EFFECT OF SLAUGHTER WEIGHT UPON THE PROCESSING CHARACTERISTICS, QUALITY AND CONSUMER ACCEPTABILITY OF PORK CARCASSES AND CUTS

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY

John Andrew Emerson

1962

This is to certify that the

thesis entitled

EFFECT OF SLAUGHTER WEIGHT UPON THE PROCESSING CHARACTERISTICS, QUALITY AND CONSUMER ACCEPTABILITY OF PORK CARCASSES AND CUTS

presented by

John Andrew Emerson

has been accepted towards fulfillment of the requirements for

Ph.D. degree in Food Science

A. M. Pearson
Major professor

Date May 14, 1962

O-169

ABSTRACT

EFFECT OF SLAUGHTER WEIGHT UPON THE PROCESSING CHARACTERISTICS, QUALITY AND CONSUMER ACCEPTABILITY OF PORK CARCASSES AND CUTS

By John Andrew Emerson

Forty Yorkshire and 40 crossbred hogs were used to study the effect of slaughter weight upon the acceptance, quality and processing characteristics of pork carcasses. The 80 animals were equally divided into 4 slaughter weight groups: 100-120 lb.; 130-150 lb.; 160-180 lb.; and 190-210 lb. Each group contained equal numbers of purebreds, crossbreds, barrows and gilts. The carcasses were dressed packer style, cut and measured using standard techniques.

As slaughter weight was increased, there was an increase in backfat thickness, carcass length, dressing percentage and loin eye area, and a decrease in the percentages of primal and lean cuts. Chemical analysis of the rough ham indicated that as slaughter weight was increased, there was a significant decrease in the percentages of protein and moisture, whereas, the percentage of ether extract increased significantly. Chemical analysis of the _L. dorsi_ muscle showed similar trends except that no significant difference was observed in the percentage of ether extract as slaughter weight was increased. Physical separation of the rough ham showed that as slaughter weight decreased, the percentage of bone and percentage of lean increased significantly, whereas, the percentage of separable fat decreased.

Taste panel scores based on the nine point hedonic scale indicated that the palatability of smoked hams and bacons was acceptable regardless of slaughter weight. Differences in percentages of smoked yields attributable to slaughter weight were not significant, except in the case of

bacons from the lightest weight group where the yield was significantly lower ($P < .01$). Slaughter weight had no significant effect on either palatability or percentage of cooking losses from fresh pork chops.

Munsell color measurements of hue and value were not significantly affected by slaughter weight; however, significant decreases in chroma were noted as slaughter weight decreased. The difference in age between the animals from the heaviest weight group and those from the lightest weight group was approximately 3 months. Thus, if the concentration of the muscle pigment myoglobin does in fact increase with age, this could possibly account for the increases in chroma as found in this study.

The water-holding capacity of the L. dorsi muscle was studied by the filter paper-press technique. Differences in the water-binding properties due to slaughter weight were found to be non-significant. It was noted, however, that the amounts of expressible moisture were somewhat higher in the case of the 2 lightest weight groups. A second method of determining water-holding capacity was developed during the course of this study. The method proved to be both rapid and repeatable.

Consumer studies conducted on fresh-frozen pork chops, Boston butt roasts, and loin roasts indicated strong consumer preferences for the chops and butt roasts from both the heaviest and the lightest weight groups. In the case of the loin roasts, however, the preference was decidedly in favor of the heaviest weight group. Thus, it appeared that certain cuts from lightweight hogs would be favorably accepted by the consumers. The smaller size of some of these cuts seemed to be one of their more desirable attributes. However, it was apparent that consumers will strongly object to cuts which are too small. Such appeared to be the case with the loin roasts. Family size also had a strong influence upon selection. As family size increased, the demand for cuts from the heaviest weight groups became more pronounced.

The difference in the breeding of the animals was found to have had considerable influence on various characteristics of the carcasses. The crossbred hogs had significantly higher dressing percentages ($P < .01$) and larger loin eye areas ($P < .05$), whereas, they were shorter in carcass length ($P < .01$) and produced a lower percentage of primal cuts ($P < .05$). No significant differences were found between the Yorkshire and crossbred hogs in percentage of lean cuts or in backfat thickness. Chemical analysis indicated that the rough hams and loin eye muscles from the carcasses of Yorkshire hogs were significantly higher in percentage of protein, but lower in percentage of ether extract. Physical separation data on the rough hams indicated that carcasses from the Yorkshires had significantly higher percentages of bone than those from the crossbreds; however, no significant differences in the percentage of separable lean or percentage of separable fat were observed between breed groups.

Taste panel evaluation of smoked hams and bacons indicated no significant differences in palatability due to breed. The smoked yields of the hams did not differ significantly between breeds, however, the bacon from the crossbred hogs had a significantly higher ($P < .01$) yield than that from Yorkshire hogs. The fresh pork chops from the Yorkshire hogs were found to be more tender than those from the crossbreds; however, the latter were rated higher in overall acceptability by the taste panel. The chops from the Yorkshire hogs had significantly lower cooking losses than those from the crossbreds.

The carcasses from gilts were generally superior to those from barrows. The gilts produced higher percentages of lean and primal cuts, were longer in carcass length and had larger loin eye areas. Carcasses from barrows had significantly more backfat thickness. Chemical analysis indicated that the rough hams from the carcasses of gilts were significantly higher in percentage protein and percentage moisture, but were lower in percentage ether extract. The loin eye muscles from the gilts contained significantly less ether extract, but no significant differences occurred in percentage protein or moisture. Physical separation data of the rough hams indicated that those from gilts contained significantly lower percentages of separable fat and higher percentages of separable lean than those from barrows.

The palatability of the smoked hams and bacons did not differ significantly between sexes. The smoked yields of hams were similar regardless of sex, however, bacon from barrows was higher ($P < .05$) in percentage of smoked yield than bacon from gilts. No significant differences due to sex were found between the taste panel scores and percentages of cooking losses of the fresh pork chops.

The results of this investigation indicated that the acceptance, quality and processing characteristics of carcasses from hogs slaughtered at weights as low as 100 pounds compared very favorably with those from hogs slaughtered at normal market weights.

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By

John Andrew Emerson

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Food Science

1962

BIOGRAPHICAL SKETCH

The author, John Andrew Emerson, was born February 13, 1928, in Haverhill, Massachusetts. He graduated from Berkeley Preparatory School of Boston, Massachusetts, in February, 1946.

In March, 1946, he enrolled as a student at Tufts College, Medford, Massachusetts, and received the degree of Bachelor of Arts in Economics from that institution in June, 1950.

In July, 1952, he entered the United States Navy and was released from active service in June, 1955, with the rank of Lieutenant (junior grade).

In September, 1955, he enrolled in the University of Florida and received the degree of Bachelor of Science in Agriculture from that institution in June, 1957.

As a University of Florida undergraduate, he was a member of the University Meats Judging Team and Alpha Zeta, agricultural honorary fraternity.

In June, 1957, he commenced his graduate studies in the Animal Husbandry and Nutrition Department of the University of Florida and received the degree of Master of Science in Agriculture in January, 1959.

In March, 1959, he entered the Graduate School of Michigan State University, Department of Food Science. He is a member of the American Society of Animal Production, the Reciprocal Meats Conference, the Institute of Food Technologists, and the Society of Sigma Xi. He is now a candidate for the degree of Doctor of Philosophy.

ACKNOWLEDGMENTS

The author wishes to express his deep appreciation to Dr. A. M. Pearson, Professor of Food Science, for his guidance and assistance throughout this study and in the preparation of this manuscript.

To Dr. B. S. Schweigert, Head of the Department of Food Science, Professor L. J. Bratzler, and to Dr. J. A. Hoefer, Dr. P. E. Reineke and Dr. R. W. Luecke, members of the author's guidance committee, sincere appreciation is expressed for their cooperation and council.

Special gratitude is extended to Mrs. Dora Spooner for her invaluable assistance with the chemical analyses, conduction of the taste panels and the statistical analyses. The author sincerely thanks Mrs. Beatrice Eichelberger for her excellent typing of this manuscript.

Above all, the author wishes to thank his wife, Louise, who made all this worthwhile.

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INTRODUCTION

Numerous consumer acceptance studies have indicated leanness to be the most important criterion in the selection of meats. Consumer resistance to fat has placed increased emphasis upon production of hogs that will yield leaner, meatier carcasses that satisfy consumer demands.

A number of methods have been proposed for increasing the leanness of pork carcasses. Selection and breeding towards certain carcass traits has resulted in considerable improvement of carcass meatiness in recent years. The use of breeds having superior muscling has become increasingly popular in crossbreeding programs. High-fiber diets from various sources have been utilized to restruct the energy intake and, therefore, to reduce the overall fatness of swine (Bohman et al., 1955; Merkel et al., 1958; Hochstetler et al., 1959; Larsen et al., 1960). The influence of limited feeding as a means of producing leaner swine carcasses (Lucas and Calder, 1956; Brunstad and Fowler, 1959; Self et al., 1960) has been investigated.

A method of reducing fatness, which has recently stimulated much interest, is the slaughtering of hogs at lighter weights than the usual 200-220 pounds. Recent investigations (Mullins et al., 1960; Field et al., 1961) have indicated this method to be as effective as breeding and high-fiber diets in increasing carcass leanness and more efficient in terms of feed savings.

The current study was conducted in order to determine the quality and processing characteristics of carcasses from hogs slaughtered at weights ranging from 100 to 200 pounds. Any undesirable effects of practical consideration, other than production factors, resulting from slaughtering hogs at lighter weights should become apparent within this weight range.

The specific objectives were to observe the effect of slaughter weight on:

(1) carcass cut-out data,

(2) the chemical composition of the loin eye muscle and the rough ham,

(3) percentages of bone, lean, fat and skin of the rough ham as determined by physical separation,

(4) yields and panel ratings of smoked hams and bacons,

(5) percent cooking losses and panel ratings of fresh pork chops,

(6) surface color of fresh pork chops,

(7) the water-holding capacity of the _L. dorsi_ muscle, and

(8) the consumer acceptance of pork chops, Boston butts, and loin roasts.

REVIEW OF LITERATURE

Effect of Growth and Development on Carcass Composition

Many studies have been made of the changes in body composition and measurements of farm animals from birth to maturity. Meek (1901), Brody and Ragsdale (1924), and Lush (1928), studying changes in live weight and external body measurements of cattle during growth, found the skeleton to be more completely developed at birth than muscle or fat, whereas, it is the latter which makes up the greater proportion of the adult animal's weight.

Hammond (1932) completely dissected bodies of sheep from birth to four years of age. His study showed that the developmental changes in the animal are caused by a primary growth wave originating at the cranium. This wave moves forward to the facial parts of the head and posteriorly to the lumbar region. A secondary growth wave, originating at the metacarpals and metatarsals, was found to continue down to the digits and upwards along the limbs and trunk to the lumbar region. Consequently, the lumbar region is the last to attain maximum growth since it is the latest maturing part of the animal. The results of Hammond were confirmed by Wallace (1948), and Palsson and Verges (1952a, 1952b).

McMeekan (1940, 1941), studying growth in pigs, reported findings similar to those of Hammond. He found that growth in body proportions exhibits a well-defined anterior-posterior gradient from the earlier to the later developing regions. The limbs developed relatively early, with the forelimbs developing slightly earlier than the hindlimbs. The growth and development of the major body tissues were found to occur in a well-defined order commencing with the skeleton, then muscle, and lastly, fat.

Effect of Sex on Carcass Composition

Callow (1949) considered gilts to be physiologically younger than barrows of the same chronological age. Woodman (1937) and Callow (1949) reported gilts to have a greater growth of muscle and bone and to deposit fat more slowly than barrows. Hetzer *et al*. (1950) noted that gilts yielded a higher percentage of primal cuts and a higher percentage of lean in the ham than barrows of comparable live weight. Fredeen *et al*. (1955) reported gilts to yield heavier, longer, leaner hams than barrows. Hetzer *et al*. (1956) found barrows to be fatter than gilts, and gilts to be fatter than boars when compared at 250 pounds live weight.

Fredeen and Lambroughton (1956) studied more than 1,300 pork carcasses and found the gilts to be superior to barrows in many desirable attributes, including less backfat and a larger loin eye area. Bruner *et al*. (1958) observed differences in 385 littermate barrow and gilt pairs. The barrows gained faster than the gilts. The gilts produced leaner carcasses than the barrows, based on percent of lean cuts, backfat thickness, loin eye measurement, and the weight of the loins and hams. Wallace *et al*. (1959), studying the effect of slaughter weight on hogs, found that barrows gained faster than gilts; however, gilts had less backfat and larger loin eye muscles. Judge *et al*. (1959), studying fresh pork loins from 321 carcasses, found no significant differences in the color or firmness of the *L. dorsi* muscle due to sex differences. The difference in marbling approached significance with the barrows having more intramuscular fat than the gilts.

Effect of Breed on Carcass Composition

Enfield and Whatley (1961) studied the heritability of carcass length, backfat thickness, and loin eye area using pigs of Duroc, Beltsville No. 1, and Hampshire breeding. According to the authors, the heritability estimates indicated that all three traits are moderately heritable (carcass length, 0.52; backfat thickness, 0.63; loin eye area, 0.44). The phenotypic correlations reported were: carcass length to backfat thickness, -0.36; carcass length to loin eye area, 0.10; and loin eye area to backfat thickness, -0.27. These results are consistent with the findings of Whiteman and Whatley (1953) and Hazel and Kline (1952). Aunan and Winters (1949) and Brown *et al.* (1951) have reported that the correlations between carcass length and backfat thickness are negative, but of varying magnitude. Estimates of phenotypic correlation coefficients between loin eye area and carcass length have varied from -0.18 (Stothart, 1938) to 0.38 (Aunan and Winters, 1949).

Enfield and Whatley (1961) concluded that selection for backfat thickness and loin eye area should be slightly effective in reducing carcass backfat and increasing loin lean area. Although carcass length appears to be quite heritable, it is only moderately related to other measures of carcass leanness.

Zobrisky *et al.* (1954, 1959), while investigating the effect of carcass length on the yield of lean, found no strong relationship between the two. However, the data indicated that the effect of length on the yield of lean varies between breeds. The correlations obtained were as follows: Landrace-Poland crosses, -0.20; Hampshires, 0.12; and Durocs, 0.36.

Pearson *et al.* (1959) compared seven breeds of hogs as to backfat thickness, carcass length, loin eye area, and percentage of the various

trimmed wholesale cuts. It was found that highly significant differences occurred between some breeds for all traits investigated. Ranking of the breeds according to yield of primal or lean cuts was not found to be a true indication of actual carcass value. Certain breeds were proportionately higher in percentage ham and loin, whereas others were higher in percentage shoulder and belly.

Judge et al. (1959) compared the loins from six breeds of swine as to color, marbling and firmness. It was found that certain of the breeds tended to produce light colored, slightly marbled, soft muscles, whereas, other breeds frequently produced dark, abundantly marbled, firm loins.

Rupnow and Weller (1961), comparing 12 Hampshire and 12 Palouse hogs, determined the effect of breed on tenderness as indicated by the Warner-Bratzler shear method. It was found that loin chops from the Hampshire breed were significantly more tender than the chops from the Palouse hogs.

Indices of Carcass Composition

Physical Separation

Hammond's (1932) work with sheep introduced the concept of dividing the carcass into well-defined anatomical sections. The procedure for dissecting these sections into skin, bone, tendon, muscle and fat has been described in detail by McMeekan (1940). This technique has also been utilized by Pomeroy (1941).

Lush (1926), using the 9-10-11th rib cut of beef, was the first to study the relationship between the composition of a single cut and that of the entire carcass. The value of the 9-10-11th rib cut was subsequently confirmed by Hopper (1944), and Hankins and Howe (1946).

Utilization of the percentages of separable lean, fat and bone of the ham as an index of pork carcass composition has been studied by many investigators. Hankins and Ellis (1934) found a high association ($r = 0.93$) between the fat content of the right ham and that of the edible portion of the carcass. McMeekan (1941) reported highly significant correlations between the total weight of bone, muscle and fat ($r = 0.94$, 0.98, and 0.98, respectively) in the loin plus the ham and the total weight of these tissues in the entire carcass. High correlations also existed when either the loin or ham was considered separately. The percentage of separable lean and fat of the ham was found by Aunan and Winters (1949) to closely parallel the percentages of these tissues in the carcass.

Backfat Thickness

Scott (1927) demonstrated that the differences in percentage of ham, loin and other pork cuts are primarily due to differences in the degree of fatness of the carcass. The significance of backfat thickness in carcass evaluation studies has been studied by many researchers (Hankins and Ellis, 1934; McMeekan, 1941; Aunan and Winters, 1949; Reynolds and Kiehl, 1952; Zobrisky *et al.*, 1954). Studies conducted by Engleman *et al.* (1950), Wiley *et al.* (1951), and Fox *et al.* (1953) indicate that as backfat thickness increases, carcass value decreases. These investigations indicated backfat thickness to be a simple, rapid, practical estimator of carcass fatness. However, its relationship to cut-out value is generally lower than would be desirable.

Loin Eye Area

The use of loin eye area has been used extensively as a tool in pork carcass evaluation. The measurement has usually been taken across the tenth and/or the last rib, and the values have been used alone or in combination with other carcass measures to predict carcass leanness. The general practice amongst investigators to select relatively posterior locations of the loin for loin eye area measurements is consistent with the findings of earlier workers (Hammond, 1932; McMeekan, 1940, 1941) which indicate this area to be one of the latest developing parts of the carcass. A part which grows late in the development of an animal, forms the best index of the state of development of the carcass as a whole.

Whiteman and Whatley (1953a) compared two methods of measuring loin eye area (length by width estimate and planimeter reading) to other indices of carcass leanness. Both loin eye measures appeared to be about equal in value for predicting carcass merit. Kline and Hazel (1955) compared loin eye areas taken at both the tenth and last rib in regards to their absolute size, relationship to each other, and accuracy in predicting lean cut-out values. The loin area at the last rib averaged 0.43 square inches greater than that at the tenth rib, which was a large and highly significant difference. No significant difference was found amongst the correlations between percent lean cuts and loin eye area at the tenth or last rib. However, the latter area was slightly more closely related to percent loin.

Pearson *et al.* (1956a) investigated the use of the cross-sectional fat/lean ratio of the rough loin at the last rib as a measure of carcass leanness. The area of lean at the tenth or last rib was found to be only slightly less reliable ($r = 0.52$) than the ratio of fat to lean ($r = -0.60$) for estimating carcass cut-out. Zobrisky (1959) reported that the cross-sectional area of loin eye, the cross-sectional area of lean in the ham, and dressing percentages were significantly correlated with percentage carcass lean, with values of 0.60, 0.46, and 0.36, respectively. Hegarty (1960) obtained correlations between loin eye area and percentage lean cuts of 0.67 and 0.60, when measured at the last and tenth rib, respectively. He indicated that there may be a higher relationship between percent lean cuts and loin eye area when measured at the last rib than when measured at the tenth rib.

Specific Gravity

Many investigators have reported the use of specific gravity as a tool for estimating carcass composition. Brown et al. (1951), Whiteman et al. (1953b), and Kraybill et al. (1953) reported specific gravity values to be more accurate than backfat thickness in predicting carcass cut-out value. Kline et al. (1955) indicated that the use of specific gravity as a measure of fatness requires standardized conditions. Studying 40 carcasses, he found the average specific gravity after 0, 24, 48 and 72 hours chilling at an unspecified temperature to be 0.997, 1.021, 1.025 and 1.028, respectively.

Pearson et al. (1956) evaluated the specific gravity of several single cuts as estimators of carcass fatness and leanness. The specific gravity of a single untrimmed ham was found to be a slightly more reliable index of the specific gravity of the entire carcass than were the specific gravities of the rough loin and the untrimmed shoulder. Specific gravity of either the entire carcass or a single ham was shown to be superior to backfat thickness as an indicator of carcass cut-out value. Whiteman et al. (1953b) reported a high correlation ($r = 0.95$) between specific gravities of the half carcass and the ham. Price et al. (1957) indicated that the chemical composition of the ham, the area of the loin eye at the tenth or last rib, and the backfat measurements were more closely associated with carcass specific gravity than with the specific gravity of the ham.

Barton and Kirton (1956) reported a correlation of 0.88 between the reciprocal of specific gravity and the percentage of ether extract in half-carcasses of sheep. An identical correlation was obtained between specific gravity and the ether extract in the 9-10-11th rib cut. In a later study, Kirton and Barton (1958) found that the relation between carcass fat and specific gravity is non-linear. The largest deviation from the linear regression occurred in data obtained from very lean ewes. Animals having a very low fat content had lower specific gravity values than would be predicted from a linear regression fitted to data from animals of medium fatness. At the other extreme, the specific gravity decreased faster than would be predicted from the same linear regression equation.

Effect of Slaughter Weight on Carcass Characteristics

Wallace *et al*. (1959) studied hogs slaughtered at 150, 180, 210 and 240 pounds. It was found that as slaughter weight decreased, dressing percentage, backfat thickness, and loin eye area at the 10th rib decreased. Percentage lean cuts increased when slaughter weight was decreased.

Mullins *et al*. (1960) studied the carcass characteristics and consumer acceptability of pork cuts from 160- and 220-pound hogs. The heavier carcasses dressed 3 percent higher and were about 2.5 inches longer than those of the lighter weight group. The lighter carcasses had about 0.4 inches less backfat and 0.6 square inches more loin eye area per 100 pounds of chilled carcass. The carcasses of the lighter weight group produced 4 percent more lean cuts and 5 percent less trimmed fat. The wholesale value of the pork cuts from the lighter group was about $2.00 more per hundredweight of carcass. Consumer acceptance was studied on ham roasts, ham center slices, loin roasts, loin chops, picnics, Boston butts and bacon. Loin blade roasts, Boston butts, picnics and bacon from both weight groups were rated lower on general acceptability and were consistently criticized for being too fat.

McCampbell and Baird (1961) conducted a study on purebred Poland China hogs slaughtered at 170, 190, 210 and 230 pounds. Dressing percentages were similar for all groups. Although carcass length and backfat thickness increased with slaughter weight, loin eye area increased only slightly. The percentage lean and primal cuts decreased as slaughter weight increased. The average returns in dollars per head above the costs of production were $9.22, $10.02, $11.05 and $10.37, respectively, for the 4 weight groups.

Field _et al_. (1961) studied the effect of slaughtering hogs at 160 and 220 pounds. It was found that the lighter hogs required significantly less feed per 100 pounds of gain than the heavy animals. Twenty-five packers from 13 states were asked for their opinions on the merits of slaughtering hogs at the two weights. Eighty-three percent of the packers preferred hogs weighing 200 to 225 pounds. The meat packers estimated processing costs to be 20 percent greater per unit weight for hogs weighing under 175 pounds. Because of the greater processing costs, the packers estimated that the lighter hogs were worth about $1.50 less per hundredweight than the 220-225 pound hogs. The packers cited the following reasons for the greater production costs: (a) "It takes practically the same time and facilities to dress, chill and cut the light weight hog as it does a hog which yields twice as many pounds of pork", (b) "Lesser value of the thin bellies from light hogs", and (c) "The yield of the lighter hogs is less".

The same authors asked 73 retailers from 19 states to indicate the size of hams, loins, picnics and Boston butts that they preferred to merchandise. In general, they preferred smaller cuts than were commonly available. Some of their reasons included: (a) consumer acceptance, (b) balanced movement of retail cuts, (c) profit cut-out, (d) more flavor and tenderness, (e) consistently leaner, and (f) more attractive unit cost.

A survey was conducted of consumers' reactions to fresh center pork chops, whole and sliced Boston butts, cured hams, cured picnics and sliced bacon from hogs of the two weight groups (Field et al., 1961). The consumers indicated that a higher percentage of the cuts from the heavier group were too fat and that the whole hams and center chops were too large. A consumer-panel found no significant differences in tenderness or flavor of cuts from either weight group. Similarly, a laboratory taste panel did not show a significant preference between the two weight groups. Loin roasts from the lighter hogs had a significantly lower shrinkage than those from the heavier group, which was probably due to increased rendering of fat. Carcass data indicated no significant difference in dressing percent. The lighter hogs produced significantly more lean and primal cuts, which made the lighter carcasses worth \$1.27 more per hundredweight. The increased value of the carcasses offset the added processing costs which had been estimated by the packers.

