. Also, questions were answered any time they were asked during the session. The panelists were informed during practice sessions that the lean was of two sources, and that there were different levels of fat. Panelists were not permitted to discuss their ratings until after they had completed each session. They were also allowed to compare scores with other judges after each session.

Cooking data recorded included evaporation loss, drip loss, total loss, and internal temperature for both fried and broiled individual samples (see Appendix E).

IV. COOKING PROCEDURE

The patties to be broiled were taken out of the freezer the day before the panel test was to be done and placed in a refrigerator to thaw overnight. They were then removed and allowed to thaw at room temperature until time for cooking. The patties were broiled in a conventional oven that had been preheated. Patties of the same fat level were placed on a broiling pan eight inches from the heating unit. A copper-constantine thermocouple was inserted into the center of one patty of each fat level and cooked to an internal temperature of approximately 130 to 140°F. They were turned and cooked until the internal temperature reached approximately 180 to 190°F.

The patties to be fried were handled in the same manner as the patties to be broiled in preparation for cooking. The grills for cooking the fried patties were standardized at 350°F. Patties of different fat levels were fried on separate grills and the drip loss was collected in a grease well attached to each grill. A copper-constantine thermocouple was inserted into the center of patties of each fat level to be cooked. When the internal temperature reached 130 to 140°F, they were turned. The patties were allowed to cook on the second side until internal temperature reached 180 to 190°F.

A sample approximately one inch wide was taken from across the center of each cooked sample. When patties of this same fat level were cooked simultaneously, the samples from each patty were blended and analyzed as one fat level. Percent moisture was calculated after drying samples in a vacuum oven. Percent protein was determined by the Kjeldahl procedure and percent fat was determined by the Goldfisch extraction method (see Appendix E).

CHAPTER IV

RESULTS AND DISCUSSION

I. FAMILY TASTE PANEL

Husbands were compared to wives for their preference of all fat levels of ground beef. The percent of times preferred was calculated for each fat level when compared to all other fat levels. Twenty-five percent fat ground beef was preferred the most number of times by both husbands and wives. However, the husbands preferred it 63.8 percent of the time while wives chose it 55 percent of the time (Figure 1). The lowest level of preference was for the 45 percent samples. Husbands chose it 38.9 percent of the time while women chose it only 36.1 percent of the times possible. Part of this lower level of preference by the wives may have been due to their visual appraisal of the high fat content prior to cooking.

High income families were compared to low income families for the preference of ground beef at the five fat levels. This comparison seemed to follow the same pattern as the wives comparison. There was essentially no difference for preference of high and low-income families for 16, 25, 30, and 35 percent fat levels (Figure 2). With the exception of the 59.4 percent preference of 25 percent ground beef by high-income families, all degrees of preference for these levels is approximately 50 percent which indicates that they were chosen as often as all other samples. The 45 percent fat level received the lowest degree of

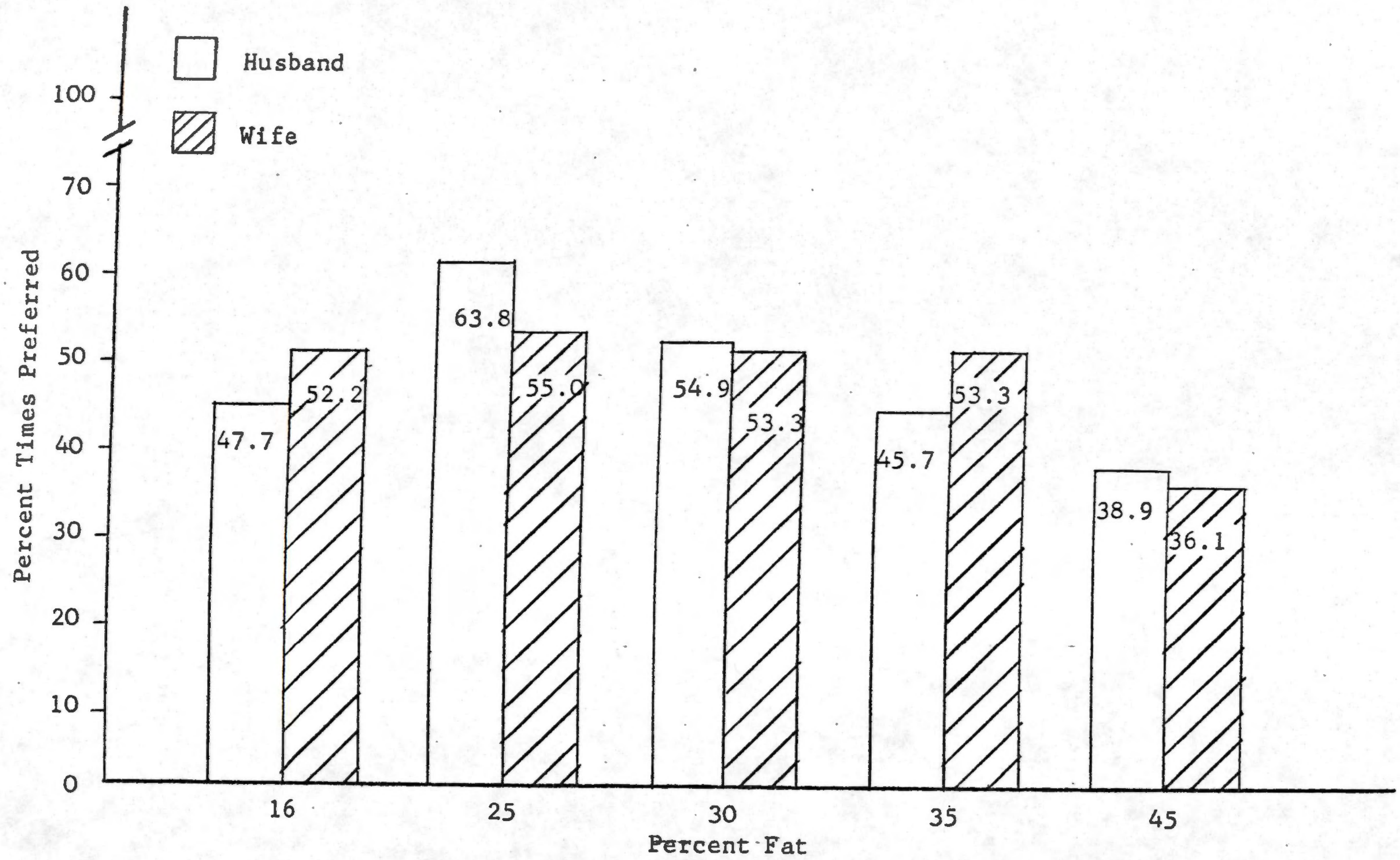

Figure 1. Preference of ground beef of five fat levels by husbands and wives.