Consumer Acceptance Studies

Numerous studies have been conducted to determine the factors which consumers consider most important in selecting meat cuts. The results of these studies have generally made it apparent that consumers are demanding leaner cuts of beef and pork. Such considerations as tenderness, color, overall size, flavor and amount of bone have also been shown to be important attributes. However, one of the most important factors in the initial selection of a cut of meat appears to be its lean content.

Studies conducted in St. Louis, Missouri, (Rhodes, 1955), and Phoenix, Arizona (Campbell, 1956), have indicated strong consumer rejection of beef cuts containing excess fat. The objections were not limited to trimmable fat alone, but included marbling as well. The majority of consumers preferred cuts from cattle of the Good and Standard grades.

Studies with pork indicate similar preferences. Vrooman (1952) conducted a survey of pork product preferences in five Oregon cities. A clear-cut preference for lean pork was expressed in all cities regardless of income group. Birmingham _et al_. (1954) studied consumer preference for pork in Columbia, Missouri. Cuts from both the Medium and Choice No. 1 grades were presented for evaluation before and after cooking. Prior to cooking, a definite preference for bacon and pork chops and a slight preference for ham slices from the Medium grade was found. Leanness was the characteristic most often mentioned as the reason for selection of cuts from the Medium grade hog carcasses. Consumers selecting cuts from Choice No. 1 carcasses gave apparent freshness as the basis for their selection. Color appeared to be more important in the selection of cured meats. Only a small percentage of the panelists gave marbling as a criterion for selection. After the cuts were cooked, the panelists continued to prefer the cuts from the Medium grade carcasses. The principal reason given for selection of the cooked pork of both grades was flavor, whereas, less importance was placed on tenderness and leanness.

Larzelere and Gibb (1956) studied consumer opinions of quality in pork chops in the Detroit area. Where fat covering was the only variable, chops having 1/8-inch fat covering were preferred first. Chops with 1/2-inch fat covering were preferred last. Where color of lean and fat covering constituted the only variables, the amount of fat appeared to be the major criterion for selection. Where amount of marbling, size of loin eye, color and firmness were variables, the respondents rated size of eye muscle most consistently as being the deciding factor in making their selection.

Gaarder *et al.* (1960) surveyed pork preference in the Des Moines, Iowa, area. Income and family size were the most important factors influencing total pork consumption. As family size increased, pork consumption increased. As income increased, pork consumption gradually declined. The favorite pork dishes were usually pork chops and ham. Eighty-nine percent of those interviewed preferred lean or medium chops over the fat chops. Chops having a larger-than-average size eye muscle area (about 6 square inches) were preferred. Bone and texture were relatively unimportant factors.

Kauffman (1960) cited a study conducted at Madison, Wisconsin, on consumer reaction to marbling in pork. A definite preference for lean, unmarbled pork chops was found. However, upon tasting and comparing unmarbled and marbled chops, the majority of the consumers indicated willingness to pay more for the marbled chops. Similar findings were reported by Naumann *et al.* (1960) in Columbia, Missouri. Although a laboratory panel indicated no clear cut preference between chops differing in marbling, a consumer panel preferred heavily marbled chops over those with sparse marbling.

Meat Color

Muscle Pigments

The ideal color for fresh pork muscle is generally considered to be grayish-pink (Ziegler, 1958; Briskey et al., 1959a). However, there appears to be some question as to the degree of importance that consumers place on color in their selection of fresh pork. Larzelere and Gibb (1956) found that a large scale consumer panel selected a chop of "inferior" color as their first choice in one test, but in another test a similar chop was fifth choice.

Early workers (Hoagland, 1915; Brooks, 1933) stated that oxyhemoglobin was the muscle pigment responsible for the color of red meat. Brooks (1937) later reported the color to be due primarily to myoglobin. Although myoglobin is located within the muscle fiber and is largely responsible for muscle color, the total color of meat is probably influenced by hemoglobin as well. Husaini et al. (1950) found that the total pigment extracted from beef muscle was 90-95 percent myoglobin. Broumand (1953) stated that the bright red color of beef is due to the presence of 90-100 percent oxymyoglobin and 0-10 percent hemoglobin. Craig et al. (1959) reported the composition of total muscle pigment to be 65 percent myoglobin and 35 percent hemoglobin.

In cured meats (Wilson, 1960), myoglobin and/or metmyoglobin are converted to nitrosomyoglobin, which in turn may be converted to nitrosohemochrome, a stable pink pigment. This is accomplished, in the case of myoglobin, by reacting the pigment with nitric oxide which replaces the water attached to the heme portion of the molecule forming a nitroso-complex. The iron of the heme remains in the ferrous state. Metmyoglobin (ferric) must first be reduced and then reacted with nitric oxide to form nitrosomyoglobin. Nitrosomyoglobin may then be converted to nitrosohemochrome by the addition of heat which denatures the globin portion. It is probable that the denatured globin is detached from the heme pigment at this point. Another pathway exists for attaining nitrosohemochrome where metmyoglobin may be heated directly to form denatured metmyoglobin, which in turn may be reduced and reacted with nitric oxide to form the desired pigment.

Factors Affecting Muscle Color

There appears to be considerable disagreement as to the effect of myoglobin concentration on muscle color and also as to the factors which cause changes in myoglobin concentration. Kennedy *et al.* (1926) stated that myoglobin concentration could be increased in dogs by exercise. Brooks (1933) stated that myoglobin concentration also depends on other factors, such as age, breed, and type of ration fed. According to Millikan (1939), myoglobin concentrations are higher in muscles which are normally more active. Hall *et al.* (1944) and Poel (1949) also attribute higher myoglobin content to increased activity. Lawrie (1950) concluded that activity is the fundamental factor responsible for controlling the amount of pigment in any muscle. However, he also stated that variations of pH cause color differences in muscles having a similar myoglobin content. Muscles appeared darker at pH 7.0 than at 6.3.

Mitchell (1933), however, found no differences in muscle pigmentation between exercised and unexercised cattle. Bull *et al.* (1942) and Craig *et al.* (1959) have made similar observations. Briskey *et al.* (1959b), studying the effect of exercise on hogs, found no significant differences between myoglobin content of muscles from exercised and unexercised animals. His observations on the effect of pH were similar to Lawrie's (1950) in that exercised muscles were higher in pH and darker in color. Rongey (1958) also verified the effect of pH on ham muscles. On the other hand, Wilson *et al*. (1959) concluded that the condition of "two-toning" in hams was due primarily to differences in myoglobin concentration and suggested that these differences were heritable characteristics.

Briskey *et al*. (1959c, 1960a) studied the effect of ration and exercise on pork ham muscles. He observed that exhaustive exercise produced hams of dark color and that high sucrose rations produced hams of very light color. However, muscles were similar in color from hogs that were both exercised and fed the high sucrose ration and from hogs that received the basal ration and were unexercised.

It is therefore doubtful if muscle color can adequately be explained on the basis of myoglobin concentration, muscle pH, muscle activity, or ration alone, but a combination of these factors is probably responsible for the variations observed.

Disk Colorimetry

The theory and application of disk colorimetry is explained in detail by Nickerson (1946). The method involves the use of spinning colored disks and the Munsell system of numerically notating colors to scales of hue, value and chroma. Munsell hue is defined as "that attribute of certain colors in respect to which they differ characteristically from a gray of the same lightness and which permits them to be classed as reds, yellows, greens, blues, or purples". Value "is that attribute of all colors which permits them to be classed as equivalent to some member of a series of grays that are equally spaced under the standard conditions for which the scale was derived. The Munsell scale of grays extends from 0, black, to

10, white . . ." Chroma "is that attribute of all colors possessing hue which determines their degree of difference from a gray of the same value. The notation is numerical, with 0 at gray, extending outward from the neutrals toward 10 or more for the strong colors."

Nickerson further states that on comparing the spinning disks to a sample, a difference in hue would be recognized where the disks appeared redder or less red (or yellower, etc.) than the sample. A difference in value could be told where the disks appeared lighter or darker; and chroma, where one appeared stronger or weaker. Thus, hue is the actual color observed, value its degree of lightness or darkness, and chroma is the concentration or amount of color.

An example of numerical notation is given below:

5YR 6/4

In this example, the hue is yellow-red, the value is 6 and the chroma is 2. A notation of 6YR 4/2 compared to the above would indicate a color whose hue is still yellow-red, but containing a greater proportion of yellow. The value is numerically less indicating a higher proportion of black to white, hence darker. The chroma of 2 would indicate a lesser total amount of yellow-red pigment.

The spinning disks are slotted so that they may be fitted together. Normally, four disks are used and, in the example above, would be red, yellow, black, and white. The proportionate area exposed by any of the disks may be changed by the operator until their combined amounts produce a color which matches that of the sample.

The Water-holding Capacity of Meat

Definition

Hamm (1960), in his extensive review of the biochemistry of meat hydration, defines water-holding capacity as the ability of meat to hold fast to its own or added water during application of any force, such as pressing, heating, grinding, etc. The amount of immobilized water determined depends on the method used; therefore, water-holding capacity must be expressed in terms of the method of measurement. The water-holding capacity of meat can be expressed in terms of the amount of free water related to the total content of moisture in the muscle.

Importance of Water-holding Capacity

According to Hamm (1960), water-holding capacity is one of the most important features of meat quality, as indicated by its role in the following areas. It is closely related to taste, tenderness and color, and is influenced by the treatment that the animal receives prior to slaughter. In addition, it affects the quality of meat during almost all processing operations after slaughter. It plays an important role in the production of such meat products as frankfurter-type sausages and canned hams. It is of economic importance in problems of weight losses during storage, cooking, freezing and thawing of meat. Water-holding capacity investigations give information on changes in the charges and structure of muscle proteins.

Basic Concepts of Meat Hydration

Hamm (1960) presented the following basic concepts of meat hydration. Muscle proteins are responsible for the binding of water in meat. About 34 percent of the muscle proteins are water soluble, the remainder repre-

senting the structural substance. The structural proteins consist of 34-38 percent myosin, 13-15 percent actin, 7 percent X-protein, and 15-17 percent stroma proteins. Also present is tropomyosin which is similar to myosin. Changes of the water-holding capacity of meat may mainly concern actin and myosin or the actomyosin complex. Hamm cites Fujimaki and Nakajima (1958) as reporting that the globular proteins also have an effect on water-holding capacity. Meats containing a greater quantity of globular proteins, as between certain species, seemed to have greater water-binding properties.

According to Hamm, different kinds of water-binding exist in muscle tissue with no sharp distinction between tightly bound and loosely bound water. Certain hydrophilic groups play a role in the binding of water to proteins. Water molecules, being dipolar, are attracted by all types of polar groups in the protein and are bound by hydrogen bonds. Water molecules are initially bound to proteins by single molecules of water being bound to single polar groups. The affinity for water of the different polar groups varies. Thus, water attaches first to the most active groups, and then to the less active. The true water of hydration of muscle is that which is attached to proteins by mono- or multimolecular absorption. The physical properties of this bound water are different from those of "free" water. The bound water has a lower freezing point, a lower vapor pressure, and a lower dissolving power than normal water by virtue of its association with the protein.

Hamm (1960) cites several investigations in which one or more of the above properties were used to measure the amount of bound water in muscle. The results of these studies indicated that the amount of water bound by

hydration varies from 16-50 g. per 100 g. of protein. This, however, does not nearly account for the total water in muscle. The remaining water must, therefore, be "free" water. According to Hamm (1960), it has the same physical properties as normal water, and there is no indication that it is tightly bound to the protein molecule. This water appears to be mechanically immobilized by the network of the cellular protein membranes, protein filaments, and perhaps even by cross linkages and electrostatic forces between the peptide chains. Changes in the water-holding capacity of meat do not affect the tightly bound water except under conditions of high temperature, high concentrations of salts, or other drying procedures. It appears that although the polar groups of a protein may hold the protein chains together by electrostatic forces, these same polar groups may be completely available for the coordination of small dipolar molecules, such as water. Thus, the state of dissociation does not seem to affect the binding of water of hydration.

Briggs (1931, 1932), as cited by Hamm (1960), found that changes in pH or the addition of salts to proteins does not affect the water of hydration, but does affect the absorption of "free" water. The "free" water retained within the protein structure appears to have a continuous transition to the "loose" water, which is forced out by applications of very low pressures. The amount of free water immobilized within the tissue is dependent upon the spatial structure of the muscle tissue. A tightening of the network of proteins decreases immobilized water and increases easily expressible water. A loosening of the protein network has the opposite effect.

Factors Affecting Meat Hydration

Grau *et al.* (1953) indicated the relationship which exists between pH and water-holding capacity. They found that as the pH approached the isoelectric point of muscle proteins, at about pH 5, the water-holding capacity decreased accordingly. A number of investigations have indicated that the relationship between pH and water-binding is rather high (Wierbicki *et al.*, 1956; Judge *et al.*, 1959; Swift and Berman, 1959; Webb, 1959; Hamm and Deatherage, 1960; Briskey *et al.*, 1960b; and Sherman, 1961b).

Various mineral ions have been found to affect the water-binding properties of muscle. The increase in water-holding capacity by the addition of calcium, magnesium, potassium and sodium chlorides has been studied by Wierbicki *et al.* (1957) and Hamm (1960). Swift and Berman (1959) found a positive correlation between water-binding and zinc.

Hamm (1960), Sherman (1961b) and Mahon (1961) investigated the mechanism in which polyphosphates increase the water-holding capacity of meat. Hamm (1960) indicates that polyphosphates chelate calcium, magnesium and zinc in the raw meat, thus removing them from the protein molecule and thereby increasing the water-holding capacity. Sherman (1961b), however, considers the effect primarily due to solubilization of the protein, particularly actomyosin. Mahon (1961) observed the effect of phosphates in increasing the water-binding of cured meats.

Hamm (1960) cites a number of German investigations of the effect of specie, sex, and age of animals on water-holding capacity. The studies indicated that water-binding is higher in pork than in beef, that veal has higher binding properties than older cattle, and that cows have a higher water-binding capacity than bulls. The following series in increasing water-holding capacity was presented:

$$\text{Bull} < \text{Ox} < \text{Heifer} < \text{Cow} < \text{Calf} < \text{Pig}$$

However, the data presented by Wierbicki and Deatherage (1958) do not appear to support these conclusions. An arrangement of the four species studied according to increasing water-holding capacity would be as follows:

$$\text{Lamb} < \text{Pork} < \text{Veal} < \text{Beef}$$

<u>Methods of Measurement</u>

The methods which are appropriate for the study of water-holding capacity, according to Hamm (1960), are those which measure changes in the binding of "free" water. These methods are based on measuring the loose water liberated upon application of pressure to the tissue. This pressure may be applied in several ways: sedimentation, centrifugation, filtration, or pressing between two plates.

Sedimentation (Hamm, 1960) which is normal acceleration by gravity, although a very simple method, has many disadvantages for studying water-holding capacity in meats. The predominant disadvantage being the long duration of time required which makes it unsuitable for studies of post-mortem changes.

The use of centrifugation has been reported by several investigators (Bendall, 1954; Swift and Ellis, 1956; Wierbicki et al., 1957; Webb, 1959; Sherman, 1961a, 1961b). The method is quite suitable for studying the effect of heating on the water-holding capacity of meat, but according to Hamm (1960), it has certain severe disadvantages. Considerable amounts of water must be added which makes conditions quite different from those in fresh or processed meats. If water is not added, it may not be possible to separate any juice from the tissues even at high speed centrifugation. If no water is added and the meat is heated to only 40°C., the

amount of juice separated is within the range of experimental error (Wierbicki and Deatherage, 1958). Although adding water is not necessary if the meat is heated to 70°C., the resulting denaturation often masks the changes of hydration that one wishes to observe.

A method of filtration was used by Lloyd and Moran (1933) for determining bound water in gelatin. However, this method usually involves long periods of time and, therefore, is not suited for studying meats.

The press method was first used primarily to determine the water-holding capacity of cooked meats. Various "pressometers" were used to study the juiciness of meats (Sartorius and Child, 1938). With the use of filter paper, the method was transformed to a quantitative technique. Grau and Hamm (1953, 1957) developed the combination press and filter paper method for determining water-holding capacity. Tissue samples weighing 300 mg. are placed on filter paper and pressed between two Plexiglas plates. The meat is pressed to a round thin film and the expressed juice is assumed to be proportional to the amount of loose water. Within the area of pressed meat the pressure is so high that the paper absorbs almost no water. Grau and Hamm showed that the pressure of screwing the plates together by hand is so great that individual differences of pressure do not significantly affect the amount of expressed loose water. The results of Grau and Hamm were confirmed by Wierbicki and Deatherage (1958). The method has been modified by several authors using hydraulic presses to maintain constant pressures (Wierbicki and Deatherage, 1958; Briskey _et_ _al_., 1960a; Henry, 1962).

EXPERIMENTAL PROCEDURE

Experimental Animals

A total of 80 animals were studied, consisting of 40 Yorkshire and 40 crossbred hogs. The hogs were produced at the Michigan Agricultural Experiment Station Farm and received standard growing and finishing rations (Appendix I and J). The crossbred hogs represented various combinations of Hampshire, Chester White, Yorkshire, and Duroc breeding.

As the animals attained a weight of 70-90 pounds, they were randomly divided into 4 slaughter weight groups. Each group was balanced as to breeding (purebreds and crossbreds) and sex (barrows and gilts). The weight ranges of the 4 groups were: Group I, 190-210 pounds; Group II, 160-180 pounds; Group III, 130-150 pounds; and Group IV, 100-120 pounds.

The hogs were weighed and taken off feed 24 hours prior to slaughter. Fresh water was provided *ad libitum* during the pre-slaughter period. They were weighed again just prior to slaughter. This weight was considered as the slaughter weight, and was used in computing dressing percentages and the percentages of primal and lean cuts on the live basis.

Slaughter Procedure

Slaughtering was conducted at the Michigan State University Meats Laboratory. All animals were dressed packer style with head off, jowls attached, and leaf-fat and kidneys loosened. The hams were faced with the facings left attached. The carcasses were weighed to the nearest 1/2 pound prior to chilling. The hot weights (less leaf-fat and kidney weights) were used to calculate hot dressing percentage and cooler shrinkage. The carcasses were chilled at approximately 36°F. for 48 hours prior to cutting.

Carcass Measurements

Approximately 24 hours after slaughter, carcass length and backfat measurements were obtained. The length of carcass was measured to the nearest 1/10 inch from the anterior edge of the first rib to the anterior edge of the aitch bone. Backfat measurements were taken to the nearest 1/10 inch opposite the first, seventh and last ribs, and the last lumbar vertebra. The 4 measurements were averaged to give mean backfat thickness, which was used in all comparisons.

Prior to cutting, the leaf-fat and kidneys were removed and the chilled carcasses were weighed to the nearest 1/2 pound. Chilled carcass weight was used to calculate cold dressing percentage, cooler shrink, percentage primal and lean cuts on the carcass basis, and percentage of lean and fat trimmings. The weight of the leaf-fat was included in the fat trimmings.

Cutting Procedure

Conventional cutting procedures were used as outlined by Cole (1951) with some modifications. The hind foot was removed by sawing through the bony projection on the inside of the hock. The front foot was removed approximately 1/2 inch above the knee joint.

The rough ham was removed at the 4th sacral vertebra and perpendicular to the long axis of the leg. After sawing through the vertebra, a knife was used to complete the separation through the loin portion. After severing the loin muscle, the knife was angled toward the hock and around the ham. The flank meat was left on the untrimmed belly.

A 2 1/2-rib shoulder was removed by sawing across the 3rd rib perpendicular to the general line of the back. The neck bones were removed

from the shoulder leaving as little lean as possible. The jowl was then separated from the shoulder by cutting parallel to the loin cut. The jowl was squared and the trimmings were separated into lean and fat trimmings. The collar portion of the shoulder was removed so as to make a smooth juncture at the shank and main portion of the shoulder. The rough shoulder was skinned by removing the clear plate from the outside of the shoulder to within 4 inches of the base of the shank. Approximately 1/4 inch of fat covering was left on the skinned shoulder. The New York shoulder was then separated into the picnic and Boston butt by cutting about 1/2 inch below the scapula and parallel to the backline.

The rough loin was separated from the belly and spareribs by cutting from a point just below the *psoas major* on the loin end to a point about 1 inch below the juncture of the ribs and backbone at the blade end. The cut followed the general curvature of the back in order to give the loin uniform thickness. The spareribs were removed from the rough belly by cutting through the secondary flank muscle and as close under the ribs as possible. The belly was then trimmed by cutting just inside and along the teat line and squaring the flank end. The rough loin from the right side of the carcass was divided between the 10th and 11th ribs and just posterior to the last rib by sawing through the backbone at a right angle to the backline. Tracings of the loin eye muscle at these locations were made on acetate paper for subsequent area measurements. The backfat was removed from the rough loin so as to expose the false lean at the blade end and leaving about 1/4 inch fat covering over the remainder of the loin.

The right ham remained unskinned for subsequent physical separation. The left ham was skinned by first removing the tail and the sacral

vertebra, then cutting along the natural seam between the flank and ham to remove the flank meat. The cut was continued to the outside of the ham where the excess fat, including the ham facing, was removed from the butt-end down to approximately two-thirds of the distance to the hock. Approximately 1/4 inch of fat covering was left on the ham.

Fat trimmings included all cutting fat in addition to the leaf-fat, while the lean trimmings consisted of all small pieces of lean removed during trimming.

Weights of the various rough and trimmed cuts were recorded on carcass data sheets (Appendix K). Since the right ham was not skinned, the weight of the left ham after skinning was doubled for use in calculating the percentage of primal and lean cuts.

Area of Lean

Tracings made of the loin eye muscle at the 10th and last rib were measured to the nearest 0.1 square inch by means of a Keuffel & Esser compensating polar planimeter. The average of 3 measures which did not vary over 0.1 square inch was used in all comparisons.

Specific Gravity Determination

The rough ham from the right side of the carcass was weighed to the nearest 0.1 pound in air. This weight was converted to grams by multiplying by 453.6. The ham was then weighed to the nearest gram under water. Weights under water were obtained by suspending the ham from a gram balance and submerging the ham in water at a temperature of about 13°C.

Specific gravity was calculated according to the following formula:

$$\text{Specific gravity} = \frac{\text{Wt. in air (grams)}}{\text{Wt. in air (grams)} - \text{Wt. in water (grams)}}$$

Physical Separation

The rough hams from the right side of the carcass were physically separated into fat, skin, lean, and bone. The ligaments and tendons were included with the bone. The 4 components were weighed separately to the nearest gram.

Preparation of Samples for Analysis

The composite sample consisting of the lean, fat and skin from the physically separated right ham was ground 5 times through a 3-mm face plate with subsequent mixing after each grinding. The procedure was the same for the samples from the *L. dorsi* muscle of the posterior section of the right loin except that a 2-mm face plate was used. The grinders were thoroughly washed and dried after each sample was ground. The ground samples were placed in glass jars, sealed, frozen and stored at -20°F. until removed for chemical analysis.

Chemical Analyses

Twelve hours prior to analysis, the sample jars were removed from the freezer and held at room temperature to allow the contents to thaw before weighing. The samples were then thoroughly mixed with a spatula. Approximately 5 grams of the ground sample were placed in tared disposable aluminum dishes and weighed to the nearest .0001 gram. The sample weight was then obtained by difference. The samples were dried at 100°C. for 24 hours, placed in a dessicator and cooled to room temperature. The dried samples were weighed and moisture losses were determined and used for calculation of percentage moisture. Percentage moisture was calculated according to the following formula:

$$\text{Percentage moisture} = \frac{\text{Wt. of dried sample (grams)}}{\text{Wt. of fresh sample (grams)}} \times 100$$

The dish was folded over the dried sample leaving each end open to facilitate extraction. Each sample was placed in an alundum cup which in turn was placed in a metal sample holder and extracted for 4 hours with anhydrous diethyl ether on a Goldfisch Fat Extractor (Hall, 1953). During extraction, the ether and ether extract were collected in a tared glass beaker. After extraction, the ether was distilled off and collected for re-use. The beaker and ether extract were dried to a constant weight at 100°C. and the weight of the ether extract was obtained by difference. Percentage ether extract was determined using the following formula:

$$\text{Percentage ether extract} = \frac{\text{Wt. of ether extract (grams)}}{\text{Wt. of fresh sample (grams)}} \times 100$$

Percentage protein was determined by weighing approximately 1.5 grams of the ground sample on a piece of tared, nitrogen-free, parchment paper. The paper was then folded about the sample and dropped into a Kjeldahl flask (Benne _et al._, 1956). Standard Kjeldahl procedures were then employed (A.O.A.C., 1960).