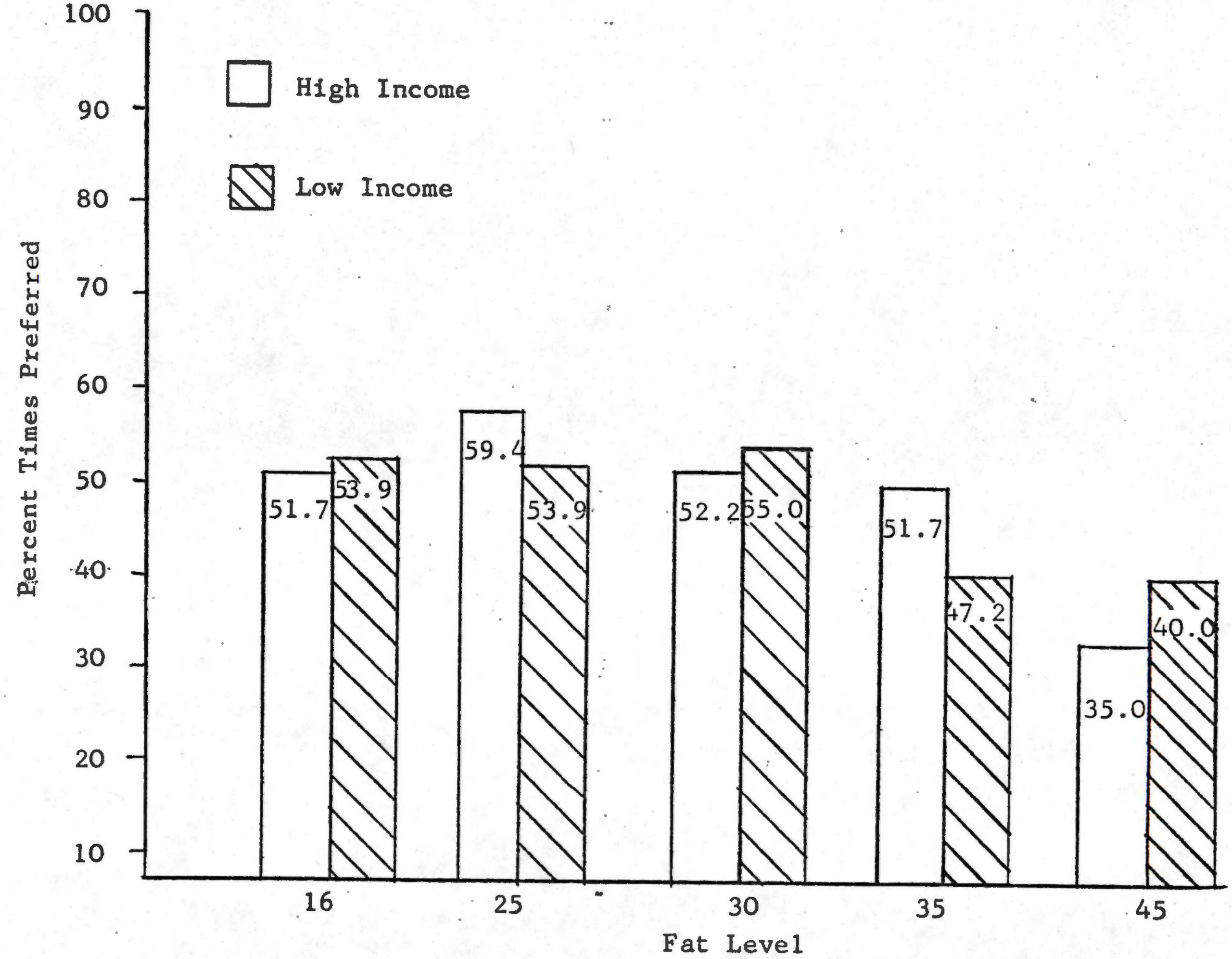

Figure 2. Preference of ground beef of varying fat content by high- and low-income families.

preference by both high and low-income families. Its degree of preference was 35 percent and 40 percent for the high and low-income families, respectively.

The preference for lean beef of U. S. origin and foreign origin was compared at each of the five fat levels (Figure 3). In all cases, ground beef of U. S. origin was preferred over ground beef of foreign origin by roughly a two-thirds to a one-third majority. There was a trend for preference of domestic lean to increase as percent fat increased (Figure 3).

The high-income families were compared to the low-income families for their preference of domestic lean source as compared to the foreign lean source. Here there was marked preference for the domestic lean over the foreign lean. The high-income families preferred domestic lean 62.4 percent of the time, while the low-income families preferred the domestic source of lean 62.0 percent of the time. The high-income families preferred the foreign source of lean 37.6 percent of the time, and the low-income families preferred the foreign source of lean 38.2 percent of the time, again showing roughly a two-third to a one-third preference of the family panel for the domestic source of lean in the ground beef patties (Figure 4). There was essentially no difference in high- and low-income preference for domestic lean and no difference in preference for foreign lean.

II. TRAINED TASTE PANEL

There was a decline in preference of broiled samples from the 16 percent fat level to the 35 percent fat level. However, there was a sharp

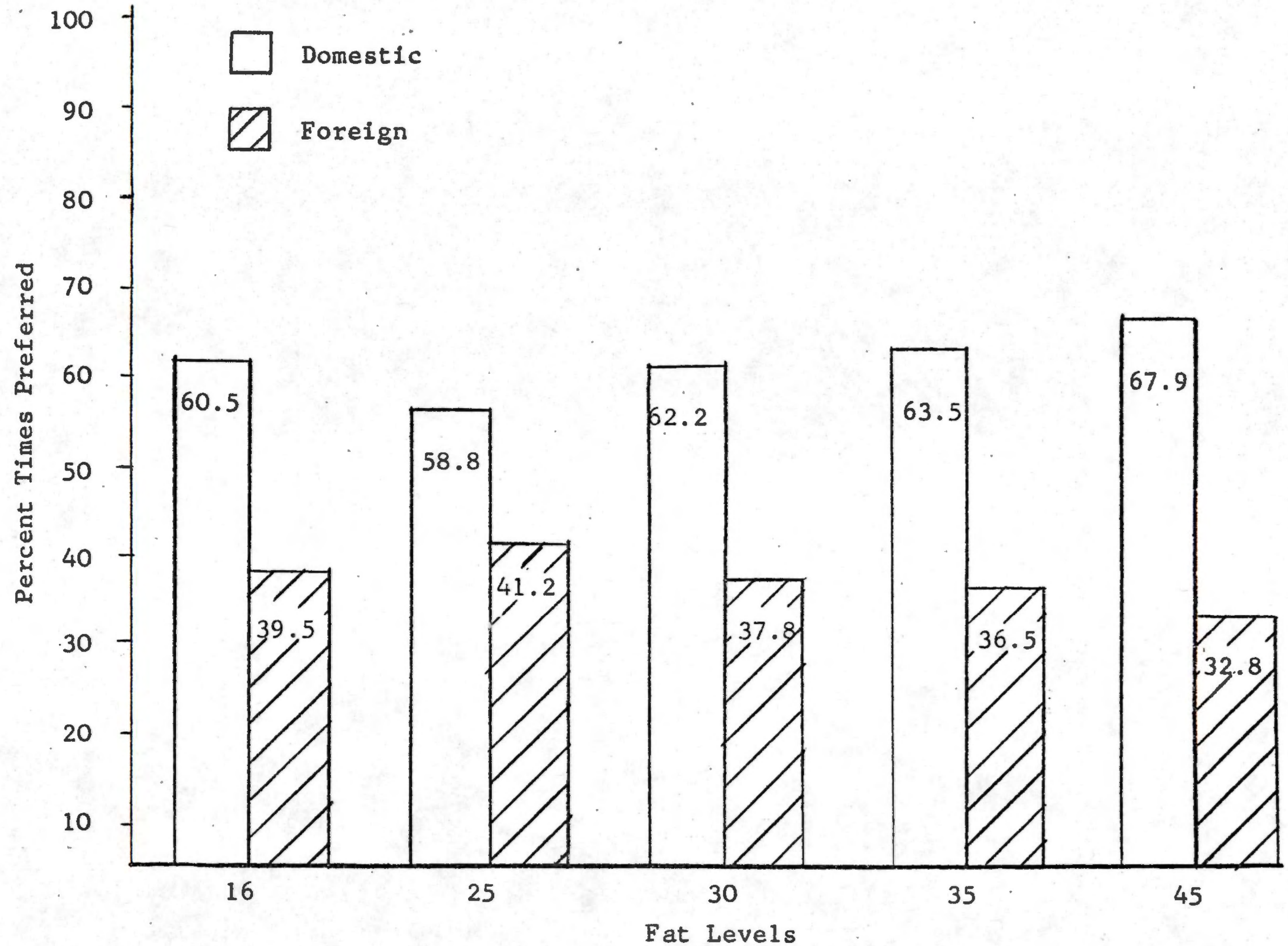

Figure 3. The effect of lean source on preference of ground beef at five fat levels by family taste panel.

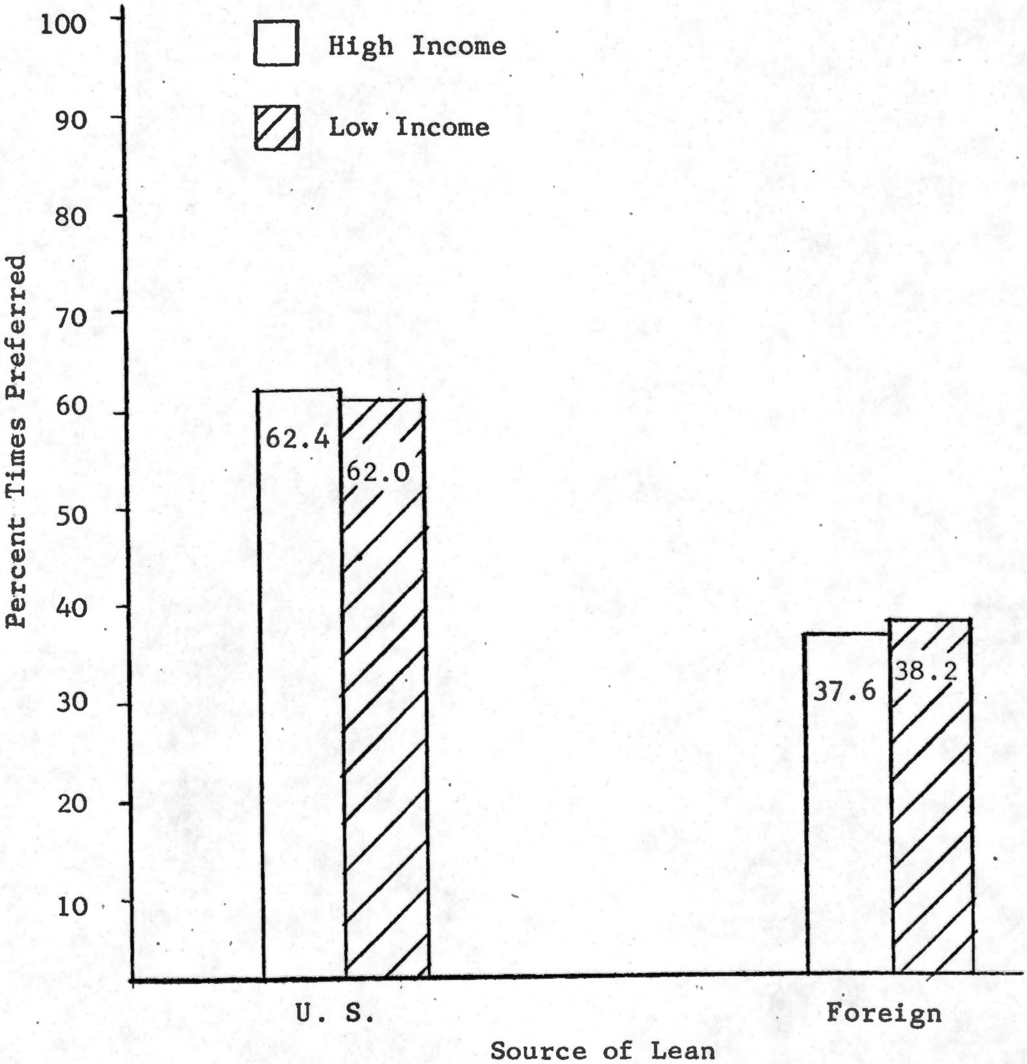

Figure 4. Preference of ground beef from two lean sources by high- and low-income families.

rise in preference for the 45 percent fat level patties (Figure 5). The 16 percent fat level was preferred 56.5 percent of the time when compared to all other fat levels. The 25 percent fat level patties were preferred 54.6 percent of the time, very close to the 16 percent patties. Thirty percent fat showed a sharper decline in preference, being preferred only 45.4 percent of the time. Thirty-five percent was even lower, being chosen only 33.3 percent of the time when compared to all other fat levels. The 45 percent fat level patties, however, did not follow the pattern set by the other four fat levels, being preferred 60.2 percent of the time.

The taste panel showed a high preference for the lower levels of fat until they reached the 45 percent fat level. The 45 percent fat level was preferred more often by the panel than any other level. This is virtually unexplainable.

The fried samples were compared in the same manner as the broiled samples being tested a total of 108 times at each level of fat by a trained taste panel.

There was a marked decline in preference from the 16 percent fat level to the 30 percent fat level. At the 35 percent fat level, there was a slight increase in preference and then a sharp rise from the 35 percent fat level to the 45 percent fat level.

The 16 percent fat patties were preferred 65.7 percent of the time when compared to all other fat levels. The 25 percent fat was preferred 45.4 percent, a marked decline, and 30 percent fat was preferred only 31.5 percent of the time when compared to all other levels of fat. However, the 35 percent fat level showed a slight increase in preference

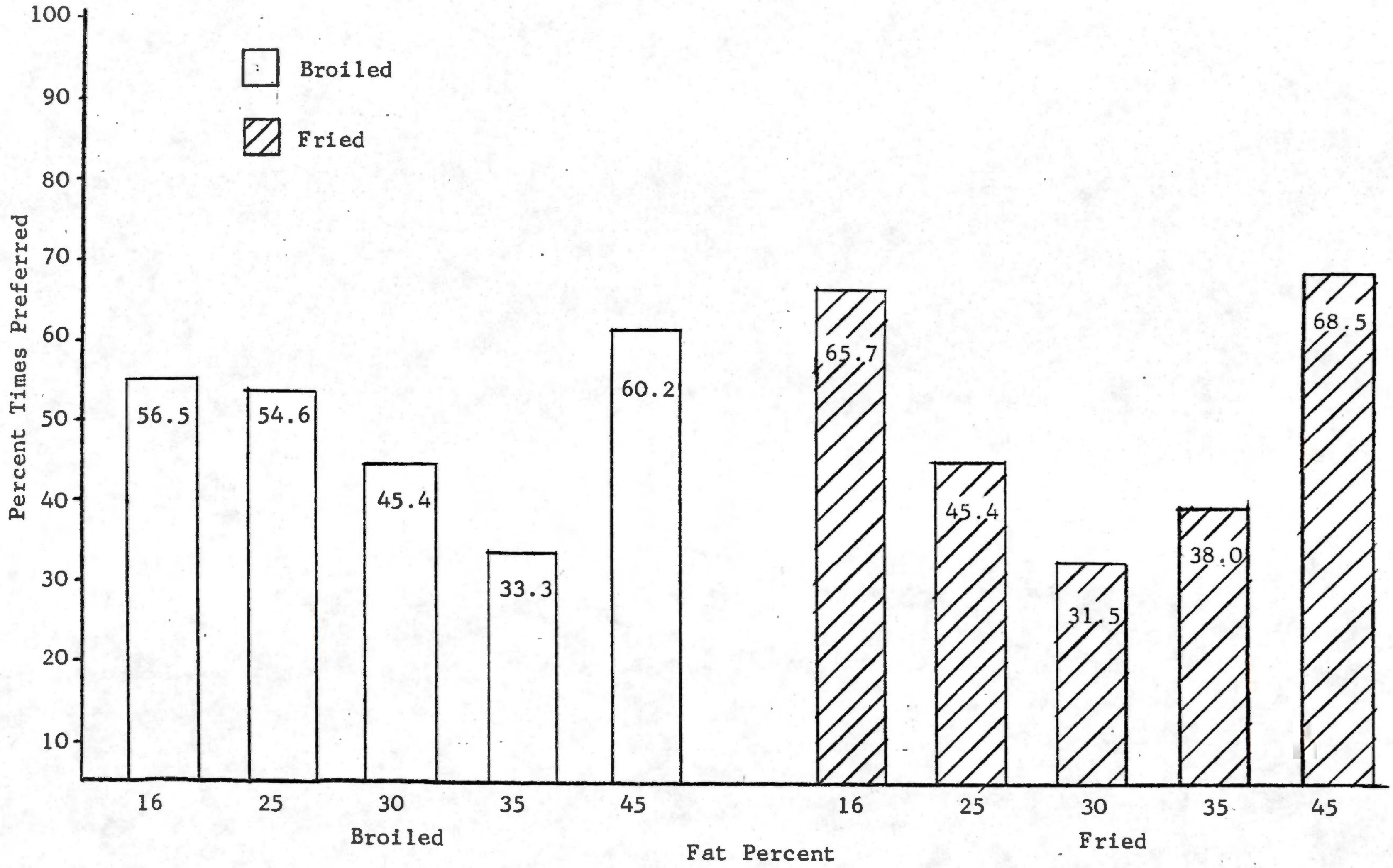

Figure 5. Trained taste panel preference of five fat levels of ground beef.

to 38.0 percent. A marked increase to 68.5 percent for the 45 percent fat level fried ground beef was shown.

This is unexplainable and opposite from the family taste panel preference. In an effort to explain these differences, a bacteria count was run on the fat levels. It showed a higher concentration to be present in the 45 percent fat level, indicating some possible aging had taken place, perhaps in the fat source. A possible explanation for this difference in results might be that the trained panel members preferred the slight aged taste while the family panel members objected to it (Figures 1 and 5, pages 17 and 23, respectively). Also, the trained panel did not see the meat before cooking.