Color Measurement

The _L. dorsi_ muscle was excised from a chop removed at the 10th rib and "butterflied" so as to expose a fresh-cut surface. The muscle was placed in a Cryovac bag which was then filled with air and sealed. Prior to color measurement, the muscle was placed in a 36°F. cooler for 1 1/2 hours.

Hue, value, and chroma renotations were determined using the Munsell spinning disk method as described by Voegeli (1952). After the color measurements were taken, muscle pH was measured with a Beckman, Model G, pH meter by inserting the glass electrodes into the tissue.

Curing Procedure

The following basic curing formula was used for curing the bellies and hams removed from the left sides of the carcasses.

Salt	8.0 pounds
Sugar	2.0 pounds
Sodium nitrate	1.0 ounces
Sodium nitrite	1.5 ounces

The fresh bellies were rubbed with 22 grams of dry cure mixture per pound. The bellies were placed in a pressure-type, metal bacon box and cured for 7 days per inch of thickness. After removal from the cure, they were soaked in fresh water for 15 minutes, then hung on bacon combs and allowed to dry in a 36°F. cooler for 15-18 hours. After drying, the bacons were smoked for approximately 8 hours beginning with a smokehouse temperature of 130°F. When the internal temperature of the bacon reached 120°F., the smokehouse temperature was reduced to 120°F. for the remainder of the smoking period. To insure that all bacons were smoked for a period proportionate to their individual weights, the following formula was used to calculate total smoking time for each bacon:

Total smoking time (hr.)=Time (hr.) to reach internal temp. of 120°F x 1.6

After smoking, the bacons were returned to a 36°F. cooler for 15 hours. Then weights were recorded to the nearest 0.1 pound and used for calculation of smoked yields.

The hams were cured by injection of a 75° (salometer reading at 40°F.) pickle. The pickle was injected into the femoral artery, and the ham was pumped to a final weight of 110 percent. After pumping, the surface of the ham was rubbed with dry cure. The hams were cured on a shelf in a 36°F. cooler for 3/4 day per pound of ham. After curing, the

hams were soaked in fresh water for 15 minutes, placed in stockinette, and dried in a 36°F. cooler for 15 hours. The hams were then smoked according to the following schedule.

Table 1. Smoking schedule for hams.

Time	Dry bulb temp.	Wet bulb temp.	Relative humidity
(hr.)	(°F.)	(°F.)	(%)
1	120	minimum	--
1	120	100	49
2	130	108	48
2	140	116	47
2	150	125	47
2	160	131	45

The final dry and wet bulb temperatures were maintained until the internal temperatures of the hams reached 142°F., which took approximately 10-12 hours. They were then cooled in a 36°F. cooler for 15 hours, after which, the weight was recorded to the nearest 0.1 pound. Smoked yield was then calculated. The hams and bacons were then held at 36°F. until removed for taste panel evaluation.

Cooking Procedures

Two 1-inch thick center ham slices were removed by cutting 1 inch posterior and parallel to the aitch bone. The semimembranosus muscle from each slice was excised and roasted in an electric oven at 300°F. to an internal temperature of 170°F. The cooked ham muscles were placed in a 36°F. cooler for 30 minutes, then they were brought to room temperature for subsequent taste panel evaluation.

Twelve bacon slices, 3-mm in thickness, were removed from the anterior portion of the bacon beginning at the last rib. The slices were roasted at 350°F. to medium doneness, as estimated visually. The bacon was allowed to cool to room temperature before taste panel testing.

One-inch thick pork chops were cut from the center and blade end of loins from the right side of the carcass. Three chops, one each from the blade end, 9th rib, and 12th rib, were thawed at 36°F. for 12 hours. The chops were deep-fat fried at 300°F. to an internal temperature of 170°F. They were stored at 36°F. for 24 hours before subsequent tenderness evaluation by the Warner-Bratzler shear method.

The remaining portions of the loin were cut into 1-inch thick chops and thawed at 36°F. for 12 hours. They were weighed to the nearest gram and roasted at 300°F. to an internal temperature of 170°F. After cooking, the chops were blotted dry and weighed to the nearest gram. Cooking losses were then calculated. The chops were cooled at 36°F. for 15 minutes, after which they were brought to room temperature before taste panel testing.

Taste Panel Procedure

Samples were evaluated by a 12-member taste panel. The judges were picked at random for each session. Panels were conducted during mid-morning and/or mid-afternoon, and only one type of meat was evaluated during any one session. Not more than 6 samples were presented to each judge at any one sitting. All samples were coded in such a manner that panelists could not compare scores. Judges were given no information regarding the samples and were asked to evaluate each sample independently of the others. The scoring system used was the 9-point hedonic scale where 1 = dislike extremely and 9 = like extremely. The judges were requested to indicate the description most accurately describing their taste sensation on the evaluation sheet provided (Appendix L and M).

The hams and bacons were evaluated only for overall acceptability. The pork chops were evaluated for tenderness, flavor, juiciness, and

overall acceptability.

Shear Values

Cores 1/2-inch in diameter were removed from the L. dorsi muscles of deep-fat fried pork chops. Each core was cut parallel to the direction of the muscle fibers. Two to 5 cores were removed from each chop, the number of cores being dependent on the size of the muscle. Care was taken to avoid the inclusion of large pieces of connective tissue or fat. Three shear values were obtained from each core using the Warner-Bratzler shear apparatus. Mean shear values were calculated by averaging all readings obtained from the three chops.

Consumer Acceptance

A study of the consumer acceptance of fresh-frozen cuts representing the 4 slaughter weight groups was conducted at the University Meats Laboratory. The cuts studied were 7-rib loin roasts, Boston butt roasts, and center-cut loin chops. All cuts were uniformly trimmed to about 1/4 inch of fat covering. The cuts were weighed to the nearest 0.1 pound and packaged in transparent bags. Four chops from each loin were packaged together in such a manner that the loin eye muscles were visible. The roasts were packaged singly and were coded to provide the following information: (1) the slaughter weight group; and (2) the ranking of the cut within its respective slaughter weight group according to the individual weight for the roasts or the area of loin eye for the chops.

The sale of the cuts was advertised on the University campus, and was conducted in 3 sessions with one for each of the 3 cuts. Each session was completed before commencing with another.

The cuts were presented in an open top display case which was held at 0°F. Twelve cuts were randomly arranged in the case so that there

were 3 cuts from each slaughter weight group. All cuts were priced the same per pound regardless of their weight group. The lightest roasts or the chops having the smallest loin eye areas from each weight group were displayed first. As a cut was selected and removed from the display case, it was replaced by another from its corresponding group.

Each person was allowed to complete his selection(s) prior to admitting the next respondent. Each respondent was limited to 2 selections. When the selection was made, the respondent was asked to fill out the questionaire provided (Appendix N), and the display case was replenished. The session was terminated when all of the cuts from any one of the slaughter weight groups were sold.

Water-holding Capacity

Two methods of determining water-holding capacity were compared using fresh, unground L. dorsi muscle from adjacent loin chops. Each of the 80 loins were studied using Method I. Later in this study, Method II was developed and 56 loins were evaluated by it. Both methods of determination utilized the filter paper-press technique.

Method I: This method employed a hand press similar to that described by Grau and Hamm (1953). The calculation of water-holding capacity was a modification of the method described by Weirbicki and Deatherage (1958).

The press consisted of two 6 x 2 1/2 x 3/8 inch steel plates joined by 2 thumbscrews. Two 6 x 2 1/2 x 1/4 inch Plexiglas plates were placed between the steel plates. A freshly-cut 200- to 400-mg. sample was weighed to the nearest 0.1 mg. The sample was placed on a 9-cm. No. 1 Whatman filter paper, which had been held in a desiccator over saturated potassium chloride solution in order to maintain a constant moisture

content. The filter paper and meat sample were then placed between the Plexiglas plates and the press was tightened by hand. The sample was pressed for a period of 5 minutes. During pressing, the meat formed an almost circular film (meat film), whereas, the expelled water was absorbed by the filter paper forming a circular area (free moisture area) around the meat film.

Immediately after pressing, the Plexiglas plates and the meat sample were removed. The meat film area was traced with a pencil on the opposite side of the filter paper since the meat film usually adhered to the upper plate. It was not necessary to trace the free moisture area as the juice permanently stained the filter paper. The paper was then removed from the plate and the total area and the meat film area were subsequently measured by a planimeter in the manner previously described for loin eye area. The free moisture area was obtained by subtracting the meat film area from the total area. The total moisture (mg.) in the sample was determined by oven drying as previously described.

In order to estimate the weight (mg.) of free moisture per unit area (sq. in.) of free moisture after pressing, a regression equation was calculated by the following procedure. Forty grams of frozen and thawed loin eye muscle, which had been ground in the manner previously described, was placed in a 125 ml. centrifuge bottle. The sample was warmed at room temperature for 30 minutes and then centrifuged at 2000 rpm for 30 minutes. The juice was decanted from the bottle, filtered through No. 1 Whatman filter paper, and the clear juice stored at 36°F. for 2 hours. The moisture content of the juice was found to average 85.26 percent as determined by the oven drying method previously described. The juice was then transferred, dropwise, in increasing amounts on tared No. 1

Whatman filter paper, weighed to the nearest 0.1 mg., and pressed under standardized conditions. The areas of pressed juice were measured by planimeter and tabulated along with the corresponding weight of water in the juice (Appendix O). The latter was obtained by multiplying the juice weight by 85.26 percent. The free moisture area was related to the weight of the free moisture in the juice by the following equation:

$$\hat{Y} = bX + a \pm s_{x \cdot y}$$

where:

$\hat{Y}$ = estimated mg. of free moisture
b = 52.02
a = -1.92
$s_{x \cdot y}$ = ±4.12

Thus, the equation of the line (figure 1) may be written as:

$$\hat{Y} = 52.02\ X - 1.92 \pm 4.12$$

Water-holding capacity (Method I), expressed in terms of free moisture, was calculated according to the following formula:

$$\%\ \text{Free moisture} = \frac{(\text{total area - meat film area}) \times 52.02}{\text{total moisture (mg.) in muscle sample}} \times 100$$

Method II

In method II, a hydraulic press having plates with relatively large surface areas was employed for the direct determination of meat film weight. From this weight and that of the initial sample, the weight of the expressed juice was determined by difference. This approach had several distinct advantages: (1) sample size could be markedly increased and, therefore, reduce sampling errors; (2) the pressure applied could be more accurately controlled; and (3) the time required for the calculation of percent free moisture was reduced to where results could be immediately compared.

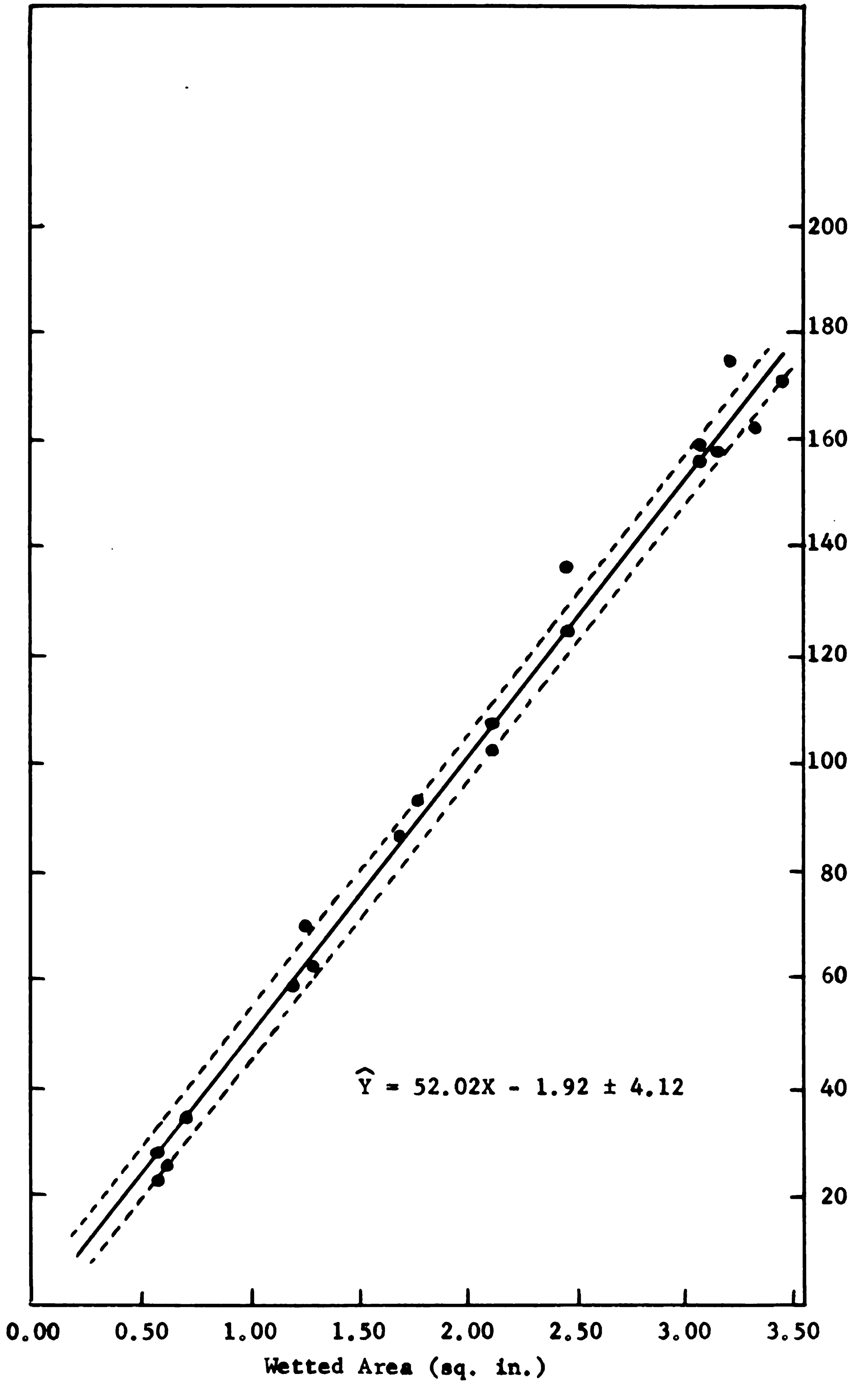

Figure 1. Relationship of free moisture (mg.) to wetted area (sq. in.).

A Carver Press was modified by the replacement of the original 6 x 6 inch plates with circular plates having a useable surface of 12 inches in diameter. A pressure gauge calibrated from 0 to 20,000 psi was used.

Six to 8 gram sections of the L. dorsi were removed from each chop and weighed to the nearest .0001 gram. Each sample was placed between two, 18.5 cm. No. 1 Whatman filter papers. The filter papers and meat sample were pressed between two 17 x 11 x 1/4 inch Plexiglas plates at an initial pressure of 4500 psi. The sample was pressed for 5 minutes, during which, the pressure slowly lowered to about 3900 psi. After pressing, the filter papers containing the pressed sample were removed. Using scissors, the excess filter paper, which included the wetted area, was cut away from the meat film area. The meat film-filter paper disk was immediately weighed to the nearest .0001 gram. After weighing, the area of the meat film was traced on a clean, dry filter paper, cut out and weighed. This weight was multiplied by 2 and subtracted from the weight of the filter paper-meat film disk to estimate the weight of the meat film alone.

Percentage of free moisture was calculated according to the following formula:

$$\text{\% free moisture} = \frac{(\text{Wt. of muscle sample - wt. of meat film})\text{x}85.26}{\text{Total moisture (grams) in muscle sample}} \text{ x } 100$$

The pH of the chops used in methods I and II were measured in the same manner as described for surface color measurement.

Statistical Analysis

Analysis of variance, simple correlation coefficients, standard deviations and predicting equations were computed as outlined by Snedecor

(1959). Multiple range and Multiple F Test Tables (Duncan, 1955) were used for testing significance between means.

RESULTS AND DISCUSSION

Carcass Cut-out Value

For the purpose of clarity, the carcass measures and cut-out data are discussed on a basis of the effects of slaughter weight, breed and sex. The tables of mean squares from the analysis of variance are given in the Appendix (Tables P through S). The significance of differences between means was tested by Duncan's Multiple Range Test.

Effect of Slaughter Weight: The effect of slaughter weight on various carcass measurements and cut-out values is shown in table 2. The data show that as slaughter weight decreased, both hot and cold dressing

Table 2. Duncan's Multiple Range Test -- Effect of slaughter weight group on carcass cut-out value.[1/]

	Weight groups			
	I (200#)	II (170#)	III (140#)	IV (110#)
Hot dressing %	75.8	75.5	74.3	72.7
Cold dressing %	73.5	73.0	71.7	69.9
% lean cuts, live	39.2[2/]	39.7	40.7[2/]	40.1
% lean cuts, carcass	53.2	54.4	56.9	57.5
% primal cuts, live	48.5	48.9	49.2	48.2
% primal cuts, carcass	65.9	67.1	68.8	69.0
Backfat thickness (in.)	1.5	1.3	1.2	0.9
Carcass length (in.)	30.4	28.9	27.0	25.6
Loin eye area ($in.^2$)	3.8	3.5	3.2	2.8

1/Means underscored by same solid line are not significantly different at P < .05.
Means underscored by same broken line are not significantly different at P < .01.
2/The means of groups I and III are significantly different (P < .05).

percentage decreased. The differences were highly significant except for those between groups I and II.

As slaughter weight decreased, there appeared to be a slight trend for an increased percentage of lean cuts on the live basis. A significant difference was observed between group I and group III, however, no significant differences were found between groups I, II and IV. When based on carcass weight, there was a definite increase in percentage lean cuts due to lowered slaughter weight, although the differences between groups I and II were not significant. No trend nor significant differences were found between means of percentage primal cuts based on live weight. It appears that the inclusion of the belly with the 4 lean cuts (ham, loin, Boston butt, picnic shoulder) eliminated the slight trend observed in percentage lean cuts, live basis. There was an increase in percentage primal cuts based on carcass weight as slaughter weight decreased. However, the differences were not as pronounced as those found between the percentage lean cuts, carcass basis. Again, this was probably due to the inclusion of the belly with the 4 lean cuts.

Slaughter weight had a highly significant effect on backfat thickness, carcass length and loin eye area (table 2). As slaughter weight was lowered, the corresponding reduction in carcass fatness was reflected by the decrease in backfat thickness from 1.5 inches to 0.9 inches. The animals in group IV were slaughtered at an age approximately 3 months younger than those in group I, and as a result, were nearly 5 inches shorter in carcass length. The reduction of slaughter weight markedly reduced loin eye area from 3.8 square inches in group I to 2.8 square inches in group IV.

<u>Effect of Breed</u>: Table 3 presents the effect of breed on various carcass measurements and cut-out values. The crossbred hogs produced carcasses that were higher ($P < .01$) in dressing percentage when calculated on both the hot and cold carcass weights. No significant differences were observed due to breed in percentage of lean cuts, live or carcass basis, nor in percentage primal cuts, live basis. However, the carcasses from Yorkshire hogs produced a significantly higher percentage of primal cuts when based on carcass weight.

Table 3. The effect of breed on carcass cut-out value; from analysis of variance.[1/]

	Yorkshires	Crossbreds	
Hot dressing %	73.8	75.3	**
Cold dressing %	71.4	72.7	**
% lean cuts, live	39.9	40.0	
% lean cuts, carcass	55.9	55.0	
% primal cuts, live	48.6	48.8	
% primal cuts, carcass	68.2	67.1	*
Backfat thickness (in.)	1.2	1.2	
Carcass length (in.)	28.6	27.6	**
Loin eye area (in.^{2})	3.2	3.4	*

1/ * $P < .05$
** $P < .01$

No difference was noted in backfat thickness between the 2 breed groups, although the Yorkshire hogs are generally considered to be a leaner breed than those breeds from which the crossbred hogs were largely derived (Hampshire, Chester White, Duroc). The greater ($P < .01$) carcass

length exhibited by the Yorkshires was expected as the breed is noted for its body length. The crossbred hogs excelled the Yorkshires in loin eye area with 3.4 compared to 3.2 square inches. The difference was statistically significant.

Effect of Sex: Differences in various carcass measurements and cut-out values between carcasses from barrows and gilts are shown in table 4. Although no significant differences due to sex were observed in either hot or cold dressing percentages, the carcasses from gilts excelled those from barrows in most other respects. The percentages of lean cuts based on both live and carcass weight were higher ($P < .01$) in carcasses from gilts. Carcasses from gilts produced higher ($P < .01$) percentages of

Table 4. The effect of sex on carcass cut-out value; from analysis of variance.1/

	Barrows	Gilts	
Hot dressing %	74.3	74.8	
Cold dressing %	71.8	72.2	
% lean cuts, live	39.0	40.9	**
% lean cuts, carcass	54.3	56.7	**
% primal cuts, live	47.9	49.5	**
% primal cuts, carcass	66.8	68.6	**
Backfat thickness (in.)	1.3	1.1	**
Carcass length (in.)	27.9	28.4	**
Loin eye area (in.^{2})	3.0	3.6	**

1/ * $P < .05$
** $P < .01$

primal cuts on both the live and carcass bases. The gilts had less ($P < .01$) backfat thickness and were longer ($P < .01$) in carcass length. The gilts also produced carcasses having 0.6 square inches larger ($P < .01$) loin eye areas than the barrows. The overall superiority of carcasses from gilts, as indicated in this study, is in agreement with the findings of many workers (Fredeen and Lambroughton, 1956; Bruner *et al*., 1958; Wallace *et al*., 1959).

Chemical Analysis of the Rough Ham and Loin Eye Muscle

The following discussion is based on the effects of slaughter weight, breed and sex on the percentages of protein, ether extract, and moisture as indicated by analysis of variance and Duncan's Multiple Range Test. The mean squares from analysis of variance are presented in Appendix T.

Effect of Slaughter Weight: Table 5 shows the results of chemical analysis of the rough ham and *L. dorsi*. The effect of slaughter weight on percentage protein was similar for both the ham and *L. dorsi*. Highly significant differences were noted between all groups other than adjacent groups.

As slaughter weight was lowered, the percentage ether extract in the ham decreased. Although the differences between the 2 heaviest weight groups and those between the 2 lightest weight groups were not significant, all other differences were significant at the $P < .01$ level. The percentage of ether extract in the *L. dorsi* decreased with the reduction of slaughter weight, however, the differences were not significant. This would indicate that the animals had attained nearly as much marbling in the loin eye muscle at 100 pounds as they attained at 200 pounds. As slaughter weight decreased, percentage moisture in the ham increased.

Although no significant difference was observed between groups I and II, a difference significant at the P < .05 level was found between groups III and IV. All other differences were highly significant.

There was a trend for percentage moisture in the *L. dorsi* to increase with lowered slaughter weight, although no significant differences were observed between groups I and II, and between groups III and IV.

Table 5. Duncan's Multiple Range Test -- Effect of slaughter weight on the chemical analysis of the rough ham and the *L. dorsi*.1/

	Weight groups			
	I (200#)	II (170#)	III (140#)	IV (110#)
Rough ham				
% protein	15.6	16.0	16.5	16.9
% ether extract	30.5	28.7	25.1	23.2
% moisture	52.9	54.4	57.2	59.1
L. dorsi				
% protein	21.8	21.8	21.2	21.3
% ether extract	3.0	2.6	2.2	2.2
% moisture	73.3	73.7	74.4	74.5

1/Means underscored by same solid line are not significantly different at P < .05.
Means underscored by same broken line are not significantly different at P < .01.