The preference of the trained taste panel for domestic and foreign source of lean ground beef was compared (Figure 6). For the fried sample comparisons, the U. S. source was preferred 55.9 percent of the time, while the foreign source was preferred 44.1 percent of the time (Figure 6). When the broiled samples were compared, the U. S. source was preferred 47.8 percent of the time it was offered, and the foreign source was preferred 52.2 percent of the time (Figure 6).

When fried and broiled preferences were added and percentages of times preferred calculated, the results were 51.9 percent for the domestic source of lean and 48.1 percent for the foreign source of lean (Figure 6).

There were essentially no differences in the trained taste panel's preference for domestic and foreign sources of lean in the ground beef patties of the five fat levels. Also, the method of cooking did not seem to affect the preference for U. S. or foreign source of lean.

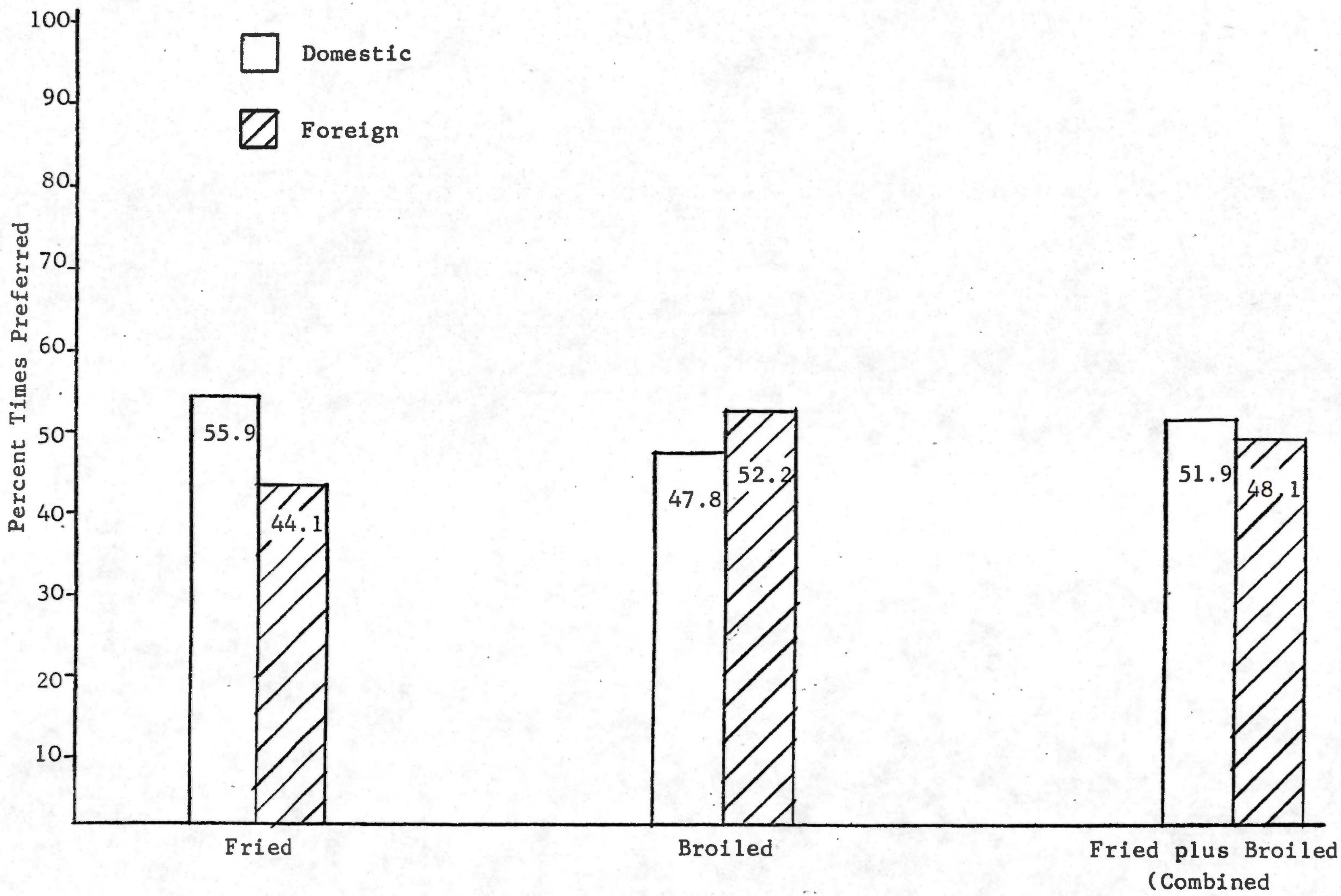

Figure 6. Trained taste panel preference for ground beef made from domestic and foreign lean sources.

III. CHEMICAL PROPERTIES OF BROILED GROUND BEEF

Fat level exerted a highly significant ($P < .01$) influence on percent moisture in the broiled ground beef patties (Table I). The higher the raw fat level, the less moisture except in the case of the 45 percent fat level. In this case, the 45 percent fat level retained 0.83 percent more moisture than the mean of 49.28 percent moisture. This was more moisture than the 25 percent fat level retained but less than the 16 percent fat level (Table II). This particular statistic is unexplainable.

A highly significant effect was exerted by fat level on percent fat in the cooked patties (Table I). However, the difference in the percent fat after broiling of the various initial fat levels was not as great as expected. The mean for percent fat after cooking broiled ground beef for the five fat levels was 24.68 percent (Table II). It is interesting to note that in the cooked samples the fat percents were all close to the mean regardless of their fat level before cooking.

Fat level exerted a highly significant effect on percent protein (Table I). As fat level went up, percent protein declined except in the case of the 35 percent fat level. In this case, the percent protein was more than that of the 30 percent fat level. However, the percent variation explained by this was so small that it may be disregarded.

The mean for percent moisture retained after broiling was 49.28 percent. The domestic source of lean had 48.63 percent moisture while the foreign lean contained 1.12 percent more. This could possibly have been due to the fact that the domestic lean contained from 10 to 16 percent fat, a great portion of which was intramuscular, while the foreign

TABLE I

ANALYSIS OF VARIANCE OF THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN ON PERCENT MOISTURE, FAT, AND PROTEIN OF BROILED GROUND BEEF

		Mean Square		
Source	d.f.	Percent Moisture	Percent Fat	Percent Protein
Fat Level	4	52.16**	181.70**	69.50**
Lean Source	1	27.15**	46.61**	7.53*
Fat x Lean	4	0.61	5.40**	3.93*
Remainder	80	1.51	0.37	1.23

*p $<.05$.

**p $<.01$.

TABLE II

LEAST SQUARES CONSTANTS AND MEANS FOR THE EFFECT OF FAT LEVEL, LEAN SOURCE AND FAT X LEAN ON PERCENT MOISTURE, FAT, AND PROTEIN IN BROILED GROUND BEEF

Percent Fat Before Cooking	Composition After Cooking		
	Percent Moisture	Percent Fat	Percent Protein
Mean	49.28	24.68	25.00
16	2.20	-5.13	2.94
25	0.33	-1.06	0.59
30	-1.27	2.27	-0.82
35	-2.09	2.20	-0.33
45	0.83	1.71	-2.38
Domestic Lean	-0.55	0.72	-0.29
Foreign Lean	0.55	-0.72	0.29
16% Fat x Domestic Lean		0.18	-0.14
16% Fat x Foreign Lean		-0.18	0.14
25% Fat x Domestic Lean		-0.00	0.02
25% Fat x Foreign Lean		0.00	-0.02
30% Fat x Domestic Lean		-0.86	0.61
30% Fat x Foreign Lean		0.86	-0.61
35% Fat x Domestic Lean		0.65	-0.67
35% Fat x Foreign Lean		-0.65	0.67
45% Fat x Domestic Lean		0.04	0.18
45% Fat x Foreign Lean		-0.04	-0.18

lean contained only 5 to 11 percent fat, which was also mostly intramuscular. This means more fat had to be added to the foreign source of lean than to the domestic source in order to blend it to the desired fat levels. In cooking, intramuscular fat seems to be held more strongly (Woolsey and Paul, 1969), therefore offering a possible explanation of why domestic lean was lower in moisture since there is an inverse relationship between fat and moisture.

Lean source had a highly significant effect on percent fat of the cooked ground beef (Table I, page 27). The mean percent fat was 24.68 percent. The domestic lean source was 0.72 percent above the mean, and the foreign lean source was 0.72 percent below the mean (Table II). The domestic lean source had a higher percentage of fat after cooking, which again supports Woolsey and Paul, 1969; intramuscular fat seems to be held more strongly.

A significant effect was exerted by the lean source on percent protein (Table I). The domestic source contained 24.71 percent while the foreign source had 25.29 percent (Table II). This should be expected since there is an inverse relationship between fat and percent protein.

IV. CHEMICAL PROPERTIES OF FRIED GROUND BEEF

The level of fat exerted a highly significant effect on percent moisture in fried ground beef (Table III). As the level of fat increased, the percent moisture tended to decrease (Table IV). However, there was more moisture found in the 45 percent fat level ground beef patties after cooking than there was in either the 35 or the 30 percent fat level patties. Although this is unexplainable, it was also true of the 45

TABLE III

ANALYSIS OF VARIANCE OF THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN INTERACTION ON PERCENT MOISTURE, FAT, AND PROTEIN OF FRIED GROUND BEEF

Source	d.f.	Mean Square Percent Moisture	Percent Fat	Percent Protein
Fat Level	4	42.75**	120.64**	26.58**
Lean Source	1	12.59	26.25**	11.39
Fat x Lean	4	4.01	3.40*	0.33
Remainder	80	8.36	1.01	4.14

*p $<$ .05.

**p $<$ .01.

TABLE IV

LEAST SQUARES CONSTANTS AND MEANS FOR THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN ON PERCENT MOISTURE, FAT, AND PROTEIN IN FRIED GROUND BEEF

Percent Fat Before Cooking	Composition After Cooking		
	Percent Moisture	Percent Fat	Percent Protein
Mean	46.86	25.27	26.72
16	2.89	-5.26	2.32
25	0.78	-0.93	0.31
30	-1.61	2.22	-0.93
35	-1.72	1.86	-0.03
45	-0.34	2.10	-1.67
Domestic Lean	-0.47	0.68	-0.45
Foreign Lean	0.46	-0.68	0.45
16% Fat x Domestic Lean		0.17	
16% Fat x Foreign Lean		-0.17	
25% Fat x Domestic Lean		0.14	
25% Fat x Foreign Lean		-0.14	
30% Fat x Domestic Lean		-0.80	
30% Fat x Foreign Lean		0.80	
35% Fat x Domestic Lean		0.67	
35% Fat x Foreign Lean		-0.67	
45% Fat x Domestic Lean		-0.17	
45% Fat x Foreign Lean		0.17	

percent fat level in the broiled samples previously mentioned.

A highly significant effect was exerted by level of fat on percent in the fried samples (Table III, page 30). This was expected due to the fact that different levels of fat were mixed for testing. However, after cooking, the 16 percent fat level only varied -5.26 percent from the mean of 25.27 percent. The 45 percent fat level was only 2.10 percent more than the mean. There was very little variation in percent fat from the mean in the samples after cooking (Table IV).

Fat level exerted a highly significant effect in percent protein (Table III). There was an inverse relationship between fat content and protein content of fried ground beef (Table IV).

The source of lean had a highly significant effect on percent fat in fried samples (Table III). The fried samples from lean of domestic origin contained 1.36 percent more fat on the average than samples from lean of foreign source. The relationship of the physical form of fat in the samples can again be offered as an explanation for this difference in percent cook out of fat as suggested in the data of Woolsey and Paul (1969).

There was a significant effect of fat and lean interaction on percent fat (Table III). Although it was significant at the ($P < .05$) level, it explained such a small percent of the variation that it was disregarded as being important to the explanation of the results.

V. ORGANOLEPTIC PROPERTIES OF BROILED GROUND BEEF

The level of fat was significantly related to flavor score (Table V). As the level of fat increased, the flavor score decreased until the

TABLE V

ANALYSIS OF VARIANCE OF THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN ON TENDERNESS, JUICINESS, FLAVOR, AND OVERALL SCORE OF BROILED GROUND BEEF

		Mean Square			
Source	d.f.	Flavor Score	Tenderness Score	Juiciness Score	Overall Score
Fat Level	4	2.03*	7.25**	9.03**	2.68**
Lean Source	1	0.77	5.14**	1.68**	0.66
Fat x Lean	4	2.43**	1.49**	0.41	0.96**
Remainder	80	0.65	0.22	0.20	0.19

*$p < .05$.

**$p < .01$.

45 percent fat level was reached. At the 45 percent fat level, flavor score was 0.05 less than the mean. This was a higher score than that recorded for 35 and 30 percent fat levels, but slightly lower than the score recorded for the 25 percent fat level. The 16 percent fat level was given the highest flavor score by the trained taste panel (Table VI).

Fat level exerted a highly significant effect on the tenderness score. Tenderness scores given by the trained taste panel tended to increase as the level of fat increased. However, the 30 percent fat level was scored 0.05 more than the mean, which was higher than the score given to the 35 percent fat level patties. The 45 percent fat level patties were scored higher than any of the other fat levels.

Fat level exerted a highly significant effect on juiciness score. The trained taste panel rated juiciness higher as the percent of fat increased. The mean for the juiciness score was 6.57. The 16 percent and 25 percent ground beef were scored less than the mean with 45 percent patties receiving the highest scores. A slight exception to the relationship between fat content and juiciness score was the somewhat lower rating given to the 35 percent product than that containing 30 percent fat.

The overall score was determined by adding the scores for tenderness, juiciness, and flavor and taking the average of these three scores. This score does not necessarily indicate the trained taste panelist preference for one fat level over another.

Fat level exerted a highly significant effect on overall score (Table V). Generally, as fat level increased, overall score increased (Table VI). However, the 35 percent fat level's overall score, was 0.18

TABLE VI

LEAST SQUARES CONSTANTS AND MEANS FOR THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN INTERACTION ON FLAVOR SCORE, TENDERNESS SCORE, JUICINESS SCORE, AND OVERALL SCORE OF BROILED GROUND BEEF

Fat Percent Before Cooking	Flavor[1] Score	Tenderness[2] Score	Juiciness[1] Score	Overall[3] Score
Mean	5.95	6.72	6.57	6.41
16	0.50	-0.45	-0.98	-0.21
25	0.10	-0.44	-0.31	-0.21
30	-0.14	0.05	0.33	0.07
35	-0.41	-0.24	0.09	-0.18
45	-0.05	1.08	0.89	0.64
Domestic Lean	-0.09	0.24	0.14	0.08
Foreign Lean	0.09	-0.24	-0.14	-0.08
16% Fat x Domestic Lean	0.34	0.34		0.25
16% Fat x Foreign Lean	-0.34	-0.34		-0.25
25% Fat x Domestic Lean	0.23	0.25		0.18
25% Fat x Foreign Lean	-0.23	-0.25		-0.18
30% Fat x Domestic Lean	0.18	-0.22		-0.08
30% Fat x Foreign Lean	-0.18	0.22		0.08
35% Fat x Domestic Lean	-0.19	-0.06		-0.01
35% Fat x Foreign Lean	0.19	0.06		0.01
45% Fat x Domestic Lean	-0.55	-0.31		-0.33
45% Fat x Foreign Lean	0.55	0.31		0.33

[1]Flavor and juiciness scores on 9 point scale; 9 = excellent, 1 = extremely poor.

[2]Tenderness scored on a 10 point scale; 10 = extremely tender, 0 = rejected sample.

[3]Overall score is an average of flavor tenderness and juiciness score.

less than the mean. The 45 percent fat level overall score was 0.64 greater than the mean. This was also the highest of the overall scores. The low overall score received by the 35 percent patties is explained by the fact that 35 percent patties scored low in both tenderness and juiciness (Table VI).

The source of lean was not significantly related to flavor. However, it had a highly significant effect on tenderness (Table V, page 33). The domestic source of lean was considered more tender, having a score of 6.96 compared to the foreign lean which was scored 6.48. This could be explained by the fact that the cooked domestic lean contained a higher percentage of fat in both broiled and fried samples (Tables II and IV, pages 28 and 31, respectively).

Lean source exerted a highly significant effect on juiciness score (Table V). The ground beef from domestic lean was scored 6.71 by the taste panel while the mean score for patties from foreign lean was 6.33. This may be explained by the fact that more fat remained in the domestic lean source patties after cooking (Tables II and IV).