Effect of Breed: It may be seen in table 6 that breed differences had a marked effect on the chemical composition of the carcasses as indicated by analysis of the rough hams and *L. dorsi* muscles. Percentage protein was higher (P < .01) in both the hams and loin eye muscles of carcasses from the Yorkshire hogs. This appears to be partially due to

the higher percentages of ether extract found in the hams ($P < .05$) and loin eye muscles ($P < .01$) of the crossbred hogs. The difference in the fat content of the L. dorsi was especially noteworthy. The crossbred hogs contained over twice as high a percentage of ether extract in the L. dorsi muscle as did the Yorkshire hogs. Thus, the muscles of crossbred hogs presumably contained a greater amount of visible marbling. No significant differences due to breed were noted in the moisture content of the hams or loin eye muscles.

Table 6. The effect of breed on the chemical analysis of the rough hams and loin eye muscles.

	Yorkshires	Crossbreds	
Ham:			
% protein	16.9	15.6	**
% ether extract	25.7	28.1	*
% moisture	56.4	55.3	
L. dorsi			
% protein	22.6	20.5	**
% ether extract	1.6	3.4	**
% moisture	73.8	74.1	

* $P < .05$
** $P < .01$

Effect of Sex: The effects of sex on the chemical analysis of the rough hams and L. dorsi are presented in table 7. The hams from carcasses of gilts were higher ($P < .01$) in percentage of both protein and moisture, whereas, barrows produced carcasses with hams containing a higher ($P < .01$) percentage of ether extract. Chemical analysis of the L. dorsi showed no

significant differences in percentage of protein or percentage of moisture. However, the generally greater leanness of gilts as against barrows is reflected in the significantly lower percentage of ether extract contained in the loin eye muscles from the carcasses of gilts.

Table 7. The effect of sex on the chemical analysis of the rough hams and loin eye muscles.

	Barrows	Gilts	
Ham:			
% protein	15.8	16.7	**
% ether extract	28.5	25.3	**
% moisture	54.7	57.0	**
L. dorsi			
% protein	21.4	21.6	
% ether extract	2.9	2.1	*
% moisture	73.9	74.1	

* $P < .05$
** $P < .01$

Physical Separation of the Rough Ham

The effects of slaughter weight, breed and sex on the physical separation data were determined by testing the significance of differences between means by analysis of variance and Duncan's Multiple Range Test. The mean squares from the analysis of variance are presented in Appendix U.

Effect of Slaughter Weight: Table 8 depicts the effect of slaughter weight on the physical separation of the rough ham. As slaughter weight was decreased, the percentage of bone increased, although the difference

between the 2 lightest weight groups was not significant. Percentage of lean increased as slaughter weight decreased, however, the differences between groups I and II and between groups III and IV were not significant. Reduction of slaughter weight resulted in a corresponding reduction of fat, although again, the differences between the 2 lightest groups were not significant. No significant difference due to slaughter weight was observed in percentage of skin. These results indicate that as

Table 8. Duncan's Multiple Range Test -- Effect of slaughter weight on the physical separation data of the rough ham.[1/]

	Weight groups			
	I (200#)	II (170#)	III (140#)	IV (110#)
% bone	7.9	8.8	9.6	10.0
% lean	58.2	59.9	62.4	63.5
% fat	29.5	27.4	23.9	22.0
% skin	3.9	3.9	4.2	4.5
% lean (fat-free)	83.1	82.5	81.9	81.4
% fat (lean-free)	71.4	68.3	63.4	60.3

1/Means underscored by same solid line are not significantly different at $P < .05$;
Means underscored by same broken line are not significantly different at $P < .01$.

slaughter weight was increased, the rough hams decreased in percentage of lean and increased in percentage of fat. This is true when the percentages of the individual components are based on the weight of the entire ham. These results do not imply that as an animal matures, it will contain less total muscling. When percentage of lean was calculated on the fat-free basis (table 8), the effect of slaughter weight changed in 2

respects: (1) differences between weight groups became non-significant, and (2) there was a trend for an increase in percentage of lean with increased slaughter weight. When percentage of fat was calculated on the lean-free basis, the increase in fat corresponding with slaughter weight became even more evident.

A relatively high relationship between percentage of separable lean of the ham and percentage of lean cuts, carcass basis, was found ($r = 0.81$). It was interesting to note that when percentage of separable fat was compared to percentage of lean cuts, a slightly higher correlation ($r = 0.86$) was obtained.

Effect of Breed: The effects of breed on the physical separation data of the rough ham are presented in table 9. The Yorkshire hogs produced hams having a higher ($P < .01$) percentage of bone than the hams from the crossbred hogs. Although the differences were not significant, there was a trend towards higher percentages of lean in the hams from the Yorkshire hogs, and higher percentages of fat in the hams from the crossbred hogs.

Table 9. The effect of breed on the physical separation data of the rough ham.

	Yorkshires	Crossbreds	
% bone	9.7	8.7	**
% lean	61.4	60.3	
% fat	25.0	26.4	
% skin	3.9	4.3	

** $P < .01$

Effect of Sex: Table 10 illustrates the effect of sex on the physical separation data of the rough hams. There was no significant difference in the percentage of bone attributable to sex. However, the hams from gilts were distinctly more desirable in terms of leanness. The gilts produced hams that were markedly leaner ($P < .01$) and lower in fat ($P < .01$). No significant differences were found between percentages of skin.

Table 10. The effect of sex on the physical separation data of the rough hams.

	Barrows	Gilts	
% bone	9.27	9.12	
% lean	59.19	68.80	**
% fat	27.51	23.86	**
% skin	4.02	4.20	

** $P < .01$

Smoked Hams and Bacons

The effects of slaughter weight, breed and sex were determined by testing the significance of differences between means by analysis of variance and Duncan's Multiple Range Test. The mean squares from the analysis of variance of the percentages of smoked yields and the taste panel evaluation data are presented in Appendix V.

Effect of Slaughter Weight: The effects of slaughter weight on the taste panel scores and the smoked yields of the hams and bacons are presented in table 11. No significant differences due to slaughter weight were observed in either the hams or the bacons. The taste panel gave an

average rating of at least "7" (like moderately) for samples of both products regardless of the slaughter weight groups from which they originated.

Table 11. Duncan's Multiple Range Test -- Effect of slaughter weight on taste panel scores and smoked yields of hams and bacons.[1/]

	Weight groups			
	I (200#)	II (170#)	III (140#)	IV (110#)
Taste panel				
Hams	7.1	7.3	7.2	7.4
Bacons	7.1	7.0	7.0	7.1
% yield				
Hams	100.3	99.5	98.5	99.5
Bacons	83.2	83.1	81.6	78.3

1/Means underscored by same solid line are not significantly different at $P < .05$.

The smoked yields of the hams were not significantly different between weight groups. The hams had average final yields approaching 100 percent, which commercial packers nomally try to attain. In the case of the bacons, there was a trend for lower yields as slaughter weight decreased. However, no significant differences were observed in the smoked yields of bacons from groups I, II and III, with yields ranging from about 81 to 83 percent. The yield of bacons from group IV, the lightest weight group, was only 78.3 percent, a reduction in yield which was significant at the $P < .01$ level. The decrease in yield was probably due to the extreme thinness (approximately 3/4 inch) of the bacons of this group, which resulted in an increased surface area per unit of weight.

Effect of Breed: Table 12 depicts the effect of breed on the taste panel evaluation and smoked yields of hams and bacons. No significant differences were observed due to breed between taste panel scores of hams or bacons, nor between the smoked yields of the hams. However, the smoked yields of the bacons from carcasses of Yorkshire hogs were decidedly lower ($P < .01$) than those from the crossbred hogs.

Table 12. The effect of breed on the taste panel scores and smoked yields of hams and bacons.

	Yorkshires	Crossbreds	
Taste panel			
Hams	7.2	7.3	
Bacons	7.1	7.0	
% yield			
Hams	98.9	100.0	
Bacons	78.8	84.2	**

** $P < .01$

Effect of Sex: The effects of sex on the taste panel scores and smoked yields of hams and bacons are presented in table 13.

No significant differences were noted in taste panel evaluation of hams and bacons from carcasses of barrows and gilts. The difference between the smoked yields of hams from carcasses of barrows and gilts was not significant. However, it was found that bacons from carcasses of barrows had a significantly higher smoked yield than the bacons from carcasses of gilts. This was probably due to the barrows being generally fatter than the gilts, and thus producing thicker bellies which appear to shrink less during the smoking process.

Table 13. Taste panel scores and smoked yields of hams and bacons from carcasses of barrows and gilts.

	Barrows	Gilts	
Taste panel:			
Hams	7.2	7.3	
Bacons	7.1	7.0	
% yield			
Hams	99.8	99.1	
Bacons	82.9	80.2	*

* $P < .05$

Palatability and Cooking Losses of Fresh Pork Chops

The effects of slaughter weight, breed and sex on the taste panel scores, Warner-Bratzler shear values, and percentages of cooking loss were determined by testing the significance of differences between means by analysis of variance and Duncan's Multiple Range Test. The mean squares from the analysis of variance of palatability and cooking losses appear in Appendix W.

Effect of Slaughter Weight: Table 14 presents the effects of slaughter weight on the palatability and cooking loss data of fresh pork chops. It was found that slaughter weight had no significant effect on the tenderness of roasted pork chops as evaluated by the taste panel, nor on the tenderness of deep-fat fried chops as measured by the Warner-Bratzler shear. Therefore, although the animals in group I were about 3 months older than those in group IV, this age difference apparently had no effect on tenderness. The differences due to slaughter weight in flavor, juiciness and overall acceptability were all non-significant.

The lack of significant differences in percentage of cooking losses is probably due to the lack of variation of the fat content of the L. dorsi muscles between the 4 weight groups. Thus, a reduction in slaughter weight to as low as 100 pounds did not produce any appreciable differences in the overall palatability or cooking losses from fresh loin chops.

Table 14. Duncan's Multiple Range Test -- Effect of slaughter weight on the palatability and percentage of cooking losses of fresh pork loin chops.1/

	Weight groups			
	I	II	III	IV
	(200#)	(170#)	(140#)	(110#)
W-B shear	8.6	8.8	8.4	8.4
Taste panel				
Tenderness	7.0	6.7	7.0	6.7
Flavor	6.8	6.6	6.8	6.5
Juiciness	6.7	6.6	6.9	6.6
Overall	6.8	6.5	6.7	6.5
Cooking loss (%)	20.6	20.5	20.1	20.7

1/Means underscored by the same solid line are not significantly different at $P < .05$.

Effect of Breed: Table 15 illustrates the effect of breed on the palatability and the percentage of cooking losses of the fresh pork chops. The Yorkshire hogs produced loin chops that were superior in tenderness ($P < .01$) to those of the crossbred hogs when tested by either the Warner-Bratzler shear or by taste panel. It had been previously shown that the loin eye muscles of the crossbred hogs contained over twice the amount of fat as did the Yorkshire hogs. Thus, it appeared that the relation-

ship between the fat content of the muscles and tenderness was low. This was found to be true as indicated by the correlation coefficient of 0.27 between percentage of ether extract and taste panel tenderness scores. The results do indicate that the differences in tenderness of the animals studied may be primarily due to heritability. No significant differences due to breed were found in flavor or juiciness. However, there was a trend for the taste panel to rate the chops from the crossbred hogs somewhat higher in both instances.

Table 15. Effect of breed on various palatability characteristics and cooking losses of fresh pork loin chops.

	Yorkshires	Crossbreds	
W-B shear	8.1	9.0	**
Taste panel			
Tenderness	7.1	6.5	**
Flavor	6.6	6.7	
Juiciness	6.6	6.8	
Overall acceptance	6.5	6.8	**
Cooking losses (%)	19.2	21.8	**

** $P < .01$

It was found that the chops from the crossbreds were rated significantly ($P < .01$) higher in overall acceptance than those from the Yorkshires. This general preference for the chops from the crossbred hogs occurred even though the same chops were rated lower in tenderness than those from the Yorkshire hogs. Thus, it appears that flavor, juiciness and perhaps other unspecified palatability factors were more important from the standpoint of acceptance than the differences occurring in tenderness. Cooking losses were significantly ($P < .01$) greater in the case of chops from the crossbred hogs. This may have been due to the higher content of intramuscular fat in the chops from the crossbred hogs, resulting in an increased rendering of fat from the tissues. It may also have been due to the chops from crossbred hogs having larger loin eye muscles and, thus, more surface area of lean exposed for moisture loss.

Effect of Sex: The effects of sex on the palatability and percent cooking losses of fresh pork chops are presented in Table 16. The differences were highly significant when tenderness was measured by the Warner-Bratzler shear. Although the differences in taste panel scores were not significant, there was a slight difference in tenderness in favor of the barrows. Thus, the chops from the carcasses of barrows appeared to be somewhat more tender than those from the carcasses of gilts.

Table 16. Effect of sex on various palatability characteristics and cooking losses of fresh pork loin chops.

	Barrows	Gilts	
W-B shear	8.1	9.1	**
Taste panel			
Tenderness	7.0	6.7	
Flavor	6.6	6.7	
Juiciness	6.6	6.7	
Overall acceptance	6.7	6.6	
Cooking losses (%)	20.2	20.8	

** $P < .01$

No significant differences due to sex were found in panel evaluation of juiciness or flavor. The difference in overall acceptability was not statistically significant as would be expected by the proximity of the two means (6.7 vs. 6.6 for barrows and gilts, respectively). In general, it does not appear that sex influenced palatability to any appreciable extent. The differences in cooking loss due to sex were not significant, although they were slightly higher in the case of the gilts. This is somewhat surprising in view of the fact that the barrows were somewhat fatter and had more marbling. On the other hand, the area of the loin eye was larger for the gilts and may have more than compensated for the greater amount of fat in the chops from barrows.

Surface Color of Fresh Pork Chops

The effects of slaughter weight, breed and sex on the surface color measurements were determined by testing the differences between means by analysis of variance and Duncan's Multiple Range Test. The mean squares from the analysis of variance of hue, value and chroma appear in Appendix X.

Effect of Slaughter Weight: The effects of slaughter weight on the renotations of hue, value and chroma are shown in table 17. No significant differences in hue were observed due to slaughter weight. Thus, the actual color of the muscles did not vary between weight groups. No significant differences were observed in the renotations of value between weight groups. Therefore, slaughter weight had no effect on the degree of lightness and darkness of the surface color measurements. However, significant differences due to slaughter weight were found between the renotations of chroma, that is, the concentration of hue. As slaughter

weight decreased, the values of chroma increased correspondingly. Although the differences in chroma between adjacent weight groups were not significant, all other differences were significant at the $P < .05$ level. In addition, the difference in chroma between the heaviest weight group (I) and the lightest weight group (IV) was significant at the $P < .01$ level. Thus, the changes in the total color of the muscles studied, appeared to be due to an increased intensity of hue or increased chroma as slaughter weight was increased. This change may have been due to an increase in the myoglobin content of the muscle fibers, although no specific measurements of myoglobin were made in this study to support this contention. However, Henry (1959), in a study with pork, found a highly significant correlation ($r = -.69$) between the index of fading of surface color renotations and the concentration of myoglobin in the loin eye muscle.

Table 17. Duncan's Multiple Range Test -- Effect of slaughter weight on the surface color renotations of hue, value and chroma of fresh pork chops.1/

	Weight groups			
	I (200#)	II (170#)	III (140#)	IV (110#)
Hue (YR)	6.04	6.02	6.36	6.64
Value	5.5	5.4	5.4	5.4
Chroma	3.33	3.27	3.09	2.97

1/Means underscored by same solid line are not significantly different at $P < .05$.
Means underscored by same broken line are not significantly different at $P < .01$.

Effects of Breed and Sex: The effects of breed and sex on the surface color of loin eye muscles is shown in table 18. It can be seen that no significant differences were found in color renotations due to either breed or sex.

Table 18. The effect of breed and sex on the surface color renotation values of the *L. dorsi* muscles from fresh pork chops.

	Breed[1/]		Sex[1/]	
	Yorkshires	Crossbreds	Barrows	Gilts
Hue (YR)	6.14	6.38	6.44	6.11
Value	5.38	5.48	5.50	5.36
Chroma	3.17	3.16	3.13	3.20

1/Differences were not significant at $P < .05$.

Water Holding Capacity -- Method I

The effects of slaughter weight, breed and sex on the water-holding capacity of loin eye muscle were determined by testing the differences between means by analysis of variance and Duncan's Multiple Range Test. The mean squares from the analysis of variance appear in Appendix Y.

Effect of Slaughter Weight: The effect of slaughter weight on the water-holding capacity of loin eye muscles as measured by Method I is presented in table 19. Although the percentages of free moisture in groups I and II are somewhat lower, and therefore, they are higher in water holding capacity than those values of groups III and IV, there was no significant difference due to slaughter weight.

Table 19. Duncan's Multiple Range Test -- The effect of slaughter weight on the water-holding capacity of the L. dorsi muscle.1/

	Weight groups			
	I (200#)	II (170#)	III (140#)	IV (110#)
% free moisture	55.74	55.24	57.29	58.61

1/Means underscored by the same line are not significant at $P < .05$.

Effects of Breed and Sex: The effects of breed and sex on the water holding capacity of the L. dorsi muscle are presented in table 20. Although the water holding capacity of the loin eye muscles from gilts was somewhat higher than that of the barrows, the difference was not significant. However, a highly significant difference was found due to breed. The loin eye muscles from the Yorkshire hogs contained only 51.9 percent free moisture versus 61.5 percent in muscles from the crossbreds, a large and highly significant difference.

Table 20. The effect of breed and sex on the water holding capacity of loin eye muscles of fresh pork chops as determined by Method I.

	Breed1/		Sex1/	
	Yorkshires	Crossbreds	Barrows	Gilts
% free moisture	51.93	61.50	57.29	56.14

1/The differences were not significant at $P < .05$.

Water Holding Capacity -- Method II

Due to the limited number of samples (56) for which the water holding capacity was determined by Method II, the results were not compared as to the effect of slaughter weight, breed or sex. The 56 samples were considered as a single group and their water holding capacity values were compared to those determined by Method I on corresponding samples.

The 2 methods were compared by calculating the standard deviations from the means of duplicate determinations. The standard deviations were used to indicate the repeatability of each method. The standard deviation of Method I was found to be ± 2.17 percent versus ± 1.08 percent for Method II. Thus, the ability to obtain repeatable results between replicated pressings was in favor of Method II.

A second comparison was made in order to determine if each method measured differences in water holding capacity in the same direction and to the same extent. A comparison of the corresponding data using the 2 methods produced a highly significant correlation of $r = .43$. Although this correlation coefficient was statistically significant, only 18.5 percent of the variation in water holding capacity as determined by one method was accounted for by a corresponding variation in the other.

Briskey *et al.* (1960b) reported significant correlations between the percent of expressible moisture and the pH of certain pork muscles. However, in other muscles the relationship was not significant. The correlation coefficients between water holding capacity and pH values for Methods I and II were found to be .51 ($P < .01$) and .30 ($P < .05$), respectively. Although the water holding capacity as determined by both methods correlated significantly with pH, neither correlation was particularly high.

Due to the limited number of determinations conducted using Method II, it is not felt that a full evaluation of its merit can be made at this time. Although the correlation between Methods I and II was not as high as might be considered desirable, the speed and repeatability of Method II would warrant further investigation of this procedure.

Consumer Preference Study

Effect of Slaughter Weight

The effects of slaughter weight on selection of frozen pork loin chops, Boston butt roasts and 7-rib loin roasts by consumers was studied. The effect of slaughter weight on selection is illustrated (figures 2, 3 and 4) by plotting the percentage of cuts sold per weight group against the percentage of total cuts sold. Thus, a curve was plotted for the cuts from each weight group which indicates the "rate" at which they were selected in relation to those cuts from the other weight groups.

In figure 2, the selection rates for pork chops are presented. The strongest preference was in favor of the chops from the heaviest group (1), however, it was followed by a nearly equal preference for chops from the lightest group (IV). Thus, it appears that the consumers had a definite preference for either relatively large chops or for relatively small chops. No particular trend in preference was indicated between the chops from groups II and III.

The respondents were asked to indicate on the questionaire (Appendix N) the reason or reasons for making their selections. Table 21 presents the number of times each factor was given as the basis of selection of the pork chops. Results show that the size of the cut and relative

Table 21. Basis for selection of pork chops

Reasons	Weight groups				Total responses
	I (200#)	II (170#)	III (140#)	IV (110#)	
Size of cut	11	6	5	10	33
Color of cut	5	2	3	2	12
Amount of fat	20	9	9	17	55
None of above	1	0	1	1	3

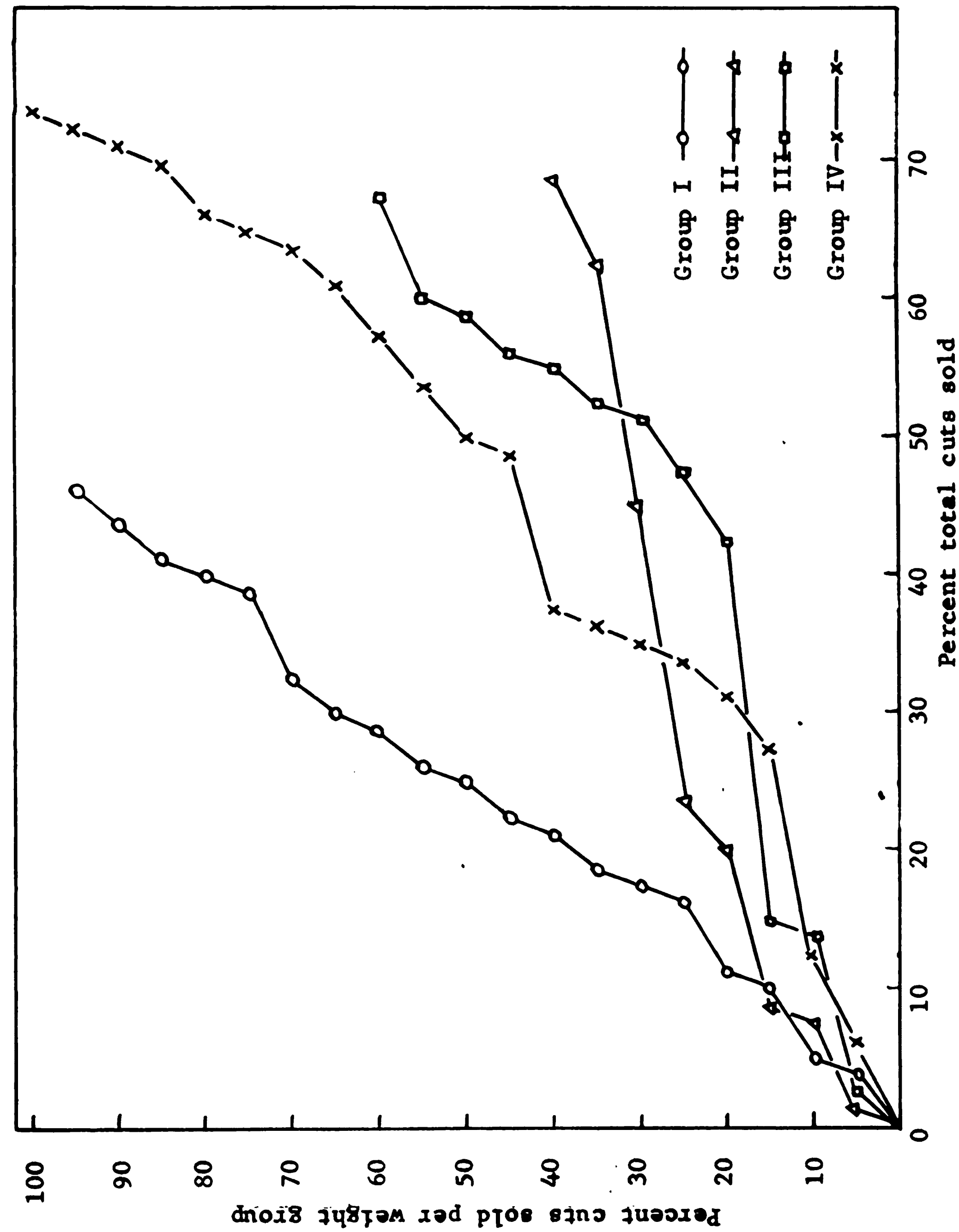

Figure 2. Rate of consumer preference - PORK CHOPS.

leanness were the fundamental reasons for selection. These factors seemed to be of equal importance in the selections from both groups I and IV. However, it is possible that the way in which the question was phrased or the order on the questionaire may have biased the respondents' answers. The question was phrased as follows:

"If your selection was based upon one or more of the following factors, please make a check beside it (or them)."