There was a highly significant effect on fat x lean interaction on flavor score, tenderness score, and overall score (Table V). However, even though it was highly significant, it explained such a small percent of the variation that it was disregarded as being important to the experiment.

VI. ORGANOLEPTIC PROPERTIES OF FRIED GROUND BEEF

Fat level exerted a highly significant effect on flavor score (Table VII). As fat level increased, flavor decreased for the first

TABLE VII

ANALYSIS OF VARIANCE OF THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN INTERACTION ON TENDERNESS, JUICINESS, FLAVOR, AND OVERALL SCORE OF FRIED GROUND BEEF

Source	d.f.	Mean Square			
		Flavor Score	Tenderness Score	Juiciness Score	Overall Score
Fat Level	4	4.18**	5.52**	4.61**	3.03**
Lean Source	1	3.01**	6.42**	1.95**	3.54**
Fat x Lean	4	0.71	0.51	0.30	0.11
Remainder	80	0.28	0.29	0.26	0.18

*$p < .05$.

**$p < .01$.

four levels--16, 25, 30, and 35 percent fat. However, the trained taste panel regarded the 45 percent as the second best in flavor, second only to the highly regarded 16 percent fat level (Table VIII).

The level of fat was highly related to tenderness score (Table VII). As fat level increased, there was a tendency for tenderness to decrease with the exception of the 30 percent level samples, which were ranked as being slightly less tender than the 25 percent fat level patties. However, the 45 percent fat level patties were considered to be the most tender with a score of 1.19 greater than the mean which was 6.52. All others were scored less than the mean (Table VIII).

Fat level was highly associated with juiciness score (Table VII). Juiciness score tended to increase as the level of fat increased, with the exception of the 35 percent fat level patties. The 35 percent fat level was scored less juicy than the 30 percent patties and about equal to the 25 percent fat level patties. The 45 percent fat level samples were considered to be juicier than any of the others (Table VIII).

The level of fat was significantly related to overall score ($P < .01$) (Table VII). The 45 percent fat level samples ranked highest. This was not surprising, however, since 45 percent samples ranked second in flavor, first in tenderness, and first in juiciness. The overall score was computed by adding the scores for tenderness, juiciness, and flavor and taking the average of the three.

A highly significant effect due to lean source was exerted on flavor score, tenderness score, juiciness score, and overall score (Table VII). In all cases domestic lean was scored higher than foreign lean for flavor, tenderness, juiciness, and overall score. However, when

TABLE VIII

LEAST SQUARES CONSTANTS AND MEANS FOR THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN INTERACTION ON TASTE PANEL FLAVOR SCORE, TENDERNESS SCORE, JUICINESS SCORE, AND OVERALL SCORE FOR FRIED GROUND BEEF

Fat Percent Before Cooking	Flavor[1] Score	Tenderness[2] Score	Juiciness[1] Score	Overall[3] Score
Mean	6.04	6.52	6.37	6.31
16	0.74	-0.12	-0.82	-0.07
25	-0.20	-0.34	-0.09	-0.20
30	-0.28	-0.26	0.08	-0.15
35	-0.71	-0.47	-0.10	-0.44
45	0.46	1.19	0.92	0.86
Domestic Lean	0.23	0.34	0.18	0.25
Foreign Lean	-0.23	-0.34	-0.18	-0.25

[1]Flavor and juiciness scores on 9 point scale; 9 = excellent, 1 = extremely poor.

[2]Tenderness scored on a 10 point scale; 10 = extremely tender, 0 = rejected sample.

[3]Overall score is an average of flavor tenderness and juiciness score.

percent of times preferred was calculated, domestic lean was only preferred 55.9 percent of the time as opposed to 44.1 percent for foreign lean (Table VII, page 37).

The fat x lean interaction was not significant in flavor, tenderness, juiciness, or overall score.

VII. COOKING LOSSES AND INTERNAL TEMPERATURE OF BROILED GROUND BEEF

Fat level was highly related to evaporation loss (Table IX). As fat level increased, evaporation loss decreased with the exception of the 35 percent fat level samples. The 35 percent fat samples had more evaporation loss than did the 30 percent samples which is not what was expected for the higher fat level, since there is an inverse relationship between fat and moisture (Table X).

There was a highly significant relationship between fat level and drip loss (Table IX). As fat level increased, drip loss increased. However, the increase in drip loss from the 30 percent fat level samples to the 35 percent fat level samples was not as great as the increase between the other levels (Table X). This does agree with the evaporation loss recorded for 35 percent samples since evaporation loss and drip loss are highly negatively correlated.

Total loss was highly significantly effected by fat level (Table IX). As fat level increased, total loss increased (Table X). However, again, the 35 percent fat level did not increase as much as was expected. This figure does agree with the other two figures, evaporation loss and drip loss, recorded for 35 percent fat samples (Table X).

TABLE IX

ANALYSIS OF VARIANCE OF THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN INTERACTION ON EVAPORATION LOSS, DRIP LOSS, TOTAL LOSS, AND INTERNAL TEMPERATURE OF BROILED GROUND BEEF

		Mean Square			
Source	d.f.	Evaporation Loss Percent	Drip Loss Percent	Total Loss Percent	Internal Temp. (F°)
Fat Level	4	201.77**	475.01**	165.27**	21.58
Lean Source	1	18.53	11.91	40.48*	10.68
Fat x Lean	4	12.20	75.35	4.68	42.93
Remainder	80	7.87	47.83	6.83	18.39

*$p < .05$.

**$p < .01$.

TABLE X

LEAST SQUARES CONSTANTS AND MEANS FOR THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN INTERACTION ON EVAPORATION LOSS, DRIP LOSS, TOTAL LOSS, AND INTERNAL TEMPERATURE OF BROILED GROUND BEEF

Fat Percent Before Cooking	Evaporation Loss Percent	Drip Loss Percent	Total Loss Percent	Internal Temperature (F°)
Mean	23.68	24.18	47.12	186.72
16	4.74	-4.83	-3.13	1.50
25	0.30	-2.97	-1.89	0.44
30	-0.80	-0.68	-0.74	-1.50
35	-0.39	-0.06	1.12	-0.22
45	-4.63	8.54	4.64	-0.22
Domestic Lean	-0.45	0.36	-0.67	-0.34
Foreign Lean	0.45	-0.36	0.67	0.34

Total loss was significantly affected by lean source (Table IX, page 41). There was less total loss in broiled samples of domestic lean source than in foreign lean source (Table X). This is probably due to the domestic lean having more intramuscular fat than foreign lean.

Internal temperature was not significantly affected by fat level, lean source, or fat x lean interaction.

VIII. COOKING LOSSES AND INTERNAL TEMPERATURE OF FRIED GROUND BEEF

Evaporation loss was highly significantly affected by fat level (Table XI). As fat level increased, evaporation loss decreased, which is what was expected since there is an inverse relationship between fat and moisture (Table XII).

Fat level exerted a highly significant effect on drip loss (Table XI). As the level of fat increased, drip loss increased (Table XII). This is as expected since drip loss is made up primarily of fat.

Total loss was highly significantly affected by fat level, but not effected by lean source, or fat x lean interaction.

Fat x lean interaction exerted a significant effect on drip loss (Table XI). Although it was significant at the ($P < .05$) level, the nature of response was such as to suggest a cause unrelated to the variation in level of fat and source of lean.

TABLE XI

ANALYSIS OF VARIANCE OF THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN INTERACTION ON EVAPORATION LOSS, DRIP LOSS, TOTAL LOSS, AND INTERNAL TEMPERATURE OF FRIED GROUND BEEF

Source	d.f.	Mean Square			
		Evaporation Loss Percent	Drip Loss Percent	Total Loss Percent	Internal Temp. (F°)
Fat Level	4	201.26**	761.73**	186.31**	5.46
Lean Source	1	1.45	1.10	0.02	20.54
Fat x Lean	4	29.92	62.07*	9.69	12.14
Remainder	80	23.93	16.50	11.84	23.93

*$p < .05$.

**$p < .01$.

TABLE XII

LEAST SQUARES CONSTANTS AND MEANS FOR THE EFFECT OF FAT LEVEL, LEAN SOURCE, AND FAT X LEAN INTERACTION ON EVAPORATION LOSS, DRIP LOSS, TOTAL LOSS, AND INTERNAL TEMPERATURE OF FRIED GROUND BEEF

Fat Per Before Cooking	Evaporation Loss Percent	Drip Loss Percent	Total Loss Percent	Internal Temperature (F°)
Mean	29.52	18.94	48.46	185.3
16	5.68	-10.67	-4.99	0.87
25	1.67	-4.28	-2.61	-0.50
30	0.30	0.66	0.96	-0.62
35	-2.45	3.63	1.18	-0.37
45	-5.20	10.66	5.47	0.61
Domestic Lean	0.16	- 0.14	0.02	- 0.60
Foreign Lean	-0.16	0.14	-0.02	0.60
16% Fat x Domestic Lean		-0.66		
16% Fat x Foreign Lean		0.66		
25% Fat x Domestic Lean		-0.78		
25% Fat x Foreign Lean		0.78		
30% Fat x Domestic Lean		-2.55		
30% Fat x Foreign Lean		2.55		
35% Fat x Domestic Lean		3.58		
35% Fat x Foreign Lean		-3.58		
45% Fat x Domestic Lean		0.40		
45% Fat x Foreign Lean		-0.40		

TABLE XIII

SIMPLE CORRELATION COEFFICIENTS BETWEEN CHEMICAL PROPERTIES, ORGANOLEPTIC PROPERTIES, AND INTERNAL TEMPERATURE OF FRIED GROUND BEEF

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Percent Moisture		-.70	-.28	.33	.22	.07	.26	-.13	-.35	-.78	-.03
2. Percent Fat			-.42	-.43	.12	.51	.08	-.43	.72	.73	-.06
3. Percent Protein				.09	-.47	-.72	-.45	.66	-.47	--	.07
4. Flavor Score					.54	.12	.69	.21	-.26	-.19	.10
5. Tenderness Score						.71	.94	-.29	.29	.15	--
6. Juiciness Score							.75	-.65	.60	.24	-.10
7. Overall Score								-.30	.26	.08	.01
8. Evaporation Loss									-.83	-.21	.02
9. Drip Loss										-.72	.03
10. Total Loss											.09
11. Internal Temp.											--

NOTE: All correlations are based on 57 degrees of freedom. Values greater than .26 and .33 are significant at the $p < .05$ and $p < .01$ levels of probability, respectively.

Tenderness score was highly correlated to juiciness score (r = 0.71) and overall score (r = 0.94). It would seem, in the case of fried ground beef patties, that as fat level increases, juiciness increases; therefore, tenderness and overall score increases. Tenderness is positively correlated to drip loss (r = 0.29) but only explains 8 percent of the variation in drip loss due to tenderness.

Juiciness score had a high positive correlation to overall score (r = 0.75). The higher the juiciness score, the higher the overall score. The highly significant correlation (r = 0.60) between drip loss and juiciness score indicates that the higher the fat level, the higher the juiciness score, and the higher the fat level, the higher the drip loss; therefore, the higher the juiciness score, the higher the drip loss.

X. SIMPLE CORRELATIONS BETWEEN VARIABLES OF BROILED SAMPLES

Simple correlations between variables of broiled samples are shown in Table XIV.

Percent moisture was highly associated (r = 0.30) with flavor score. There was a negative relationship (r = -.22) between percent moisture and juiciness score. This would be expected since juiciness is usually positively related to percent fat, and percent fat and percent moisture are negatively related.

The level of fat was negatively correlated (r = -.38) to flavor, but positively correlated to tenderness (r = 0.42) and juiciness (r = 0.75). The negative relationship (r = -.38) between percent fat in

TABLE XIV

SIMPLE CORRELATION COEFFICIENTS BETWEEN CHEMICAL PROPERTIES, ORGANOLEPTIC PROPERTIES, AND INTERNAL TEMPERATURE OF BROILED GROUND BEEF

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Percent Moisture		-.69	.12	.30	.08	-.22	.10	.06	-.17	-.38	-.09
2. Percent Fat			-.79	-.38	.42	.75	.33	-.61	.38	.43	-.19
3. Percent Protein				.27	-.63	-.85	-.53	.79	-.39	-.25	.33
4. Flavor Score					.16	-.15	.53	.20	-.09	-.03	-.01
5. Tenderness Score						.73	.87	-.57	.41	.31	-.24
6. Juiciness Score							.71	-.77	.46	.35	-.24
7. Overall Score								-.50	.34	.30	-.22
8. Evaporation Loss									-.50	-.23	.19
9. Drip Loss										.51	-.05
10. Total Loss											.16
11. Internal Temp.											--

NOTE: All correlations are based on 89 degrees of freedom. Values greater than .21 and .27 are significant at $p < .05$ and $p < .01$ levels of probability, respectively.

the cooked product and flavor score was unexpected and is difficult to explain. However, similar findings were recorded by Backus (1968) using a six-member experienced taste panel to score samples of the L. dorsi from the 6-7-8 rib roast for flavor, tenderness, and juiciness.

Percent protein was positively correlated to flavor (r = 0.27) but negatively related to tenderness (r = -.63) and juiciness (r = -.85). This was expected and supported by the fact that there is a negative relationship between percent fat and percent protein. Percent fat was negatively correlated to flavor and positively correlated to tenderness and juiciness and percent protein was positively correlated to flavor and negatively correlated to tenderness and juiciness. Overall score had a high negative relationship to percent protein (r = -.53).

Flavor score was not significantly correlated to any variable except overall score (r = 0.53). Flavor score variation explained 28 percent of the variation in total score; therefore, 72 percent of the variation in total score was due to other variables.

Tenderness score was highly related to juiciness score (r = 0.73) and explained 51 percent of the variation in juiciness. Tenderness was also highly related to overall score (r = 0.87) and explained 76 percent of the variation in overall score.

Juiciness score was highly correlated to overall score (r = 0.71) but not as highly correlated as tenderness was to overall score.

Overall score was computed by taking an average of the flavor, tenderness, and juiciness scores. Flavor, tenderness, and juiciness were all highly related to overall score (r = 0.53), (r = 0.87), and (r = 0.71), respectively. However, tenderness and juiciness explained more of the variation in overall score than did flavor.

CHAPTER V

SUMMARY

The objective of this study was to compare ground beef fabricated from two lean sources (domestic and foreign) to contain five levels of fat (16, 25, 30, 35, and 45 percent). USDA Choice grade plates served as the common fat source. Good grade chucks were used for the source of domestic lean, and imported boneless chucks from Managua, Nicargua were the foreign source of lean. The meat was ground and made into patties of five fat levels--16, 25, 30, 35, and 45 percent fat, half of the patties being of the domestic lean source and half being of the foreign lean source. A ten-family taste panel selected from high-income University personnel and low-income University personnel were used to evaluate paired samples and designate a preference. All possible combinations of the five fat levels and two lean sources were compared. A six-member trained taste panel was also used to score flavor, tenderness, and juiciness and declare a preference for all possible comparisons of both broiled and fried samples. Percent moisture, percent fat, percent protein, evaporation loss, drip loss, total loss, and internal temperature were recorded for the cooked samples used for taste panel scoring.

The following observations can be made upon analysis and interpretation of the data presented in this thesis.

It was found that the men of the family panel preferred 25 and 30 percent fat patties over 16, 35, and 45 percent fat levels, with 45 percent fat being preferred least of all. Women showed little difference in preference between 16, 25, 30, and 35 percent fat level patties but did show a sharp decline in preference for the 45 percent fat level patties.

The high-income families were compared to the low-income families for their preference of the five fat levels. There was little difference in preference between 16, 25, 30, and 35 percent fat levels. A decline in preference was noted at the 45 percent fat level for both high-income and low-income families.

All family panel data were combined for preference of domestic lean source and foreign lean source. At all levels of fat, the domestic lean source was preferred over the foreign lean source (62.1 percent and 37.9 percent, respectively).

There was essentially no difference in high-income families and low-income families and their preference for ground beef from domestic lean source over that from foreign lean source.

A trained taste panel was used to evaluate both broiled and fried samples from all fat levels of both lean sources. For broiled samples, there was a decline in preference from the 16 to 35 percent fat levels, but a sharp increase in preference was shown for the 45 percent fat level patties. Preference for the fried samples followed a somewhat different pattern. There was a high degree of preference for the 45 and 16 percent fat levels. Preference dropped for the 25 percent fat level patties. It was even lower for the 35 percent and the 30 percent fat level patties were preferred least of all.