( ) Size (weight) of cut

( ) Color of cut

( ) Amount of fat

( ) None of above

Thus, the respondents may have been unintentionally led to believe that a "correct" selection should have been based on size, color, or fat content. Such was not intended, nor is it known that this was the case.

Figure 3 presents the data on consumer selection for Boston butt roasts. As in the case of the pork chops, strong preferences were shown for the cuts from the heaviest and lightest weight groups. However, in this instance, the preference was strongest for cuts from group IV. Once again, there was only a mild and generally equal preference for the cuts from groups II and III. Although the total number of cuts involved in this study were relatively small, the results do indicate that the consumers would purchase Boston butt roasts from hogs slaughtered at the extremely light weight of 100-120 pounds, and that the demand for the light-weight roasts was equal to that for roasts from hogs slaughtered at normal market weights.

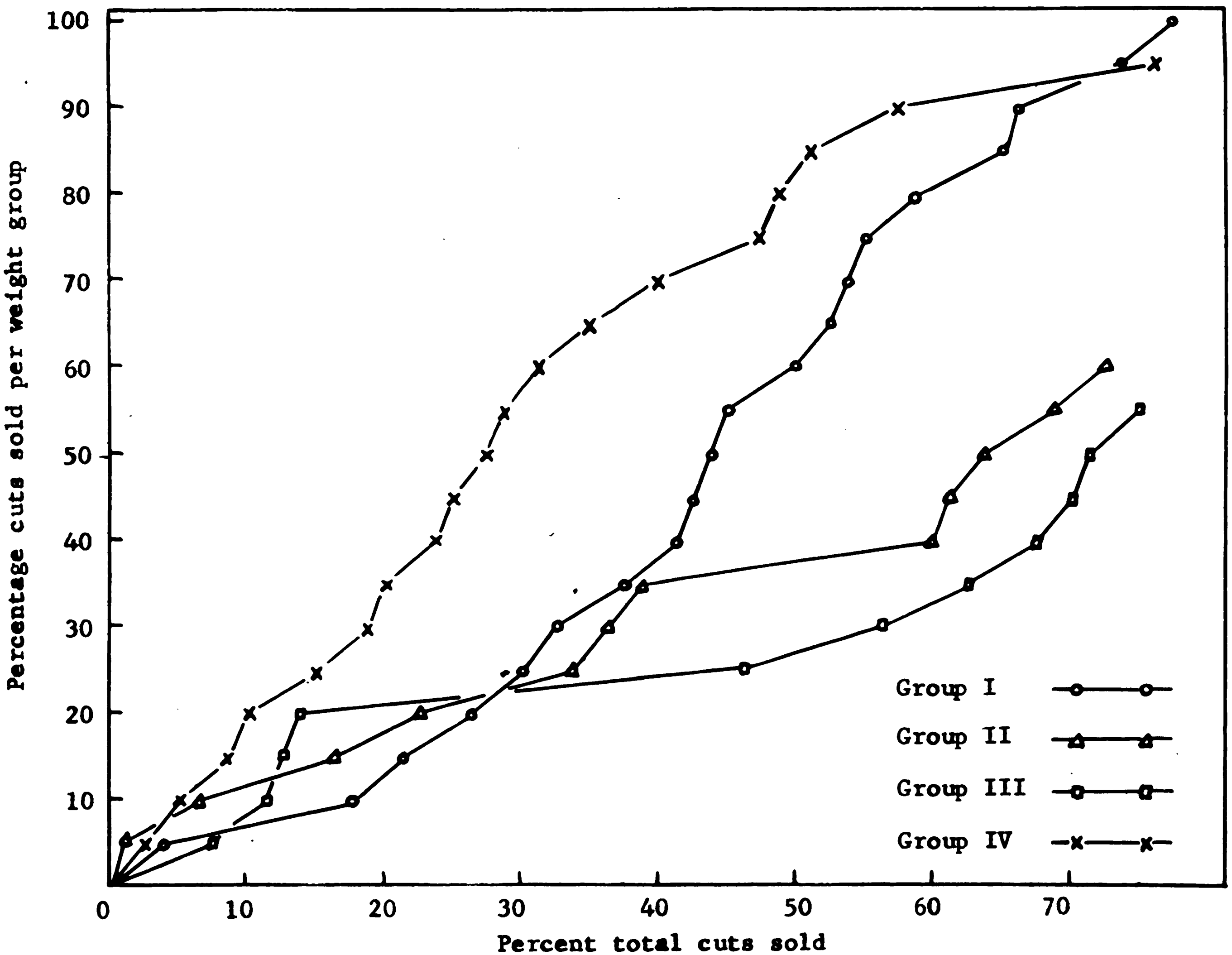

Figure 3. Rate of consumer preference - BOSTON BUTTS.

Table 22. Basis for selection of Boston butt roasts.

Reasons	I (200#)	II (170#)	III (140#)	IV (110#)	Total responses
	Weight groups				
Size of cut	15	9	9	12	45
Color of cut	8	4	1	5	18
Amount of fat	13	7	7	13	40
None of above	2	0	1	2	5

Table 22 suggests that the size of cut and amount of fat were the 2 factors which primarily influenced the selections of Boston butt roasts. Although the limitations of these data have been recognized, results indicate that the high preference which existed for the Boston butt roasts from the light-weight hogs (figure 3) was due in large part to their smaller size. Thus, the reduction in the size of certain pork cuts by the use of lower slaughter weight may be as important to certain consumers as would be the resulting increase in leanness.

Figure 4 illustrates the demand for 7-rib loin roasts from the 4 weight groups. It can be seen that the demand for these cuts is considerably different than that found for pork chops and butt roasts. A very strong preference was shown for cuts from the heaviest weight group. Only a mild preference was indicated for those cuts from groups II and III. There appeared to be a strong rejection of the cuts from group IV since only 1 cut from this group was selected out of the total of 31 roasts selected in this session.

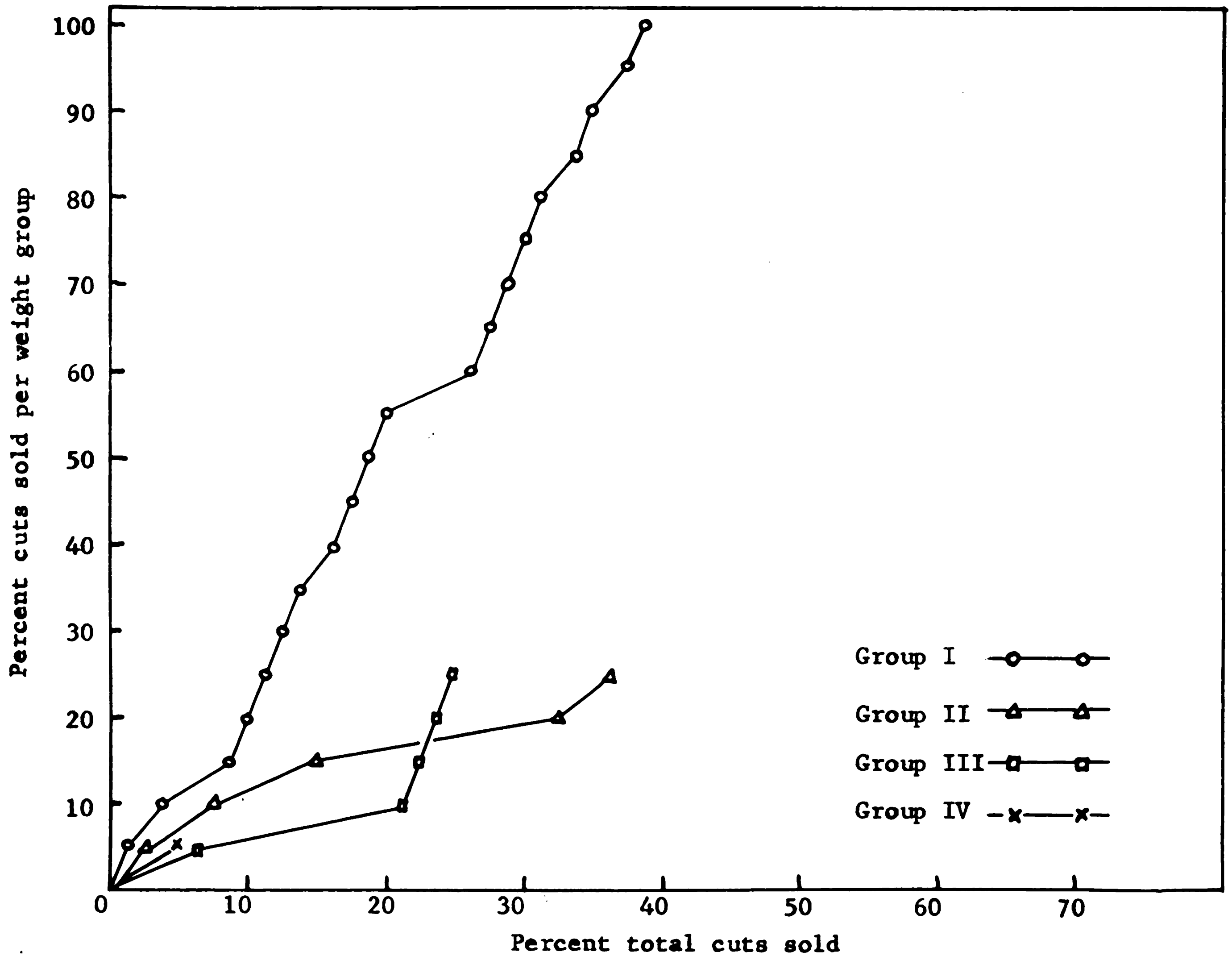

Figure 4. Rate of consumer preference - LOIN ROASTS.

Table 23. Basis for selection of loin roasts.

Reasons	Weight groups I (200#)	II (170#)	III (140#)	IV (110#)	Total responses
Size of cut	14	3	2	0	19
Color of cut	3	2	1	1	7
Amount of fat	14	4	4	0	22
None of above	2	0	0	0	2

The definite preference for loin roasts from carcasses of the heaviest weight group (figure 4) appears to have been due primarily to size and amount of visible fat as indicated in table 23. These data imply, therefore, that the rejection of the roasts from group IV was due to their small size. However, the manner in which the cuts were displayed may have been responsible in part for the preference against these cuts. The 3 lightest roasts from each weight group were presented in the display case at the start of the study. Therefore, if the cuts displayed from group IV remained unsold as a result of their size, then this method of presenting the cuts prevented the consumers from indicating their reaction to the heavier cuts from group IV. Possibly the heavier cuts would not have been considered as being so objectionable. However, the redeeming fact remains that only a slight preference was indicated for the cuts from groups II and III, these cuts being larger than the heaviest from group IV.

Effect of Family Size:

The effect of family size was studied by dividing the selection data into 3 groups on the basis of families consisting of 2, 3, or 4 or more

persons. The percentages of cuts sold per slaughter weight group were plotted against the total number of cuts sold per family group.

The effect of family size on the selection of pork chops is presented in figure 5. The numbers in parentheses at the top of the graphs represent the total number of cuts sold to each family group. Thus, only 16 cuts were sold to families which consisted of 2 persons. However, the respondents from this family size seemed to favor those cuts from the lightest slaughter weight group (IV). In families consisting of 3 persons, a preference for cuts from both the heaviest and the lightest slaughter weight group was indicated. When family size was increased to 4 or more persons, the majority of the respondents favored the cuts from the heaviest weight group, although a considerable preference for cuts from group IV was still evident. Therefore, it appeared that small families preferred the chops from the lightest carcasses, and as family size increased, the demand for the heavier cuts increased.

Figure 6 shows the effect of family size on the preference for Boston butt roasts. The respondents from the smallest sized family seemed to prefer the cuts from either the heaviest or lightest weight group with possibly a somewhat higher preference for those cuts from group IV. Although the data indicates that the respondents from families of 3 persons preferred the cuts from groups III and IV, an insufficient number (12) of cuts were involved to make any valid conclusions. As family size increased to 4 or more persons, nearly 50 percent of the total cuts sold were from group I, indicating a marked preference for cuts from the heaviest slaughter weight group. Thus, as with the pork chops, a definite demand for lighter butt roasts existed amongst small families, and the

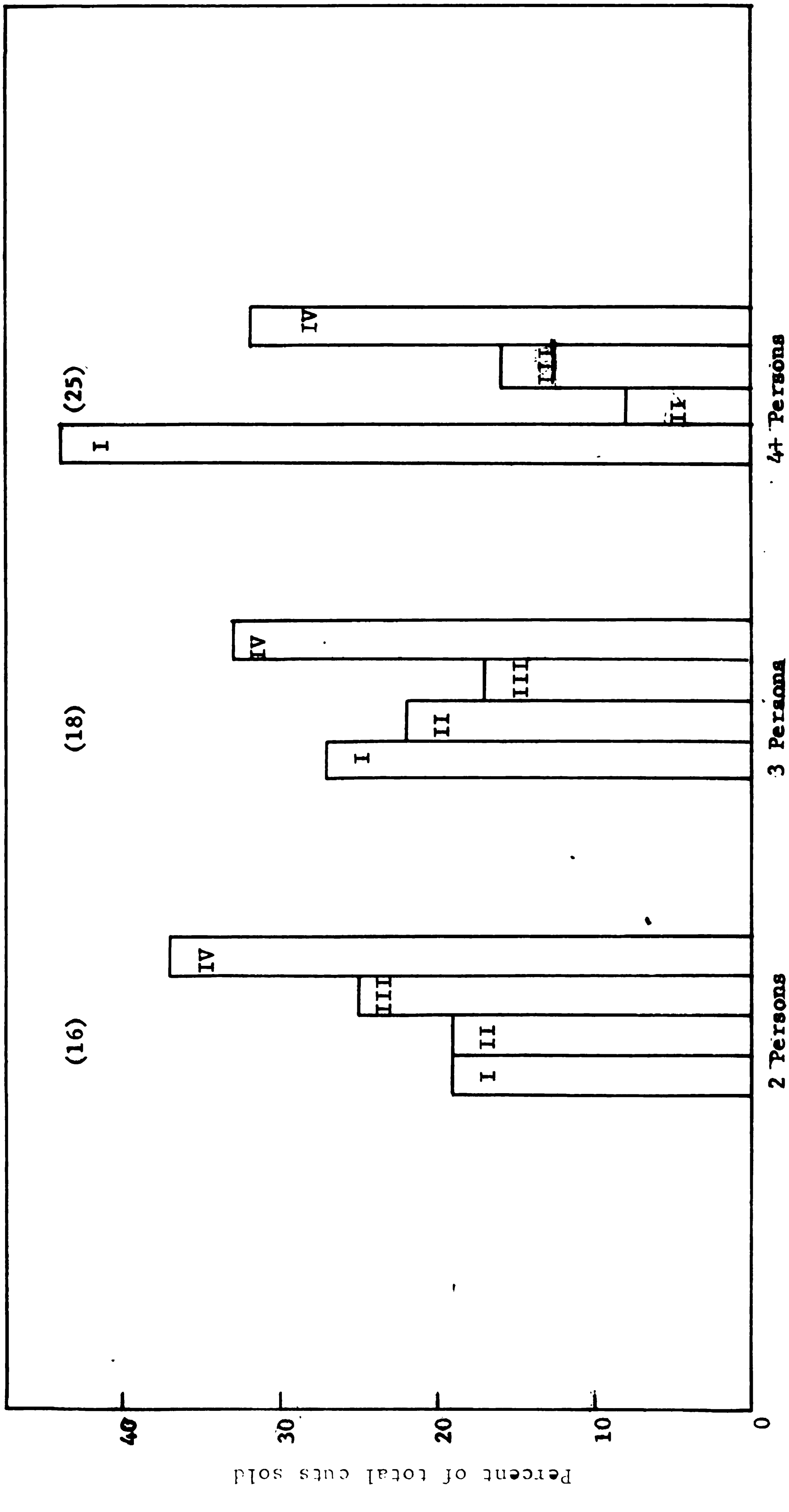

Figure 5. Consumer preference; effect of family size - PORK CHOPS.

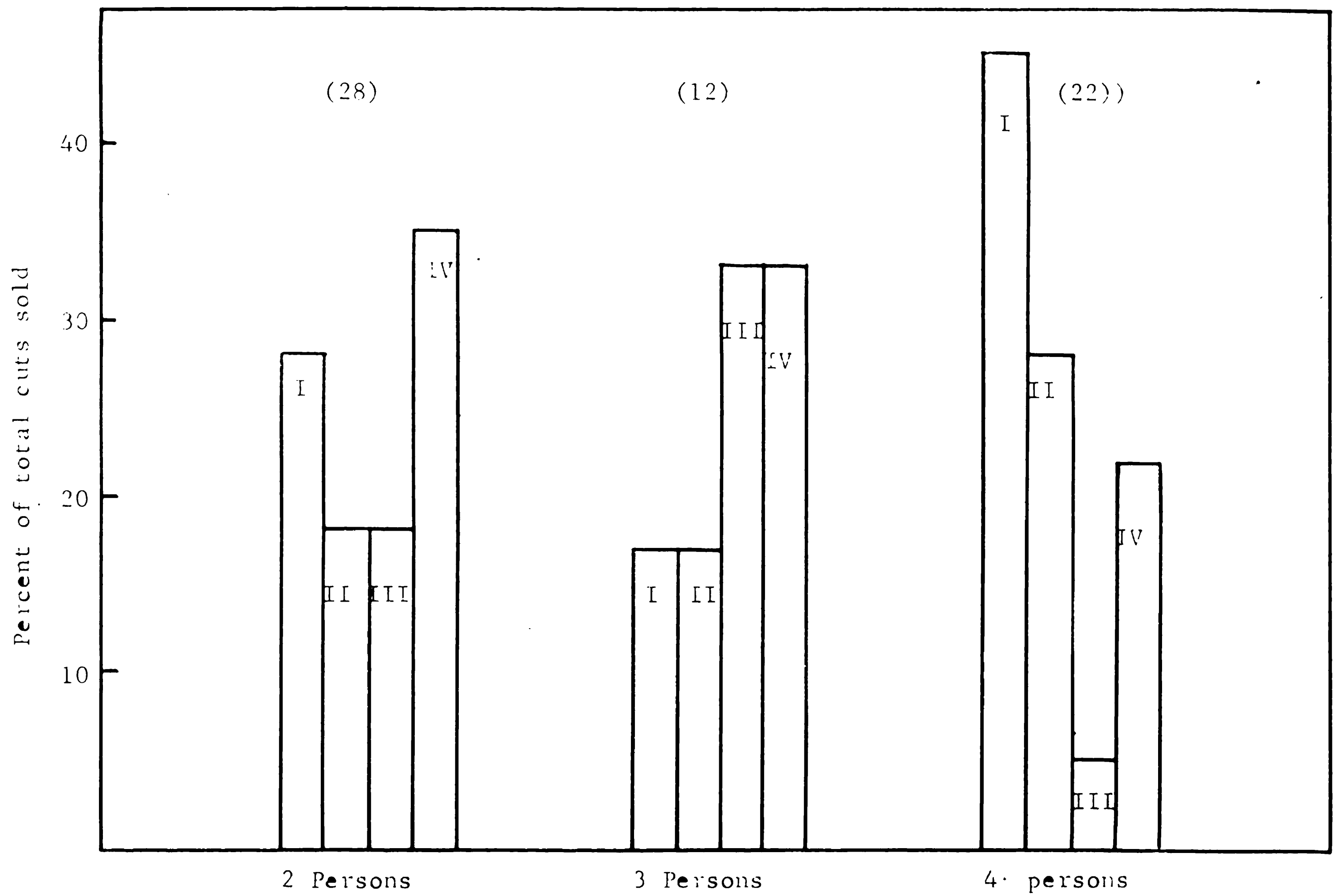

Figure . Consumer preference; effect of family size - BOSTON BUTTS.

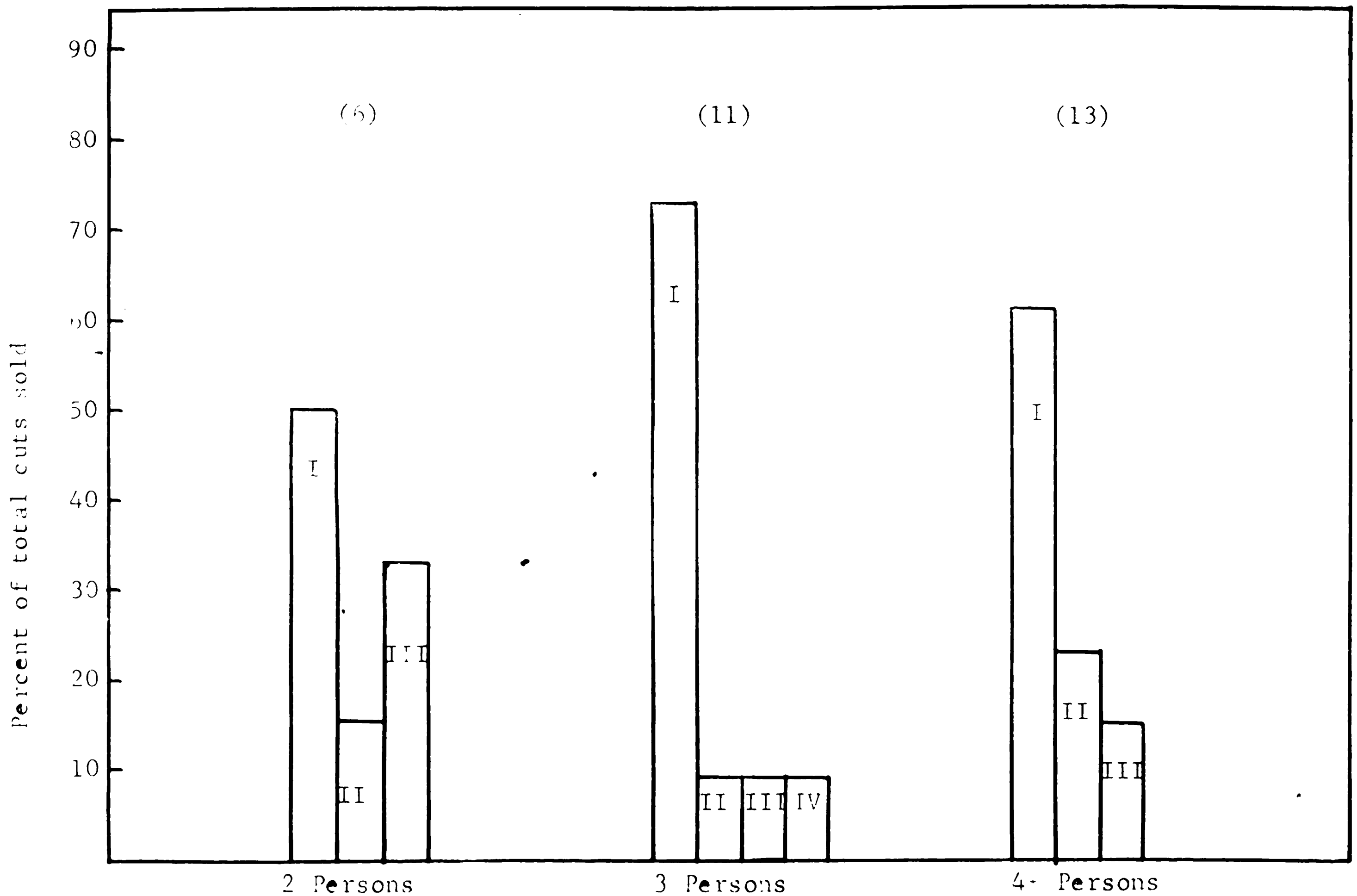

Figure 7. Consumer preference; effect of family size - LOIN ROASTS.

demand for heavier roasts increased as size of family increased.

In figure 7, which depicts the effect of family size on the selection of 7-rib loin roasts, it is apparent that, regardless of the number of persons in the family, the preference was definitely for those cuts from the heaviest slaughter weight group. The factors which may have accounted for this have been indicated previously (discussion of figure 4).