The trained taste panel's preference was compared for the domestic and foreign source of lean in both fried and broiled samples. It was noted that the domestic source of lean was preferred slightly over the foreign source for fried samples. However, the foreign source of lean was preferred slightly over the domestic source for broiled samples. When broiled and fried preferences were combined, the total preference for domestic and foreign sources of lean were essentially no different.

Chemical data (percent moisture, percent fat, and percent protein of the cooked patties) was recorded. Broiled samples tended to retain more moisture than the fried samples. However, broiled samples were lower than fried samples for percent fat and percent protein. The domestic lean source for both broiled and fried samples was lower in percent moisture, higher in percent fat, and lower in percent protein than the foreign source of lean.

Organoleptic properties (flavor, tenderness, juiciness, and overall score) were recorded. When means were compared, broiled samples were higher in tenderness, juiciness, and overall score than fried samples but lower in flavor. For broiled samples, domestic lean was higher for tenderness, juiciness, and overall score but lower in flavor than the foreign lean source. The domestic lean source in fried samples was higher for flavor, tenderness, juiciness, and overall score.

Cooking losses (evaporation loss, drip loss, and total loss) were recorded. Means were compared, and the broiled samples were higher for drip loss, but the fried samples were higher for evaporation and total loss, but lower than the domestic lean source in drip loss. In the fried samples, the domestic lean source was higher in evaporation and total loss, and lower in drip loss than the foreign lean source.

For both broiled and fried samples when flavor, tenderness, and juiciness were compared, tenderness was more highly correlated to overall score, followed by juiciness and then flavor. However, all were high positive correlations.

Tenderness and juiciness were highly related in both broiled and fried samples. However, flavor for the broiled samples was not significantly associated with tenderness or juiciness, but in the fried samples flavor was highly related to tenderness but not significantly correlated with juiciness.

Percent fat in the broiled samples was highly related to juiciness and tenderness, respectively, but had a high negative correlation to flavor. Percent fat for fried samples was highly related to juiciness but not significantly associated with tenderness, and, like the broiled samples, had a high negative correlation to flavor.

Thus, it appears that a wide range of fat percentage in ground beef is acceptable to the consumer. However, a distinct preference was noted for domestic lean as compared to foreign lean. The trained taste panel preference did not parallel the family panel data, but a wide range of fat levels was preferred by the trained panel. There was essentially no difference in the trained panel's preference for foreign lean source or domestic lean source.

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APPENDICES

APPENDIX A

PATTY DISTRIBUTION ORDER

Name ______________________________

(1)	25D	30D	Date ______________________________
(2)	45D	16F	______________________________
(3)	25D	45D	______________________________
(4)	30D	30F	______________________________
(5)	25D	30F	______________________________
(6)	45D	30F	______________________________
(7)	45D	35F	______________________________
(8)	16D	45F	______________________________
(9)	25F	45F	______________________________
(10)	16D	35D	______________________________
(11)	45D	25F	______________________________
(12)	35D	16F	______________________________
(13)	30D	35F	______________________________
(14)	30D	25F	______________________________
(15)	16F	35F	______________________________
(16)	16D	25D	______________________________
(17)	16D	25F	______________________________
(18)	30D	45D	______________________________
(19)	35D	35F	______________________________
(20)	35D	30F	______________________________
(21)	16D	16F	______________________________
(22)	25D	25F	______________________________
(23)	16F	30F	______________________________
(24)	16D	35F	______________________________
(25)	35D	45F	______________________________
(26)	35F	45F	______________________________
(27)	30F	35F	______________________________
(28)	30F	45F	______________________________
(29)	25D	35D	______________________________
(30)	25F	35F	______________________________
(31)	35D	45D	______________________________
(32)	30D	45F	______________________________
(33)	16F	45F	______________________________
(34)	35D	25F	______________________________
(35)	25D	35F	______________________________
(36)	30D	35D	______________________________
(37)	25D	45F	______________________________
(38)	16D	30F	______________________________
(39)	30D	16F	______________________________
(40)	16D	45D	______________________________
(41)	45D	45F	______________________________

(42)	16D	30D	______
(43)	25D	16F	______
(44)	25F	30F	______
(45)	16F	25F	______

APPENDIX B

INSTRUCTIONS

The numbers at the top of the page refer to the questions at the bottom.

1. Print your name

2. Print the date the meat was cooked

3. Indicate your sex

4. Print your address

5. Indicate the method of cookery you used

   Forty-five pairs of patties will be tested. All patties must be cooked the same way. Please use the method which you use most often.

   Broiling may be either in the oven or on an outdoor grill. If you fry the ground beef, it can be done in a skillet or on a griddle. Each pattie must be fried separately with no fat or oil in the skillet or on the griddle. Please do not allow the drippings from one pattie contact the other patties. The patties may be cooked to the degree of doneness which you like best.

6. Indicate the sample you preferred

7. Indicate your degree of preference

8. Comment on anything which affected your preference

---

(1) Name ______________________________ (2) Date ______________

(3) Sex (Male)____(Female)____ (4) Address ______________________

(5) Method of cookery used: Broiling____Frying______________________

(6) Which do you prefer? Sample 1________ Sample 2 ________________
(with hole)

(7) I preferred it: Slightly________Moderately________Strongly_______

(8) Comments:

APPENDIX C

GRADING CHART FOR GROUND BEEF

Date ______________________ Name ______________________

Directions: Give full value for excellent quality
Do not use fractional points

Scale for scoring tenderness:

10 - Extremely tender
9 - Very tender
8 - Tender
7 - Moderately tender
6 - Slightly tender
5 - Slightly tough
4 - Moderately tough
3 - Tough
2 - Very tough
1 - Extremely tough
0 - Reject sample

Scale for scoring flavor and juiciness

9 - Excellent
8 - Very good
7 - Good
6 - Fair plus
5 - Fair
4 - Fair minus
3 - Poor
2 - Very poor
1 - Extremely poor

Sample Number		
Flavor		
Juiciness		
Tenderness		

Which sample do you prefer? ______________________

Check degree of preference: Slight ______________

Moderate ______________

Strong ______________

APPENDIX D

TABLE XV

PLAN FOR TRIANGLE TESTS IN TRAINING OF TASTE PANEL

Test Number	Fat Level Differences Percent	Samples by Percent of Fat	Source of Lean
1	29	16 vs 45	U. S.
2	20	25 vs 45	U. S.
3	29	16 vs 45	Foreign
4	20	25 vs 45	Foreign
5	14	16 vs 30	U. S.
6	10	25 vs 35	U. S.
7	14	16 vs 30	Foreign
8	10	25 vs 35	Foreign
9	5	30 vs 35	U. S.
10	5	30 vs 35	Foreign

APPENDIX E

DATA ON COOKING AND COOKING LOSSES

Date:					
Product:					
Animal Husbandry No:					
Home Ec. Lab. No.:					
Pan. No.					
A. Before cooking:					
1. Wt. of pan and drip pan					
2. Wt. of roast before cooking					
B. After Cooking:					
1. Wt. of meat					
2. Wt. loss due to evaporation					
3. Wt. of pan and drippings					
4. Wt. of pan and drip pan					
5. Wt. of drippings					
6. Total cooking losses					
C. Cooking data:					
1. Time into oven					
2. Time out of oven					
3. Total cooking time					
4. Time per pound					
D. Percentage cooking losses:					
1. Loss due to evaporation $B_2/A_2 \times 100$					
2. Loss due to drippings $B_5/A_2 \times 100$					
3. Total loss $D_1 + D_2$					
Final Temperature					
Pair No.					

VITA

Jesse Ray Ford was born in Lynchburg, Virginia, on November 2, 1944. He attended elementary schools in that city and was graduated from Rustburg High School in Rustburg, Virginia, in 1963. The following September he entered Ferrum Junior College for one semester. The following September he transferred to The University of Tennessee where he received the Bachelor of Science degree in Animal Husbandry in June, 1968. The following January he entered the Graduate School at The University of Tennessee. He pursued a Master of Science degree in Animal Science until Summer, 1970 at which time he accepted a job as Extension Agent in Amhurst County, Virginia. After working three years, he returned to The University of Tennessee and completed the requirements of a Masters of Science degree in Animal Science in March, 1974.