SUMMARY AND CONCLUSIONS

This study was conducted in order to determine the effect of slaughter weight upon the acceptability, quality and processing characteristics of pork carcasses. A total of 80 animals were studied, consisting of 40 Yorkshire and 40 crossbred barrows and gilts. The animals were divided into 4 slaughter weight groups ranging from 100 to 200 pounds.

As slaughter weight was lowered, there was a decrease in carcass length, dressing percentage and loin eye area, and an increase in the percentage of primal and lean cuts. Chemical analysis of the rough ham indicated that reduction in slaughter weight resulted in higher percentages of protein and moisture, and lower percentages of ether extract. Analysis of the *L. dorsi* muscle showed similar trends except no significant differences were observed in the percentage of ether extract as slaughter weight was decreased. Physical separation of the rough ham showed that the percentage of lean increased and the percentage of fat decreased as slaughter weight was reduced.

Taste panel scores indicated that fresh pork chops, smoked hams and bacons from the 4 weight groups were equally acceptable. Differences in cooking losses of the fresh chops and the smoked yields of the hams and bacons were not statistically significant.

Surface color renotations of hue and value were not affected by slaughter weight, however, significant decreases in chroma were noted as slaughter weight decreased. The water-holding properties of the loin eye muscles were not found to be significantly affected by changes in slaughter weight. A second method of determining water-holding capacity developed during the course of this study proved to be both rapid and repeatable.

Consumer studies indicated strong preferences for chops and Boston butt roasts from both the heaviest and lightest weight groups. However, the preference for loin roasts was decidedly in favor of the heaviest weight group. The size of the cuts and their degree of leanness appeared to be two of the more important considerations in selection. Family size also seemed to strongly influence selection. As family size increased, the demand for cuts from the heaviest weight group became more pronounced.

No differences were found between the Yorkshire and crossbred hogs in percentage of lean cuts or backfat thickness, however, the crossbreds had significantly larger loin eye areas. Taste panel evaluation of pork chops favored the Yorkshires somewhat in tenderness, although the crossbreds were rated higher in overall acceptability. The *L. dorsi* muscles from the Yorkshire carcasses were higher in water-holding capacity than those from the crossbred carcasses.

The carcasses from gilts were generally superior to those from barrows in cut-out value. No significant differences attributable to sex were noted in palatability or water-holding capacity.

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APPENDIX

Appendix A. Slaughter data.

					Group I (slaughter weight 190 to 210 pounds)							
Animal number	Sl. wt. (lbs)	Hot dr. %	% lean cuts	% primal cuts	Cold carc. wt. (lbs)	Cold dr. %	% lean cuts	% primal cuts	Av. backfat thickness (in.)	Carc. length (in.)	Sp. gr.	Area 10th rib (sq.in.)
Crossbred												
Barrows:												
47-8	194.0	75.5	39.2	47.6	142.0	73.2	53.6	65.0	1.45	28.8	1.056	4.36
52-8	192.0	76.1	39.3	49.0	141.5	73.7	53.4	66.4	1.27	31.1	1.049	2.96
58-13	195.5	77.6	37.0	49.1	147.5	75.5	46.8	62.0	1.72	28.8	1.046	3.32
92-6	212.0	76.7	37.6	46.6	156.0	73.6	51.0	63.3	1.68	29.9	1.046	3.56
92-10	209.0	76.3	36.4	45.3	155.5	74.4	48.9	60.9	1.73	29.9	1.044	3.63
Mean	200.5	76.4	37.9	47.5	148.5	74.1	50.7	63.5	1.57	29.7	1.048	3.57
Gilts:												
50-1	200.5	77.1	40.2	48.9	149.0	74.3	54.0	65.8	1.64	29.3	1.047	4.17
58-1	200.0	77.4	41.8	51.2	150.0	75.0	55.7	68.3	1.25	30.3	1.059	4.29
92-5	211.0	73.7	37.9	46.9	151.5	71.8	52.8	65.4	1.42	30.2	1.050	4.85
93-1	206.0	77.2	39.5	48.6	154.0	74.8	52.9	65.1	1.49	30.0	1.051	4.21
96-5	194.0	78.6	41.3	50.5	146.5	75.5	54.7	66.9	1.40	30.0	1.064	4.58
Mean	202.3	76.8	40.1	49.2	150.2	74.3	54.1	66.3	1.44	29.96	1.054	4.42
Purebred												
Barrows:												
12-8	209.0	73.7	35.9	45.6	151.0	72.3	49.7	63.1	1.65	31.1	1.050	2.98
16-8	194.0	75.7	35.8	46.1	142.5	73.5	48.8	62.7	2.10	29.2	1.054	3.31
18-5	191.0	74.8	38.4	47.5	138.5	72.5	53.0	65.5	1.28	31.0	1.055	3.17
19-11	196.5	75.4	39.3	48.8	143.5	73.0	53.8	66.9	1.40	31.6	1.054	3.35
19-14	202.0	76.2	41.0	51.4	149.5	74.0	55.5	69.5	1.46	31.7	1.063	3.50
Mean	198.5	75.2	38.1	47.9	145.0	73.1	52.2	65.5	1.58	30.9	1.055	3.26
Gilts:												
4-2	204.5	76.0	39.6	48.2	150.0	73.4	54.0	65.7	1.32	31.6	1.058	3.68
5-4	191.0	74.6	39.9	48.7	138.5	72.5	55.0	67.2	1.30	30.5	1.067	4.34
12-6	191.0	74.4	40.6	50.2	138.0	72.3	56.2	69.5	1.15	30.4	1.062	4.13
15-2	196.0	74.8	39.2	48.4	142.0	72.5	54.1	66.8	1.38	30.9	1.058	3.93
19-3	189.0	74.8	43.1	52.2	137.5	72.8	59.2	71.8	1.30	31.8	1.068	4.01
Mean	194.3	74.9	40.5	54.9	141.2	72.7	55.7	68.2	1.29	31.0	1.063	4.02

Appendix A. Slaughter data. (continued)

Animal number	Sl. wt. (lbs)	Hot dr. %	% lean cuts	% primal cuts	Cold carc. wt. (lbs)	Cold dr. %	% lean cuts	% primal cuts	Av. backfat thickness (in.)	Carc. length (in.)	Sp. gr.	Area 10th rib (sq. in.)
	Group II (slaughter weight 160 to 180 pounds)											
Crossbred												
Barrows:												
49-7	172.0	76.5	38.3	48.7	126.0	73.3	52.3	66.4	1.42	27.8	1.051	3.30
50-5	164.0	75.2	37.7	47.1	119.0	72.6	51.9	64.9	1.42	27.8	1.050	3.26
52-11	166.0	75.4	39.8	49.7	121.0	72.9	54.5	68.2	1.15	29.2	1.058	3.10
58-9	161.0	75.1	40.1	49.1	116.5	72.4	55.4	67.8	1.38	27.0	1.058	3.16
58-12	178.5	76.1	38.8	48.5	130.5	73.1	53.0	66.3	1.48	28.0	1.051	3.31
Mean	168.3	75.7	38.9	48.6	122.6	72.8	53.4	66.7	1.37	28.0	1.054	3.23
Gilts:												
54-1	173.5	76.4	41.6	51.3	129.0	74.4	56.0	69.0	1.29	28.6	1.057	3.95
78-2	172.0	76.9	42.3	50.8	127.5	74.1	57.0	68.5	1.23	27.6	1.050	4.58
89-5	182.0	77.4	40.7	50.1	134.5	73.9	55.1	67.8	1.38	29.9	1.053	4.04
92-2	180.0	75.3	39.2	47.6	132.0	73.3	53.4	64.9	1.40	29.3	1.051	3.67
96-4	168.0	75.7	39.2	47.8	122.0	72.6	54.0	65.9	1.15	29.7	1.055	3.28
Mean	175.1	76.3	40.6	49.5	129.0	73.7	55.1	67.2	1.29	29.0	1.053	3.90
Purebred												
Barrows:												
6-6	179.0	75.0	41.4	50.6	130.0	72.6	57.0	69.6	1.15	30.9	1.062	3.30
12-12	171.0	74.6	36.4	45.9	123.5	72.2	50.4	63.5	1.58	28.2	1.052	2.48
16-9	169.0	75.7	40.2	49.4	124.0	73.4	54.8	67.3	1.42	28.9	1.062	3.73
17-11	168.0	74.8	38.2	47.4	122.0	72.6	52.6	65.3	1.55	28.6	1.058	3.07
18-7	168.0	74.9	37.2	46.0	121.5	72.3	51.4	63.6	1.25	29.0	1.057	3.07
Mean	171.0	75.0	38.7	47.9	124.2	72.6	53.2	65.9	1.39	29.1	1.058	3.13
Gilts:												
8-2	176.0	73.6	38.9	48.0	125.5	71.3	54.5	67.3	1.28	29.5	1.062	4.17
12-1	175.0	75.0	40.7	49.5	126.5	72.3	56.2	68.5	1.13	29.2	1.063	3.39
15-6	158.0	74.0	40.1	48.6	113.0	71.5	56.1	68.0	1.35	29.0	1.063	3.54
19-2	176.0	76.0	45.6	54.1	129.5	73.6	61.9	73.5	1.01	31.1	1.070	4.33
20-2	167.0	76.6	38.1	48.6	124.5	74.6	51.1	65.2	1.36	28.5	1.058	3.28
Mean	170.4	75.0	40.7	49.8	123.8	72.7	56.0	68.5	1.23	29.5	1.063	3.74

Appendix A. Slaughter data. (continued)

Animal number	Sl. wt. (lbs)	Hot dr. %	% lean cuts	% primal cuts	Cold carc. wt. (lbs)	Cold dr. %	% lean cuts	% primal cuts	Av. backfat thickness (in.)	Carc. length (in.)	Sp. gr.	Area 10th rib (sq.in.)
Group III (slaughter weight 130 to 150 pounds)												
Crossbred												
Barrows:												
42-8	149.0	74.4	37.0	46.0	107.0	71.8	51.5	64.1	1.38	28.0	1.048	2.60
50-9	136.0	74.0	40.9	49.6	96.5	71.0	57.6	70.1	1.26	26.5	1.055	3.30
58-6	137.0	74.5	42.2	49.3	98.0	71.5	59.0	69.0	1.05	26.6	1.054	3.35
58-7	141.0	73.2	39.3	47.7	100.5	71.3	55.2	66.9	1.18	26.0	1.054	2.86
92-8	139.0	75.7	41.0	50.1	101.0	72.7	56.4	69.0	1.04	26.8	1.067	3.13
Mean	140.4	74.4	40.1	48.5	100.6	71.6	55.9	67.8	1.18	26.8	1.056	3.05
Gilts:												
49-2	138.0	74.5	42.8	50.9	98.0	71.0	60.2	71.6	0.96	28.0	1.064	3.88
54-4	143.0	76.4	43.0	51.9	105.0	73.4	58.5	70.7	1.04	27.1	1.060	3.69
92-3	140.0	76.4	41.3	49.2	103.5	73.9	55.8	66.6	1.27	27.2	1.058	3.46
92-4	146.0	77.7	42.3	50.6	110.0	75.3	56.2	67.2	1.21	27.6	1.059	3.67
94-3	138.0	73.8	41.1	49.5	98.5	71.4	57.5	69.4	1.14	27.7	1.057	3.01
Mean	141.0	75.8	42.1	50.4	103.0	73.0	57.6	69.1	1.12	27.5	1.060	3.54
Purebred												
Barrows:												
10-6	146.0	73.8	41.3	50.0	104.0	73.8	57.9	70.1	1.24	28.8	1.063	2.52
12-10	145.0	72.9	37.8	47.0	101.5	70.0	54.0	67.2	1.30	27.5	1.058	2.72
16-11	135.0	72.2	40.0	48.2	93.0	68.9	58.1	70.0	1.13	27.3	1.063	3.42
18-6	138.5	72.1	38.1	46.5	96.0	69.3	55.0	67.0	1.10	27.3	1.058	2.45
19-9	141.0	75.4	40.5	49.2	102.5	72.7	55.7	67.7	0.92	27.8	1.065	3.20
Mean	141.1	73.3	39.5	48.2	99.4	70.9	56.1	68.4	1.14	27.7	1.061	2.86
Gilts:												
10-3	133.5	73.2	43.6	52.4	94.5	70.8	61.6	74.0	0.90	29.3	1.070	3.02
12-4	135.0	73.3	39.9	48.3	94.0	69.6	57.2	69.4	0.91	27.9	1.072	2.82
16-1	153.0	74.6	43.6	52.0	112.0	73.2	59.5	71.0	1.41	29.6	1.066	4.25
17-1	135.0	73.0	38.4	47.4	95.0	70.4	54.6	67.3	1.42	27.6	1.066	2.85
21-1	141.0	74.6	40.3	48.9	102.0	72.3	55.7	67.6	1.18	28.3	1.062	2.73
Mean	139.5	73.7	41.2	49.8	99.5	71.3	57.7	69.9	1.16	28.5	1.067	3.13

Appendix A. Slaughter data. (continued)

Animal number	Sl. wt. (lbs)	Hot dr. %	% lean cuts	% primal cuts	Cold carc. wt. (lbs)	Cold dr. %	% lean cuts	% primal cuts	Av. backfat thickness (in.)	Carc. length (in.)	Sp. gr.	Area 10th rib (sq.in.)
Group IV (slaughter weight 100 to 120 pounds)												
Crossbred												
Barrows:												
50-8	100.5	73.3	41.9	50.0	70.5	70.2	59.8	71.2	0.90	24.4	1.062	2.20
58-8	108.0	73.7	38.1	47.0	76.5	70.8	53.7	66.3	1.07	24.2	1.054	2.68
58-10	113.0	71.0	37.2	45.6	77.0	68.1	54.5	66.9	1.22	24.0	1.055	2.54
58-11	111.5	72.9	38.0	46.0	78.0	70.0	54.3	65.7	1.18	24.2	1.053	2.57
95-5	118.0	74.8	38.8	47.8	86.0	72.9	53.2	65.6	1.15	26.0	1.055	2.36
Mean	110.2	73.1	38.8	47.3	77.6	70.4	55.1	67.1	1.10	24.6	1.056	2.47
Gilts:												
47-1	111.5	72.4	41.3	49.3	77.0	69.1	59.9	71.4	0.86	26.0	1.067	2.80
54-2	118.0	75.9	40.4	49.2	86.5	73.3	55.1	67.1	0.98	26.2	1.059	2.95
95-3	107.0	74.3	43.2	50.9	76.5	71.5	60.4	71.2	0.76	25.4	1.062	3.15
96-1	111.0	73.2	43.3	50.5	79.5	71.6	60.5	70.6	0.76	26.6	1.067	3.06
96-2	108.0	74.3	39.4	47.7	78.0	72.2	54.5	66.1	0.97	25.1	1.062	2.88
Mean	111.1	74.0	41.5	49.5	79.5	71.5	58.1	69.3	0.86	25.9	1.063	2.97
Purebred												
Barrows:												
12-11	108.0	71.7	38.2	45.4	73.0	67.6	56.5	67.2	0.98	26.2	1.062	2.40
16-10	119.0	72.0	40.9	48.9	83.0	69.8	58.7	70.1	1.05	26.2	1.065	3.03
18-4	107.0	70.1	38.7	45.6	71.5	66.8	57.9	68.3	0.91	25.6	1.067	2.63
19-8	113.0	73.2	41.2	50.0	79.5	70.4	58.6	71.1	1.04	26.3	1.068	2.62
20-8	122.0	72.1	39.0	48.0	85.5	70.1	55.7	68.4	1.21	25.8	1.060	2.65
Mean	113.8	71.8	39.6	47.6	78.5	68.9	57.5	69.0	1.04	26.0	1.064	2.67
Gilts:												
4-4	110.0	69.0	39.9	46.5	73.0	66.4	60.1	70.0	0.69	26.7	1.074	2.53
8-5	107.0	73.6	40.9	49.5	76.0	71.0	57.6	69.7	1.02	25.2	1.068	2.23
12-5	108.0	75.0	39.1	47.7	75.0	69.4	56.3	68.7	0.87	25.9	1.060	2.46
15-5	108.5	69.3	39.4	46.6	72.5	66.8	59.0	69.7	0.80	25.9	1.066	2.66
16-5	113.0	72.5	43.7	51.2	78.5	69.5	62.9	73.8	0.72	26.4	1.076	3.56
Mean	109.3	71.9	40.6	48.3	75.0	68.6	59.2	70.4	0.82	26.0	1.069	2.89

Appendix B. Chemical analysis of loin eye muscles and rough hams

Group I (slaughter weight 190 to 210 pounds)						
	Loins			Rough hams		
Animal number	Moisture (%)	Ether extract (%)	Protein (%)	Moisture (%)	Ether extract (%)	Protein (%)
Crossbred						
Barrows:						
47-8	72.22	6.96	19.59	54.52	29.25	15.31
52-8	73.62	2.03	20.44	49.58	34.94	14.41
58-13	72.53	4.66	21.84	48.06	36.82	14.69
92-6	73.10	4.68	21.00	50.84	33.51	14.53
92-10	72.85	4.77	20.47	48.20	36.06	13.84
Mean	72.86	4.62	20.67	50.24	34.12	14.56
Gilts:						
50-1	71.95	5.92	19.34	51.43	33.25	14.66
58-1	73.86	2.62	20.88	55.46	26.06	16.91
92-5	74.08	3.46	20.79	53.28	30.37	15.19
93-1	74.81	1.56	21.34	52.89	31.05	15.25
96-5	74.53	1.51	21.88	54.62	28.08	16.06
Mean	73.85	3.01	20.85	53.54	29.76	15.61
Purebred						
Barrows:						
12-8	71.29	6.24	21.50	47.42	37.89	14.09
16-8	72.06	0.80	23.09	49.73	34.14	15.31
18-5	73.71	1.34	22.84	53.22	30.73	15.06
19-11	73.49	3.48	22.41	52.96	30.86	15.75
19-14	73.52	2.29	23.53	56.36	25.53	17.66
Mean	72.81	2.83	22.67	51.94	31.83	15.57
Gilts:						
4-2	74.15	2.33	22.00	53.40	30.23	16.41
5-4	73.12	0.89	23.22	55.84	26.09	17.09
12-6	72.58	2.07	23.13	56.02	25.71	16.53
15-2	74.47	0.18	22.97	55.57	27.00	15.25
19-3	73.52	1.39	24.13	58.41	22.43	18.38
Mean	73.57	1.37	23.09	55.85	26.29	16.73

Appendix B. Chemical analysis of loin eye muscles and rough hams (continued)

Group II (slaughter weight 160 to 180 pounds)						
	Loins			Rough hams		
Animal number	Moisture	Ether extract	Protein	Moisture	Ether extract	Protein
	(%)	(%)	(%)	(%)	(%)	(%)
Crossbred						
Barrows:						
49-7	74.56	1.81	21.41	53.12	30.97	14.94
50-5	72.16	7.45	18.78	53.05	32.08	14.19
52-11	74.35	3.40	20.03	56.89	26.32	16.16
58-9	74.46	3.94	20.25	55.92	27.41	15.56
58-12	73.56	3.98	21.31	52.56	31.03	15.53
Mean	73.82	4.12	20.36	54.31	29.56	15.28
Gilts:						
54-1	73.26	4.63	21.41	56.18	26.77	16.63
78-2	72.74	5.55	19.84	54.05	29.77	15.31
89-5	74.06	0.54	23.19	50.85	32.66	15.00
92-2	74.05	3.75	20.09	52.03	31.99	15.28
96-4	75.54	0.80	20.72	53.41	30.27	14.91
Mean	73.93	3.05	21.05	53.30	30.29	15.43
Purebred						
Barrows:						
6-6	74.06	0.49	23.19	56.40	25.65	17.16
12-12	72.38	4.46	22.53	49.75	34.56	15.16
16-9	73.78	0.40	22.31	54.49	27.94	16.53
17-11	72.98	2.94	22.78	51.66	31.30	16.44
18-7	72.94	2.03	22.72	53.25	29.52	16.16
Mean	73.23	2.06	22.71	53.11	29.79	16.29
Gilts:						
8-2	73.49	1.89	22.38	55.41	26.95	16.72
12-1	73.03	2.13	23.31	56.21	26.33	16.75
15-6	74.15	0.16	22.91	56.89	25.37	17.09
19-2	74.37	1.37	23.47	62.62	17.12	18.59
20-2	74.26	0.56	22.31	52.50	30.62	15.84
Mean	73.86	1.22	22.88	56.73	25.28	17.00

Appendix B. Chemical analysis of loin eye muscles and rough hams (continued)

Group III (slaughter weight 130 to 150 pounds)

Animal number	Loins: Moisture (%)	Loins: Ether extract (%)	Loins: Protein (%)	Rough hams: Moisture (%)	Rough hams: Ether extract (%)	Rough hams: Protein (%)
Crossbred						
Barrows:						
42-8	75.39	2.78	20.72	51.40	33.56	14.34
50-9	71.96	8.20	18.06	57.33	26.99	14.63
58-6	74.54	5.22	19.47	58.75	24.84	15.59
58-7	74.21	2.88	21.91	53.27	30.40	15.59
92-8	75.73	2.20	20.47	60.83	21.29	17.09
Mean	74.37	4.26	20.13	56.32	27.42	15.45
Gilts:						
49-2	75.71	0.90	20.19	60.67	21.07	17.06
54-4	73.01	6.32	19.91	59.02	23.94	16.47
92-3	76.28	0.45	20.41	56.67	26.04	15.94
92-4	75.54	0.68	20.41	56.69	25.90	16.56
94-3	75.34	2.10	20.50	56.12	27.04	16.31
Mean	75.18	2.09	20.28	58.83	24.80	16.47
Purebred						
Barrows:						
10-6	75.89	1.10	21.69	60.29	22.03	17.13
12-10	73.29	1.62	21.94	52.26	24.74	15.66
16-11	74.36	0.39	23.09	55.76	26.56	17.38
18-6	73.92	0.53	22.66	53.63	29.50	15.91
19-9	74.63	1.80	21.16	60.37	21.13	17.56
Mean	74.42	1.09	22.11	56.42	24.79	16.73
Gilts:						
10-3	74.62	0.46	22.06	62.50	18.44	17.84
12-4	73.74	1.90	22.53	57.51	24.20	17.59
16-1	74.27	0.16	22.19	60.16	20.54	17.78
17-1	73.47	2.93	22.63	53.85	28.97	16.50
21-1	73.57	1.74	22.72	56.51	25.57	16.91
Mean	73.93	1.44	22.43	58.11	23.54	17.32

Appendix B. Chemical analysis of loin eye muscles and rough hams (continued)

Group IV (slaughter weight 100 to 120 pounds)						
	Loins			Rough hams		
Animal number	Moisture	Ether extract	Protein	Moisture	Ether extract	Protein
	(%)	(%)	(%)	(%)	(%)	(%)
Crossbred						
Barrows:						
50-8	72.09	7.14	18.88	60.70	21.78	16.03
58-8	75.70	1.63	20.81	57.35	26.42	15.38
58-10	74.67	2.98	21.34	55.53	28.40	15.38
58-11	75.83	1.99	21.09	55.50	28.60	15.16
95-5	75.01	2.04	20.28	53.18	31.14	14.94
Mean	74.66	3.16	20.48	56.45	27.27	15.38
Gilts:						
47-1	73.25	5.53	19.63	62.49	18.84	17.28
54-2	71.49	7.10	19.69	58.40	24.34	16.50
95-3	75.72	2.25	19.44	61.03	21.24	16.25
96-1	76.07	0.40	20.47	61.94	19.28	16.94
96-2	75.24	0.80	20.47	59.13	22.54	16.59
Mean	74.35	3.22	19.94	60.60	21.25	16.71
Purebred						
Barrows:						
12-11	73.79	2.10	22.41	59.01	22.91	17.69
16-10	74.36	0.38	23.16	59.41	23.17	17.56
18-4	75.84	0.52	22.38	59.89	21.82	18.31
19-8	74.58	0.96	22.09	61.34	19.92	17.06
20-8	75.54	1.10	20.97	54.78	28.10	16.22
Mean	74.82	1.01	22.20	58.89	23.18	17.37
Gilts:						
4-4	73.25	1.74	22.91	61.43	18.49	18.91
8-5	74.14	1.40	22.50	59.24	22.36	17.78
12-5	73.09	2.36	22.41	55.97	26.63	16.72
15-5	75.06	0.18	22.00	60.10	22.46	16.50
16-5	74.06	1.20	22.44	64.80	15.05	19.88
Mean	73.92	1.38	22.45	60.31	21.00	17.96

Appendix C. Physical separation data of rough ham.

Group I (slaughter weight 190 to 210 pounds)					
Animal number	% bone	% lean	% fat	% skin	Specific gravity of bone
Crossbred					
Barrows:					
47-8	8.45	60.31	27.41	3.83	1.2660
52-8	8.74	54.07	33.36	3.81	1.2618
58-13	7.91	50.96	36.42	4.71	1.2650
92-6	7.43	55.32	33.50	3.73	1.3062
92-10	7.05	52.98	36.25	3.70	1.2884
Mean	7.92	54.73	33.39	3.96	1.2775
Gilts:					
50-1	7.81	54.84	31.42	5.93	1.2817
58-1	8.19	60.59	26.21	5.01	1.2938
92-5	7.25	59.74	29.27	3.73	1.2686
93-1	6.74	58.91	31.08	3.25	1.2867
96-5	7.86	61.78	26.20	4.14	1.3000
Mean	7.57	59.17	28.84	4.41	1.2861
Purebred					
Barrows:					
12-8	9.69	52.49	34.56	3.24	1.2722
16-8	8.36	54.28	33.21	4.13	1.3030
18-5	9.85	57.17	29.12	3.84	1.2379
19-11	8.67	58.30	29.69	3.33	1.2477
19-14	8.27	64.92	23.85	2.93	1.2890
Mean	8.97	57.43	30.09	3.49	1.2700
Gilts:					
4-2	8.87	58.26	29.80	3.05	1.2869
5-4	9.44	61.49	25.04	4.00	1.3219
12-6	9.48	61.34	25.73	3.42	1.2803
15-2	9.40	60.39	25.86	4.33	1.2580
19-3	9.51	66.01	21.17	3.29	1.2816
Mean	9.34	61.50	25.52	3.62	1.2857

Appendix C. Physical separation data of rough ham. (continued)

Group II (slaughter weight 160 to 180 pounds)					
Animal number	% bone	% lean	% fat	% skin	Specific gravity of bone
Crossbred					
Barrows:					
49-7	7.74	58.62	29.66	3.97	1.2927
50-5	8.56	58.33	28.86	4.26	1.2239
52-11	9.87	64.14	22.62	3.36	1.2520
58-9	8.64	61.47	25.57	4.32	1.2552
58-12	8.82	56.77	29.61	4.78	1.2887
Mean	8.73	59.87	27.26	4.14	1.2625
Gilts:					
54-1	8.49	63.78	23.97	3.77	1.2772
78-2	6.95	62.41	26.98	3.65	1.2768
89-5	8.35	56.49	31.55	3.59	1.2661
92-2	8.46	57.20	30.05	4.27	1.2455
96-4	7.48	58.48	30.79	3.23	1.2658
Mean	7.95	59.67	28.67	3.70	1.2663
Purebred					
Barrows:					
6-6	10.61	60.42	25.15	3.80	1.2450
12-12	8.88	54.57	33.46	3.07	1.2825
16-9	8.97	58.27	28.67	4.06	1.3091
17-11	8.92	56.68	29.65	4.73	1.2786
18-7	9.55	58.10	28.60	3.73	1.2541
Mean	9.39	57.61	29.11	3.88	1.2739
Gilts:					
8-2	8.72	60.53	26.73	4.00	1.2810
12-1	9.12	61.88	25.26	3.72	1.2972
15-6	9.61	61.64	24.45	4.28	1.2455
19-2	9.94	70.53	16.16	3.35	1.2543
20-2	7.62	58.41	30.47	3.48	1.3118
Mean	9.00	62.60	24.61	3.77	1.2780

Appendix C. Physical separation data of rough ham. (continued)

Group III (slaughter weight 130 to 150 pounds)					
Animal number	% bone	% lean	% fat	% skin	Specific gravity of bone
Crossbred					
Barrows:					
42-8	9.46	51.70	33.96	4.86	1.2517
50-9	9.93	60.97	24.25	4.84	1.2115
58-6	9.50	62.12	24.69	3.69	1.2061
58-7	9.42	56.65	29.41	4.52	1.2488
92-8	9.60	67.18	19.95	3.24	1.2973
Mean	9.58	59.72	26.45	4.23	1.2431
Gilts:					
49-2	9.98	66.19	18.42	5.41	1.2622
54-4	9.13	65.19	21.05	4.62	1.2266
92-3	8.56	63.03	23.76	4.63	1.2308
92-4	7.92	70.29	18.00	3.78	1.2791
94-3	8.05	63.13	25.06	3.73	1.2587
Mean	8.73	65.57	21.26	4.43	1.2515
Purebred					
Barrows:					
10-6	10.64	69.29	14.75	5.30	1.2650
12-10	10.16	55.80	30.47	3.58	1.2628
16-11	9.69	60.45	25.35	4.52	1.2672
18-6	9.74	57.68	29.09	3.50	1.2652
19-9	9.50	65.58	21.81	3.09	1.2568
Mean	9.95	61.76	24.29	4.00	1.2634
Gilts:					
10-3	12.81	58.87	23.22	5.08	1.2690
12-4	10.41	63.95	20.89	4.75	1.2612
16-1	8.82	66.47	21.80	2.89	1.3341
17-1	9.18	59.32	27.45	4.03	1.3296
21-1	8.60	63.21	24.07	4.09	1.2626
Mean	9.96	62.36	23.49	4.17	1.2913

Appendix C. Physical separation data of rough ham. (continued)

Group IV (slaughter weight 100 to 120 pounds)					
Animal number	% bone	% lean	% fat	% skin	Specific gravity of bone
Crossbred					
Barrows:					
50-8	10.40	65.40	20.30	4.00	1.2244
58-8	10.12	59.48	25.33	5.05	1.2061
58-10	9.38	59.20	27.21	4.19	1.2539
58-11	8.58	58.18	28.69	4.53	1.2491
95-5	8.35	57.11	30.59	3.94	1.2780
Mean	9.37	59.87	26.42	4.34	1.2423
Gilts:					
47-1	10.40	67.60	15.70	6.40	1.2480
54-2	9.50	62.80	18.60	9.05	1.2401
95-3	8.68	67.66	20.13	3.51	1.2492
96-1	9.69	67.71	18.83	3.57	1.2486
96-2	9.39	65.35	21.06	4.18	1.2101
Mean	9.53	66.22	18.86	5.34	1.2392
Purebred					
Barrows:					
12-11	11.48	62.57	22.67	3.28	1.2191
16-10	9.71	62.74	22.41	5.14	1.2500
18-4	10.90	64.53	21.82	3.45	1.2550
19-8	10.32	64.73	21.18	3.77	1.2561
20-8	9.08	58.01	27.80	5.09	1.2939
Mean	10.30	62.52	23.04	4.15	1.2548
Gilts:					
4-4	12.37	66.10	17.93	3.60	1.2675
8-5	10.90	63.63	20.34	5.13	1.2700
12-5	10.21	60.62	25.12	4.05	1.2456
15-5	10.86	64.10	20.52	4.50	1.2868
16-5	9.94	72.11	14.42	3.53	1.2633
Mean	10.86	65.31	19.67	4.16	1.2666

Appendix D. Palatability and cooking loss data of pork chops.

Group I (slaughter weight 190 to 210 pounds)							
		%	Tenderness		Panel		
Animal number	% drip	cooking loss	Panel	Shear	Flavor	Juiciness	Overall
Crossbred							
Barrows:							
47-8	2.98	22.05	8.0	6.5	7.1	7.4	7.4
52-8	.57	23.83	6.1	9.6	7.3	6.1	6.4
58-13	.10	21.12	6.9	7.6	6.7	6.4	6.8
92-6	.54	23.30	7.8	6.5	6.5	6.3	6.9
92-10	1.33	20.69	8.3	8.1	7.2	7.3	7.3
Mean	1.10	22.20	7.4	7.7	7.0	6.7	7.0
Gilts:							
50-1	2.40	19.35	8.3	7.7	7.3	7.8	7.6
58-1	.60	20.84	7.7	7.1	7.2	7.8	7.6
92-5	.63	20.82	7.3	9.2	7.1	6.7	7.1
93-1	1.33	23.48	6.5	8.5	6.6	6.3	6.3
96-5	1.16	25.06	6.6	9.9	6.0	5.3	5.8
Mean	1.22	21.91	7.3	8.5	6.8	6.8	6.9
Purebred							
Barrows:							
12-8	.91	15.22	7.8	6.6	7.2	7.8	7.5
16-8	.86	18.57	6.7	9.5	6.0	6.5	6.3
18-5	.25	17.61	7.7	8.0	6.8	6.6	6.8
19-11	.20	18.37	4.7	9.2	5.5	5.4	5.2
19-14	1.17	18.41	5.8	9.8	6.4	6.7	6.4
Mean	0.68	17.64	6.5	8.6	6.4	6.6	6.4
Gilts:							
4-2	1.13	23.16	7.5	10.1	7.3	6.9	7.4
5-4	.18	18.05	6.7	10.3	6.5	6.4	6.6
12-6	1.23	19.26	6.4	10.0	7.0	6.3	6.7
15-2	.32	19.75	6.4	7.6	6.8	6.9	6.5
19-3	.09	22.42	6.4	10.8	7.3	7.1	6.9
Mean	0.59	20.53	6.7	9.8	7.0	6.7	6.8

Appendix D. Palatability and cooking loss data of pork chops. (continued)

Group II (slaughter weight 160 to 180 pounds)							
		%	Tenderness		Panel		
Animal number	% drip	cooking loss	Panel	Shear	Flavor	Juiciness	Overall
Crossbred							
Barrows:							
49-7	3.89	22.58	6.9	8.7	7.1	6.5	6.8
50-5	2.60	21.45	8.0	7.8	7.3	8.2	7.8
52-11	.70	27.25	7.4	8.3	6.4	6.3	6.7
58-9	1.78	23.77	7.6	5.7	7.7	7.2	7.7
58-12	1.75	18.77	6.8	8.5	6.6	6.5	6.6
Mean	2.14	22.76	7.3	7.8	7.0	6.9	7.1
Gilts:							
54-1	3.73	22.57	7.1	7.5	6.8	6.2	6.5
78-2	.66	23.84	6.9	7.0	6.2	6.4	6.4
89-5	1.01	20.27	5.3	13.4	6.3	6.5	5.9
92-2	1.01	21.23	7.9	9.2	7.3	7.0	7.2
96-4	1.59	24.02	5.4	8.2	6.3	6.1	5.6
Mean	1.60	22.39	6.5	9.1	6.6	6.4	6.3
Purebred							
Barrows:							
6-6	1.17	18.41	6.2	10.9	6.0	6.2	6.2
12-12	1.02	15.39	5.5	7.7	5.9	5.9	5.7
16-9	1.12	17.76	7.7	8.7	6.6	6.8	7.1
17-11	.22	19.76	7.4	8.2	6.6	6.3	6.8
18-7	.81	21.60	6.2	9.0	6.6	5.8	6.3
Mean	0.87	18.58	6.6	8.9	6.3	6.2	6.4
Gilts:							
8-2	2.30	17.78	6.8	9.8	6.5	5.8	6.4
12-1	1.48	19.97	4.4	9.5	6.8	6.2	5.1
15-6	1.47	20.12	5.6	10.4	6.3	6.7	6.0
19-2	1.80	16.99	6.2	10.3	6.3	7.8	6.9
20-2	1.04	16.86	7.9	7.9	6.8	6.6	7.0
Mean	1.62	18.34	6.2	9.6	6.5	6.6	6.3

Appendix D. Palatability and cooking loss data of pork chops. (continued)

Group III (slaughter weight 130 to 150 pounds)							
		%	Tenderness		Panel		
Animal number	% drip	% cooking loss	Panel	Shear	Flavor	Juiciness	Overall
Crossbred							
Barrows:							
42-8	1.65	18.49	6.3	6.7	6.5	6.8	6.3
50-9	1.51	21.49	7.3	5.7	6.4	7.3	6.3
58-6	1.15	27.55	7.4	6.9	6.7	6.7	7.0
58-7	.33	23.62	7.5	7.5	6.3	5.9	6.7
92-8	.69	18.89	7.9	8.1	7.5	7.7	7.8
Mean	1.07	22.01	7.3	7.0	6.7	6.9	6.8
Gilts:							
49-2	1.01	20.28	6.6	11.0	6.9	8.1	6.8
54-4	1.30	20.81	7.3	7.0	6.9	7.4	7.1
92-3	2.11	20.00	8.1	7.3	6.6	6.9	7.0
94-3	1.65	19.77	8.0	7.9	7.0	7.4	7.7
92-4	3.21	20.97	7.3	8.8	6.3	7.0	7.0
Mean	1.86	20.37	7.5	8.4	6.7	7.4	7.1
Purebred							
Barrows:							
10-6	.35	20.02	5.3	10.3	6.7	6.3	5.9
12-10	1.93	20.61	6.9	9.6	7.2	6.6	6.8
16-11	2.60	19.73	6.8	9.8	6.8	6.8	6.8
18-6	1.49	17.70	6.8	8.6	6.6	6.6	6.3
19-9	.66	15.94	7.9	6.4	6.8	6.8	7.0
Mean	1.41	18.80	6.7	8.9	6.8	6.6	6.6
Gilts:							
10-3	2.00	21.44	5.7	9.2	5.8	6.3	5.8
12-4	1.74	17.49	7.1	9.0	6.7	7.1	7.0
16-1	.86	18.59	7.1	8.4	6.7	7.0	6.9
17-1	1.76	18.16	5.8	9.8	6.4	6.3	6.1
21-1	1.48	20.70	5.8	10.6	6.5	6.3	5.7
Mean	1.57	19.28	6.3	9.4	6.4	6.6	6.3

Appendix D. Palatability and cooking loss data of pork chops. (continued)

Group IV (slaughter weight 100 to 120 pounds)							
		%	Tenderness		Panel		
Animal number	% drip	cooking loss	Panel	Shear	Flavor	Juiciness	Overall
Crossbred							
Barrows:							
50-8	1.47	21.69	6.5	8.7	5.8	7.1	6.3
58-8	1.37	18.98	7.5	7.0	5.9	6.2	6.6
58-10	1.83	14.67	6.7	6.4	6.7	5.6	6.4
58-11	1.56	16.33	6.4	7.5	6.7	6.2	6.5
95-5	.20	23.23	7.6	8.6	6.8	7.2	7.2
Mean	1.29	19.98	6.9	7.6	6.4	6.5	6.6
Gilts:							
47-1	1.84	21.50	5.7	10.6	6.2	6.3	6.2
54-2	1.40	18.90	7.2	6.0	6.5	6.7	6.4
95-3	1.11	22.35	7.0	10.0	6.9	7.7	6.9
96-1	.91	26.53	6.3	9.9	6.8	6.4	6.4
96-2	.84	22.83	7.8	8.1	7.0	6.8	7.1
Mean	1.22	22.42	6.8	8.9	6.7	6.8	6.6
Purebred							
Barrows:							
12-11	1.61	19.58	7.3	6.5	7.2	6.7	7.1
16-10	2.08	18.94	6.8	9.7	6.0	6.7	6.5
18-4	1.81	18.85	6.9	8.2	6.2	7.3	6.6
19-8	1.52	18.11	6.6	8.6	6.4	6.8	6.4
20-8	1.20	22.09	7.0	8.1	7.0	5.9	6.6
Mean	1.64	19.51	6.9	8.2	6.6	6.7	6.6
Gilts:							
4-4	1.80	17.00	4.9	9.3	6.0	6.9	5.7
8-5	1.97	22.61	6.5	8.7	7.1	6.8	7.0
12-5	1.69	20.13	6.4	7.7	6.5	6.3	6.1
15-5	1.94	21.48	6.0	9.7	6.5	6.3	6.3
16-5	2.43	23.95	7.2	9.3	6.4	5.6	6.3
Mean	1.97	21.03	6.2	8.9	6.5	6.4	6.3

Appendix E. Palatability data of hams and bacons; overall acceptability

Group I Sl. wt. 190-210 lbs.			Group II Sl. wt. 160-180 lbs.			Group III Sl. wt. 130-150 lbs.			Group IV Sl. wt. 100-120 lbs.		
Animal number	Ham	Bacon	Animal number	Ham	Bacon	Animal number	Ham	Bacon	Animal number	Ham	Bacon
Crossbred											
Barrows:			Barrows:			Barrows:			Barrows:		
47-8	7.3	7.1	49-7	7.4	7.4	42-8	6.9	6.8	50-8	7.2	7.5
52-8	6.7	7.1	50-5	7.0	7.3	50-9	7.0	7.1	58-8	6.8	7.4
58-13	7.4	6.8	52-11	7.7	6.3	58-6	7.3	7.6	58-10	7.8	7.3
92-6	7.5	7.0	58-9	7.6	7.2	58-7	7.4	6.8	58-11	7.1	7.3
92-10	7.4	7.5	58-12	7.9	8.0	92-8	7.2	7.3	95-5	7.3	6.3
Mean	7.3	7.1		7.5	7.2		7.2	7.1		7.2	7.2
Gilts:			Gilts:			Gilts:			Gilts:		
50-1	7.4	8.1	54-1	7.4	7.4	49-2	6.6	7.5	47-1	7.9	7.5
58-1	7.8	7.0	78-2	7.2	6.6	54-4	7.6	7.5	54-2	8.1	6.8
92-5	6.9	6.7	89-5	6.8	7.5	92-3	7.1	7.0	95-3	6.6	6.7
93-1	7.1	7.2	92-2	7.3	7.3	92-4	7.2	6.6	96-1	7.3	6.6
96-5	7.7	8.0	96-4	8.1	7.2	94-3	7.8	6.3	96-2	7.1	6.5
Mean	7.4	7.4		7.4	7.2		7.3	7.0		7.4	6.8
Purebred											
Barrows:			Barrows:			Barrows:			Barrows:		
12-8	7.1	6.9	6-6	7.2	6.5	10-6	6.1	7.1	12-11	7.3	7.3
16-8	6.6	6.9	12-12	7.3	6.6	12-10	8.0	7.0	16-10	7.2	7.2
18-5	7.4	7.2	16-9	7.2	6.8	16-11	7.9	6.8	18-4	7.2	7.2
19-11	6.3	7.5	17-11	6.3	6.7	18-6	7.7	7.1	19-8	7.6	7.5
19-14	6.5	6.1	18-7	7.3	6.7	19-9	7.0	7.5	20-8	7.6	6.7
Mean	6.8	6.9		7.1	6.7		7.3	7.1		7.4	7.2
Gilts:			Gilts:			Gilts:			Gilts:		
4-2	7.0	6.2	8-2	6.5	6.7	10-3	7.4	6.7	4-4	8.0	7.2
5-4	6.4	6.8	12-1	7.2	6.6	12-4	7.9	6.6	8-5	7.2	7.4
12-6	7.2	7.2	15-6	7.3	7.3	16-1	7.4	6.8	12-5	7.3	7.0
15-2	7.2	7.4	19-2	7.3	6.4	17-1	6.4	6.8	15-5	7.6	7.1
19-3	6.9	6.8	20-2	7.6	6.4	21-1	6.7	6.8	16-5	7.1	6.8
Mean	6.9	6.9		7.2	6.7		7.2	6.7		7.4	7.1

Appendix F. Munsell color renotation values.

Group I Sl. wt. 190-210 lbs.				Group II Sl. wt. 160-180 lbs.				Group III Sl. wt. 130-150 lbs.				Group IV Sl. wt. 100-120 lbs.			
Animal number	Hue	Value	Chroma	Animal number	Hue	Value	Chroma	Animal number	Hue	Value	Chroma	Animal number	Hue	Value	Chroma
Crossbred															
Barrows:				Barrows:				Barrows:				Barrows:			
47-8	7.6	6.5	2.7	49-7	5.0	5.6	3.3	42-8	6.8	5.7	3.1	50-8	6.4	5.4	2.6
52-8	6.7	5.2	3.3	50-5	6.5	5.9	3.4	50-9	6.3	6.0	3.5	58-8	7.1	5.9	2.7
58-13	4.4	5.7	3.5	52-11	7.4	6.3	3.0	58-6	8.3	5.6	3.2	58-10	6.0	5.6	2.9
92-6	7.4	5.5	3.4	58-9	6.8	5.6	4.0	58-7	5.0	5.3	3.2	58-11	6.5	6.1	3.0
92-10	8.1	5.4	3.1	58-12	5.2	5.8	2.3	92-8	7.5	5.5	3.3	95-5	5.9	5.2	2.8
Mean	6.8	5.7	3.2		6.2	5.8	3.2		6.8	5.6	3.3		6.4	5.6	2.8
Gilts:				Gilts:				Gilts:				Gilts:			
50-1	6.2	5.7	3.5	54-1	6.6	5.7	3.4	49-2	3.2	5.5	2.9	47-1	6.5	5.4	3.2
58-1	4.5	6.2	3.1	78-2	7.4	5.2	3.3	54-4	6.5	5.8	3.5	54-2	5.0	5.6	3.1
92-5	7.4	5.5	3.4	89-5	6.0	5.6	3.6	92-3	4.6	5.1	3.2	95-3	8.1	4.8	3.0
93-1	8.1	5.5	3.1	92-2	7.6	5.8	3.2	92-4	5.9	5.3	3.0	96-1	5.4	5.8	2.8
96-5	6.0	5.6	3.6	96-4	3.8	5.3	4.0	94-3	8.8	5.2	2.7	96-2	7.0	4.5	2.8
Mean	6.4	5.7	3.3		6.3	5.5	3.5		5.8	5.4	3.1		6.4	5.2	3.0
Purebred															
Barrows:				Barrows:				Barrows:				Barrows:			
12-8	4.3	5.3	3.8	6-6	8.1	5.7	2.7	10-6	6.4	5.6	2.7	12-11	6.9	5.6	3.1
16-8	5.1	4.7	3.4	12-12	8.0	5.5	2.9	12-10	4.2	5.2	3.3	16-10	5.0	5.6	3.1
18-5	4.6	4.8	3.3	16-9	4.7	4.7	3.4	16-11	7.4	4.6	2.8	18-4	7.1	5.4	3.0
19-11	7.2	5.4	2.9	17-11	4.0	4.9	4.6	18-6	5.1	4.9	3.2	19-8	6.4	5.5	3.2
19-14	7.2	5.9	3.3	18-7	8.4	5.9	3.1	19-9	7.6	5.8	2.7	20-8	9.0	5.3	2.6
Mean	5.7	5.2	3.3		6.6	5.3	3.3		6.1	5.2	2.9		6.9	5.5	3.0
Gilts:				Gilts:				Gilts:				Gilts:			
4-2	4.5	5.6	3.3	8-2	5.0	5.6	3.7	10-3	5.3	5.7	3.4	4-4	7.7	5.6	3.6
5-4	4.5	4.7	3.0	12-1	5.9	4.5	2.5	12-4	8.2	5.2	2.8	8-5	4.7	5.4	3.1
12-6	5.0	5.0	3.4	15-6	4.5	5.3	3.6	16-1	7.6	5.8	3.1	12-5	7.5	5.3	3.1
15-2	6.0	5.1	2.8	19-2	5.8	5.6	3.1	17-1	5.9	5.1	3.7	15-5	8.8	5.0	2.7
19-3	5.6	5.4	3.6	20-2	4.1	4.6	3.5	21-1	6.6	5.0	2.6	16-5	5.9	5.9	3.1
Mean	5.1	5.2	3.2		5.1	5.1	3.3		6.7	5.4	3.1		6.9	5.4	3.1

Appendix G. Water holding capacity data; Methods I and II.

Group I (slaughter weight 190-210 pounds)						
	Method I			Method II		
Animal number	% free H_2O	pH	H-ion conc. (x10^7)	% free H_2O	pH	H-ion conc. (x10^7)
Crossbred						
Barrows:						
47-8	60.0	--	--	--	--	--
52-8	61.2	5.57	25.12	51.0	5.55	25.12
58-13	55.0	5.64	25.12	46.5	5.63	25.12
92-6	62.9	5.50	31.63	48.3	5.65	19.95
92-10	61.1	5.60	25.12	45.9	5.50	31.63
Mean	60.0					
Gilts:						
50-1	56.6	5.55	25.12	46.7	5.60	25.12
58-1	52.1	5.58	25.12	45.9	5.62	25.12
92-5	59.5	5.59	25.12	43.1	5.53	31.63
93-1	64.4	5.50	31.63	47.1	5.51	31.63
96-5	66.3	5.40	39.81	46.0	5.28	50.13
Mean	59.8					
Purebred						
Barrows:						
12-8	52.0	5.82	15.85	43.7	5.83	15.85
16-8	54.5	5.86	12.59	47.5	5.70	19.95
18-5	49.3	5.96	10.00	43.3	5.85	12.95
19-11	53.0	5.56	25.12	47.0	5.71	19.95
19-14	53.8	5.73	19.95	45.6	5.72	19.95
Mean	52.5					
Gilts:						
4-2	50.3	5.59	25.12	48.3	5.59	25.12
5-4	50.4	5.78	15.85	42.9	5.87	12.59
12-6	50.1	5.81	15.85	42.6	5.86	12.59
15-2	51.3	6.14	7.94	42.9	6.20	6.31
19-3	50.9	5.59	25.12	47.9	5.59	25.12
Mean	50.6					

Appendix G. Water holding capacity data; Methods I and II. (continued)

Group II (slaughter weight 160 to 180 pounds)						
	Method I			Method II		
Animal number	% free H_2O	pH	H-ion conc. ($x10^7$)	% free H_2O	pH	H-ion conc. ($x10^7$)
Crossbred						
Barrows:						
49-7	56.4	--	--	--	--	--
50-5	54.4	--	--	--	--	--
52-11	55.1	--	--	--	--	--
58-9	52.6	--	--	--	--	--
58-12	57.9	5.56	25.12	43.7	5.83	15.85
Mean	55.3					
Gilts:						
54-1	62.5	--	--	--	--	--
78-2	66.3	5.55	25.12	44.7	5.68	19.95
89-5	61.7	5.62	25.12	47.3	5.60	25.12
92-2	60.9	5.63	25.12	49.9	5.65	19.95
96-4	61.1	5.45	31.63	48.2	5.50	31.63
Mean	62.5					
Purebred						
Barrows:						
6-6	54.9	5.68	19.95	49.1	5.68	19.95
12-12	53.8	6.10	7.94	40.6	6.10	7.94
16-9	52.8	5.80	15.85	46.3	5.80	15.85
17-11	50.6	5.76	15.85	45.5	5.63	25.12
18-7	48.9	5.59	25.12	44.0	5.59	25.12
Mean	52.2					
Gilts:						
8-2	49.2	5.72	19.95	44.1	5.53	31.63
12-1	49.9	5.88	12.59	42.4	5.73	19.95
15-6	55.6	5.63	25.12	47.8	5.73	19.95
19-2	51.0	5.77	15.85	47.6	5.77	15.85
20-2	49.1	6.12	7.94	44.8	5.96	10.00
Mean	51.0					

Appendix G. Water holding capacity data; Methods I and II. (continued)

Group III (slaughter weight 130 to 150 pounds)						
	Method I			Method II		
Animal number	% free H_2O	pH	H-ion conc. ($x10^7$)	% free H_2O	pH	H-ion conc. ($x10^7$)
Crossbred						
Barrows:						
42-8	68.1	--	--	--	--	--
50-9	70.7	--	--	--	--	--
58-6	68.6	--	--	--	--	--
58-8	64.5	--	--	--	--	--
92-8	60.8	5.55	25.12	47.6	5.61	25.12
Mean	66.5					
Gilts:						
49-2	56.0	5.72	19.95	52.9	5.66	19.95
54-4	59.0	--	--	--	--	--
92-3	59.6	5.76	15.85	51.7	5.62	25.12
92-4	61.7	5.65	19.95	48.8	5.65	19.95
94-3	58.6	5.51	31.63	47.3	5.60	25.12
Mean	59.0					
Purebred						
Barrows:						
10-6	59.1	5.62	25.12	46.6	5.70	19.95
12-10	53.0	5.63	25.12	44.4	5.85	12.59
16-11	51.9	--	--	--	--	--
18-6	49.3	5.94	10.00	45.3	5.90	12.59
19-9	56.8	5.66	19.95	44.5	5.80	15.85
Mean	54.0					
Gilts:						
10-3	54.0	5.98	10.00	49.8	5.99	10.00
12-4	49.1	--	--	--	--	--
16-1	53.5	5.77	15.85	44.7	5.70	19.95
17-1	49.6	5.77	15.85	43.2	5.77	15.85
21-1	41.8	5.50	31.63	46.5	5.70	19.95
Mean	49.6					

Appendix G. Water holding capacity data; Methods I and II. (continued)

Group IV (slaughter weight 100 to 120 pounds)						
	Method I			Method II		
Animal number	% free H_2O	pH	H-ion conc. ($\times 10^7$)	% free H_2O	pH	H-ion conc. ($\times 10^7$)
Crossbred						
Barrows:						
50-8	66.1	--	--	--	--	--
58-8	64.7	--	--	--	--	--
58-10	64.2	--	--	--	--	--
58-11	66.6	--	--	--	--	--
95-5	65.5	5.58	25.12	49.4	5.71	19.95
Mean	65.4					
Gilts:						
47-1	75.0	--	--	--	--	--
54-2	60.1	--	--	--	--	--
95-3	63.3	5.60	25.12	51.5	5.58	25.12
96-1	61.0	5.62	25.12	49.5	5.62	25.12
96-2	57.9	5.62	25.12	52.7	5.55	25.12
Mean	63.5					
Purebred						
Barrows:						
12-11	52.3	--	--	--	--	--
16-10	50.9	5.78	15.85	45.1	5.64	25.12
18-4	49.3	--	--	--	--	--
19-8	55.4	5.87	12.59	47.3	5.85	12.59
20-8	53.5	5.61	25.12	49.6	5.53	31.63
Mean	52.3					
Gilts:						
4-4	53.3	--	--	--	--	--
8-5	51.9	--	--	--	--	--
12-5	53.2	--	--	--	--	--
15-5	55.0	5.90	12.59	44.0	5.80	15.85
16-5	52.9	5.56	25.12	47.0	5.40	39.81
Mean	53.3					

Appendix H. Smoked yields of hams and bacons

Group I			Group II			Group III			Group IV		
Animal No.	Ham (%)	Bacon (%)	Animal No.	Ham (%)	Bacon (%)	Animal No.	Ham (%)	Bacon (%)	Animal No.	Ham (%)	Bacon (%)
47-8	103.7	90.2	49-7	99.2	90.4	42-8	102.0	90.1	50-8	101.2	86.1
52-8	100.8	88.5	50-5	101.8	86.1	50-9	101.0	86.2	58-8	101.3	84.2
58-13	103.1	88.6	52-11	98.3	75.6	58-6	100.9	96.0	58-10	101.9	83.2
92-6	95.8	84.4	58-9	101.6	83.1	58-7	101.0	91.7	58-11	97.4	83.2
92-10	96.8	83.7	58-12	102.3	91.1	92-8	94.9	78.3	95-5	101.3	83.3
Mean	100.0	87.1		100.6	85.3		100.0	88.5		100.6	84.0
50-1	103.8	89.0	54-1	100.7	86.3	49-2	100.9	94.5	47-1	102.3	85.1
58-1	100.0	83.7	78-2	100.0	85.9	54-4	101.6	85.3	54-2	102.7	88.2
92-5	96.6	83.5	89-5	100.8	85.0	92-3	99.0	72.2	95-3	96.3	69.6
93-1	103.3	82.6	92-2	97.7	86.8	92-4	100.9	74.1	96-1	92.1	69.0
96-5	100.0	86.6	96-4	101.6	88.6	94-3	100.0	78.3	96-2	94.7	71.1
Mean	100.7	85.1		100.2	86.5		100.5	80.9		97.6	76.6
12-8	101.6	84.9	6-6	103.7	80.0	10-6	95.7	74.2	12-11	102.7	79.5
16-8	99.2	86.7	12-12	99.1	80.6	12-10	96.0	77.4	16-10	100.0	76.1
18-5	104.5	77.2	16-9	103.1	83.8	16-11	96.9	73.2	18-4	100.0	79.5
19-11	97.1	78.0	17-11	93.6	77.8	18-6	97.6	82.5	19-8	97.7	70.0
19-14	101.3	81.7	18-7	101.7	85.7	19-9	95.1	81.0	20-8	100.8	83.6
Mean	100.7	81.7		100.2	81.6		96.3	77.7		100.2	77.7
4-2	99.3	76.8	8-2	98.3	79.5	10-3	99.1	78.6	4-4	100.0	79.5
5-4	103.5	79.7	12-1	80.6	80.6	12-4	99.0	76.8	8-5	100.0	73.3
12-6	100.7	80.0	15-6	100.8	78.5	16-1	93.7	79.4	12-5	101.3	70.2
15-2	92.5	80.4	19-2	102.7	72.5	17-1	98.0	84.5	15-5	99.0	76.3
19-3	102.0	76.9	20-2	102.6	84.7	21-1	96.4	78.3	16-5	97.8	75.6
Mean	99.6	78.8		97.0	79.2		97.3	79.5		99.6	75.0

Appendix I. Composition of grower ration

Ingredient	Percentage
Corn	76.7
Soybean oil meal (44% protein)	16.0
Meat and bone scraps (50% protein)	2.0
Fish meal (60% protein)	1.0
Alfalfa (17% protein)	2.5
Limestone	.7
Dicalcium phosphate	.3
Trace mineral salt (1)	.5
Vitamin B mixture (2)	.1
Pfizer 9+ (3)	.05
A & D mixture (4)	.025
Aurofac 10 (5)	.125
	100.000

(1) Trace Mineral Salt: .400% manganese; .011% iodine; .330% iron; .048% copper; .022% cobalt; .800% zinc.

(2) Vitamin B mixture: 2000 mg./lb. Riboflavin; 4000 mg./lb. Pantothenic acid; 9000 mg./lb. Niacin; 8679 mg./lb. Choline.

(3) Pfizer 9+: 9 mg./lb. Vitamin B_{12}

(4) A & D mixture: 10,000 I.U. Vitamin A/g.; 1,250 I.U. Vitamin D_2/g.

(5) Aurofac 10: 10,000 mg./lb. Aureomycin

(6) TM 10: 10,000 mg./lb. Terramycin

Appendix J. Composition of finishing ration

Ingredient	Percentage
Corn	86.3
Soybean oil meal (44% protein)	7.0
Meat and bone scraps (50% protein)	2.0
Fish meal (60% protein)	1.0
Alfalfa (17% protein)	2.0
Limestone	.7
Dicalcium phosphate	.3
Trace mineral salt (1)	.5
Vitamin B mixture (2)	.1
A & D mixture (3)	.025
Aurofac 10 (4)	.050
TM 10 (5)	.025
	100.000

(1) Trace mineral salt: .400% manganese; .011% iodine; .330% iron; .048% copper; .022% cobalt; .800% zinc.

(2) Vitamin B mixture: 2000 mg./lb. Riboflavin; 4000 mg./lb. Pantothentic acid; 9000 mg./lb. Niacin; 8679 mg./lb. Choline.

(3) A & D mixture: 10,000 I.U. Vitamin A/g.; 1,250 I.U. Vitamin D_2/g.

(4) Aurofac 10: 10,000 mg./lb. Aureomycin.

(5) TM 10: 10,000 mg./lb. Terramycin.

Appendix K. Carcass data sheet.

Hog No.________ Lot No.________ Breed______________ Sex________________

Date weighed __________ Date slaughtered __________ Date cut________

Feedlot wt. ___________ Slaughter wt. _____________ Hot dressing %____

24 hr. shrink ______lbs. Hot carcass wt.___________ Cold dressing %____

24 hr. shrink ______% Cold carcass wt.___________ Cooler shrink___lbs.
Cooler shrink____%

Backfat thickness: 1st rib______ Last rib ______ Average B.F.________
7th rib______ Last lumbar____ Carcass length______

Leaf fat & kidney ________lbs. Viscera ________lbs. Heart__________gms.
Head (less tongue)________lbs. Viscera ________% Liver__________gms.
Tongue_________gms.

Ham:	Left	Right	Total	% live wt.	% carcass wt.
Untrimmed ham	_____	_____	_____	_________	____________

Untrimmed ham (right); Wt. in water _____gms.; Specific gravity______

Skinned ham	_____	_____	_____	_________	____________

Loin:

Rough loin	_____	_____	_____	_________	____________
Trimmed loin	_____	_____	_____	_________	____________

Marbling score (10th rib)_____ Ares L.D. 10th _____ Last___________
Area fat 10th _____ Last___________

Shoulder:

N.Y.Shoulder	_____	_____	_____	_________	____________
Total lean cuts			_____	_________	____________

Belly:

Trimmed belly	_____	_____	_____	_________	__________
Total primal cuts			_____	_________	__________

Trimmings:

Fat trimmings			_____	_________	__________
Lean trimmings			_____	_________	__________

Appendix L. Taste panel evaluation sheet.

Preference Test

Name____________________ Plate No.________ Date____________

Code ______	Code ______	Code ______	Code ______
___Like extremely	___Like extremely	___Like extremely	___Like extremely
___Like very much	___Like very much	___Like very much	___Like very much
___Like moderately	___Like moderately	___Like moderately	___Like moderately
___Like slightly	___Like slightly	___Like slightly	___Like slightly
___Neither like nor dislike	___Neither like nor dislike	___Neither like nor dislike	___Neither like nor dislike
___Dislike slightly	___Dislike slightly	___Dislike slightly	___Dislike slightly
___Dislike moderately	___Dislike moderately	___Dislike moderately	___Dislike moderately
___Dislike very much	___Dislike very much	___Dislike very much	___Dislike very much
___Dislike extremely	___Dislike extremely	___Dislike extremely	___Dislike extremely
Comments:___	Comments:___	Comments:___	Comments:___

Appendix M. Taste panel data sheet (loin chops)

Name ____________________________

Plate No. ______________________

<u>Directions</u>: Rate each sample as to its Tenderness, Flavor, Juiciness and its Overall Acceptability.
Do not compare samples as each judgement is independent.
Determine the suitable Sample Description and write the corresponding numerical Score in the space provided.

<u>Sample Description</u>	<u>Score</u>
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Sample Identification	Tenderness	Flavor	Juiciness	Overall Acceptance

Appendix N. Consumer's questionaire

<u>CONFIDENTIAL</u> Do not sign, this information is for research purposes only.

1. First of all, what is your relationship to your family:
   Wife___, Husband___, Child___, Maid___, Other____________________.

2. What are the approximate ages of the heads of your household? Please check the one which fits best.

Female head		Male head	
( ) under 30 yrs.	( ) 46-60	( ) under 30 yrs.	( ) 46-60
( ) 30-35	( ) over 60	( ) 30-35	( ) over 60
( ) 36-45		( ) 36-45	

3. Who does most of the food buying for your family? (Check one)
   Male head_____, Female head _____, Both _____, Other ______________.

4. How many persons are there in your household? That is, how many eat their meals regularly in your home? _____

5. About how many years of formal education (including elementary) have you completed? _____ yrs.

6. About what is the total income (combined income) of your family?

   Less than $80 per week ___
   $80-100 per week($4-5,000/yr)___
   $101-140 per week($5-7,000/yr.)___
   $141-200 per week ($7-10,000/yr.)___
   Over $200 per week($10,000/yr.) ___

7. About how often is fresh pork served in your household? (Any type cut)

   ( ) 3 times a week
   ( ) 2 times a week
   ( ) 1 time a week
   ( ) 1 time a month
   ( ) 2 times a month

8. If your selection was based upon one or more of the following factors, please make a check beside it (or them).

   ( ) size (weight) of cut
   ( ) color of cut
   ( ) Amount of fat
   ( ) none of above

9. Which do you consider as being your home state? (the state in which you spent the majority of your youth) ______________________________

Thank you for your cooperation.

Appendix O. Water-holding capacity. Tabulation of free moisture area vs. free moisture.

Free moisture area (sq. in.) (X)	Free moisture (mg.) (Y)
.57	28.1
.60	25.6
.61	26.4
.72	35.4
1.25	70.3
1.20	59.7
1.29	64.2
1.20	59.7
2.10	104.0
1.70	87.1
1.76	93.0
2.10	108.3
3.11	157.0
3.04	157.7
2.43	124.6
2.44	130.8
3.21	173.9
3.02	155.3
3.30	161.6
3.41	171.2

Appendix P. Mean squares from the analysis of variance of hot and cold carcass dressing percentages.

		Mean square	
Source of variance	d.f.	Hot dressing %	Cold dressing %
Weight group (WG)	3	39.95**	52.26**
Breed (B)	1	42.63**	35.65**
Sex (S)	1	4.14	3.12
B x S	1	2.81	4.51
B x WG	3	0.54	2.09
S x WG	3	0.65	0.69
B x S x WG	3	0.03	0.19
Error	64	1.62	1.80
Pooled error	74	1.49	1.74

* P < .05
**P < .01

Appendix Q. Mean squares from the analysis of variance of percentage of lean cuts on the live and carcass bases.

Source of variance	d.f.	Mean square: % lean cuts (live basis)	Mean square: % lean cuts (carcass basis)
Weight group (WG)	3	8.76*	82.22**
Breed (B)	1	0.49	17.77
Sex (S)	1	76.63**	114.96**
B x S	1	0.83	0.00
B x WG	3	0.88	3.35
S x WG	3	0.29	2.74
B x S x WG	3	1.08	1.17
Error	64	3.22	6.02
Pooled error	74	2.89	5.50

* $P < .05$
** $P < .01$

Appendix R. Mean squares from the analysis of variance of percentage of primal cuts on the live and carcass basis.

Source of variance	d.f.	Mean square: % primal cuts (live basis)	Mean square: % primal cuts (carcass basis)
Weight group (WG)	3	4.32	42.93**
Breed (B)	1	0.94	23.43*
Sex (S)	1	49.77**	68.63**
B x S	1	0.21	0.64
B x WG	3	0.74	3.11
S x WG	3	0.13	1.79
B x S x WG	3	1.34	1.97
Error	64	3.26	4.98
Pooled error	74	2.92	4.59

* P < .05
** P < .01

Appendix S. Mean squares from the analysis of variance of average backfat thickness, carcass length, loin eye area, and specific gravity.

		Mean square			
Source of variance	d.f.	Average backfat thickness	Carcass length	Loin eye area	Specific gravity ($x10^{-3}$)
Weight group (WG)	3	0.97**	82.09**	4.23**	0.267**
Breed (B)	1	0.03	17.58**	0.65*	1.030**
Sex (S)	1	0.41**	6.67**	6.01**	0.495**
B x S	1	0.01	1.38	0.14	.009
B x WG	3	0.01	0.14	0.17	.001
S x WG	3	0.05	0.35	0.23	.019
B x S x WG	3	0.01	0.47	0.01	.015
Error	64	0.03	0.58	0.14	.021
Pooled error	74	0.026	0.56	0.14	.020

* $P < .05$
** $P < .01$

Appendix T. Mean squares from the analysis of variance of percentage protein, ether extract and moisture of the rough ham and L. dorsi.

Source of variance	d.f.	Mean square: Protein (%)	Mean square: Ether extract (%)	Mean square: Moisture (%)
Rough ham:				
Weight group (WG)	3	5.90**	222.00**	153.66**
Breed (B)	1	31.84**	109.87**	24.17
Sex (S)	1	13.67**	207.21**	107.50**
B x S	1	.08	.46	2.18
B x WG	3	.34	.80	2.69
S x WG	3	.43	12.26	5.73
B x S x WG	3	.41	18.50	11.42
Error	64	.76	11.57	7.76
Pooled error	74	.70	11.30	7.54
L. dorsi:				
Weight group (WG)	3	1.90*	2.66	6.85**
Breed (B)	1	88.03**	71.44**	1.87
Sex (S)	1	.84	12.64*	.79
B x S	1	.14	3.18	.81
B x WG	3	.007	.07	.22
S x WG	3	.31	2.66	1.88
B x S x WG	3	.36	1.65	.71
Error	64	.68	3.36	1.11
Pooled error	74	.62	3.13	1.08

* $P < .05$
** $P < .01$

Appendix U. Mean squares from the analysis of variance of the physical separation data of the rough ham.

Source of variance	d.f.	Mean squares % fat	% lean	% skin	% bone	Specific gravity of bone ($x10^{-3}$)
Weight group (WG)		227.34**	112.80**	1.83	10.27**	3.032*
Breed (B)		40.23	12.26	3.47*	22.02**	4.147*
Sex (S)		265.32**	260.97**	0.64	0.49	1.870
B x S		2.22	4.96	0.32	1.77	.548
B x WG		9.67	8.45	0.41	0.39	1.037
S x WG		14.96	4.94	0.54	0.91	.233
B x S x WG		29.08	26.30	0.39	0.07	.090
Error		14.39	13.80	0.78	0.68	.588
Pooled error		14.65	13.61	0.73	0.66	.571

* $P < .05$
** $P < .01$

Appendix V. Mean squares from the analysis of variance of taste panel test scores and percentages of smoked yield for smoked hams and bacons.

		Mean squares			
		Taste panel scores		% yield	
Source of variance	d.f.	Hams	Bacons	Hams	Bacons
Weight group (WG)	3	0.26	0.08	10.61	102.98**
Breed (B)	1	0.52	0.97	26.68	571.92**
Sex (S)	1	0.04	0.15	12.01	159.27*
B x S	1	0.01	0.02	0.99	19.67
B x WG	3	0.37	0.45*	17.17	4.67
S x WG	3	0.04	0.16	8.34	14.28
B x S x WG	3	0.07	0.07	6.74	45.55
Error	64	0.20	0.16	12.65	24.06
Pooled error	74	0.19	--	12.26	23.69

* $P < .05$
** $P < .01$

Appendix W. Mean squares from the analysis of variance of various palatability characteristics and percentages of cooking loss of fresh loin pork chops.

		Mean squares					
			Taste panel				Cooking loss
Source of variation	d.f.	W-B shear	Tenderness	Flavor	Juiciness	Overall	(%)
Weight group (WG)	3	0.75	0.52	0.23	0.42	0.30	1.40
Breed (B)	1	17.20**	7.44**	0.56	0.38	2.24**	129.01**
Sex (S)	1	18.91**	1.74	0.01	0.11	0.29	7.15
B x S	1	1.00	0.09	0.09	0.20	0.01	6.36
B x WG	3	1.25	0.28	0.12	0.12	0.14	9.01
S x WG	3	0.003	0.40	0.19	0.01	0.36	7.71
B x S x WG	3	0.37	0.37	0.50	0.57	0.45	4.32
Error	64	1.86	0.71	0.18	0.37	0.31	4.93
Pooled error	74	1.69	0.66	0.19	0.36	0.30	5.20

Appendix X. Mean squares from the analysis of variance of the surface color renotations of hue, value and chroma of fresh pork chops.

Source of variation	d.f.	Mean squares		
		Hue	Value	Chroma
Weight group (WG)	3	1.76	0.01	0.53**
Breed (B)	1	1.17	0.19	0.00
Sex (S)	1	2.41	0.40	0.09
B x S	1	0.03	1.56**	0.03
B x WG	3	2.88	0.74**	0.08
S x WG	3	0.56	0.08	0.03
B x S x WG	3	2.18	0.25	0.13
Error	64	1.93	0.12	0.14
Pooled error	74	1.90	1.56	0.13

** P < .01

Appendix Y. Mean squares from the analysis of variance of the water-holding capacity (Method I) of *L. dorsi* muscles expressed in terms of percentage of free moisture.

Source of variation	d.f.	Mean squares
Weight groups (WG)	3	46.98
Breed (B)	1	1831.70**
Sex (S)	1	26.22
B x S	1	5.09
B x WG	3	21.52
S x WG	3	68.34
B x S x WG	3	36.98
Error	64	11.29
Pooled error	74	14.97

** $P < .01$

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