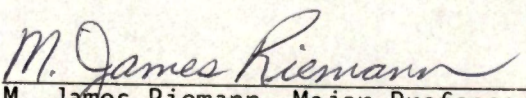
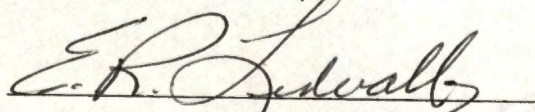
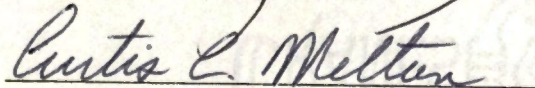


To the Graduate Council:

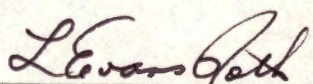
I am submitting herewith a thesis written by Mark Stephen Franzreb entitled "A Comparison of Quality, Value, Histological and Palatability Characteristics of Pork Carcasses of Varying Weights " I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Food Technology and Science.


M. James Riemann, Major Professor

We have read this thesis and
recommend its acceptance:

Accepted for the Council:


Vice Chancellor
Graduate Studies and Research

A COMPARISON OF QUALITY, VALUE, HISTOLOGICAL
AND PALATABILITY CHARACTERISTICS OF
PORK CARCASSES OF VARYING WEIGHTS

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Mark Stephen Franzreb

August 1982

3063022

ACKNOWLEDGEMENTS

The completion of this study was the culmination of the efforts and contributions of many people. The author wishes to express his sincerest appreciation to the following people:

To Dr. M. J. Riemann, who served as Major Professor and whose guidance, direction and friendship made this thesis possible;

To Dr. C. C. Melton and Professor E. R. Lidvall, Jr., Committee Members, for advice and serving on the author's committee;

To Pat Bosheers, Mark Britton, Dr. P. M. Davidson, Bruce Greene, Ruth Hill, Eddie Jarboe, Teresa Mann, Dr. J. R. Mount, Mackie Nisbett, Dee Reviere, Dr. M. J. Riemann, Helen Scott, Walker Stockley and David Watkins, for serving as taste panelists;

To Dr. J. T. Miles, Department Head, for providing financial assistance for this study;

To Denise Cardin, Lab Technician, for invaluable assistance in the laboratory as well as her sincere friendship;

To Cindy Yarbrough, for her laboratory assistance and friendship;

To Bob Grindstaff, for his help in fabrication and processing of carcasses, as well as his friendship;

To Mackie Nisbett, for his much appreciated help with statistical analyses involved in this thesis;

To Dr. Bill Sanders and Viola Gibbons, for their statistical assistance;

To Mr. and Mrs. John K. Franzreb, the author's parents, for their continued love and support;

And, to Dee Reviere and Walker Stockley, for their valuable assistance in carcass selection, transportation and fabrication as well as their invaluable friendship, the author wishes to express his warmest and sincerest appreciation.

ABSTRACT

Forty-eight barrow and forty-eight gilt carcasses (n=96), ranging from 66 to 102 kg hot carcass weight and 1.52 to 4.32 cm average backfat thickness with moderately thick being the minimum acceptable muscling score, were selected from a local Knoxville, Tennessee packing plant, identically fabricated and evaluated for various quality, value, histological and palatability characteristics.

Mean longissimus areas measured at the second, fifth and tenth ribs were all significantly greater ($P<.01$) for the trimmer carcasses (1.52 to 2.29 cm) and gilts had significantly larger ($P<.01$) longissimus areas at the second and tenth ribs than barrows.

Mean marbling and lean firmness scores were nonsignificant with respect to average backfat thickness and hot carcass weight, but marbling scores were higher ($P<.01$) for barrows and displayed a significant interaction ($P<.01$) between hot carcass weight x sex. Lean firmness scores had significant interactions ($P<.05$) for backfat x hot carcass weight and backfat x sex.

Visual lean color scores were highly significant with respect to Hunter L color-difference values ($P<.0001$) and Hunter b values ($P<.01$) but nonsignificant with respect to Hunter a values.

Percents ham, loin, picnic shoulder and belly as well as percent of the four lean cuts, percent primal cuts and percent ham-loin were all nonsignificant with respect to hot carcass weight and sex condition with the exception of percent lean cuts where gilts had significantly higher ($P<.05$) percentages than barrows. Heavier

carcasses ($P < .01$) and trimmer carcasses ($P < .001$) were significantly greater with respect to Boston butt. Percentage lean in various bacon slices decreased significantly ($P < .05$) only as average backfat thickness increased.

Mean percentages of water and fat (on both a wet and dry basis) were not significantly different ($P < .01$) with respect to hot carcass weight or sex condition. Fatter carcasses had significantly lower ($P < .01$) water percentages and trimmer carcasses had significantly lower ($P < .01$) fat percentages.

Percents volatile, nonvolatile and total cooking losses were not significantly different ($P < .01$) with respect to hot carcass weight or sex condition, but nonvolatile cooking losses were significantly lower ($P < .001$) for trimmer carcasses (1.52 to 2.29 cm).

Mean fiber diameters were significantly different ($P < .05$) only with respect to the backfat x sex interaction.

Mean scores for flavor, juiciness, tenderness and overall acceptability of pork loin chops were nonsignificant ($P < .01$) with respect to hot carcass weight and sex condition but were significantly lower ($P < .001$) for loin chops from trimmer carcasses (1.52 to 2.29 cm) across all hot carcass weight groups.

Although small, R-squared values for Warner-Bratzler Shear, muscle fiber diameter, fat percentage (wet basis) and volatile, non-volatile and total cooking losses were highly significant ($P < .0001$) with respect to all palatability traits.

Mean weights for all wholesale cuts increased in a linear

fashion with increasing hot carcass weights with no differences attributed to sex condition ($P < .01$). Loin and belly weights were not significantly different ($P < .01$) with respect to average backfat thickness, while ham, Boston butt and picnic shoulder weights were significantly lower ($P < .01$) for fatter (3.56 to 4.32 cm) carcasses.

Mean cooking losses for hams decreased with increased carcass fatness ($P < .001$) but increased with increasing hot carcass weights ($P < .001$). Mean cooking losses for bellies significantly decreased ($P < .001$) with increased carcass fatness but were not significantly different ($P < .01$) with respect to hot carcass weight. Hams were nonsignificant and bellies were significant ($P < .05$) with respect to cooking losses and sex condition with gilts having greater belly cooking losses than barrows.

It was concluded that carcass quality and cutability is at least maintained or possibly improved with respect to increased slaughter weights as long as backfat deposition is adequately controlled with trimmer carcasses generally having greater total values. This would indicate that it would be beneficial for packers to pay producers premiums for heavier hogs that yield carcasses of superior merit.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION	1
II. REVIEW OF LITERATURE	3
The Relationship of Sex Condition, Live Animal Weight, Carcass Weight and Backfat Thickness on Pork Carcass Quality and Cutability . . .	3
Quality	3
Cutability	4
The Relationship of Sex Condition, Carcass Weight and Backfat Thickness to Composition, Cooking, Histological and Palatability Traits of Pork Loin Chops	9
Composition	9
Cooking	10
Histological	10
Palatability	13
Effect of Sex Condition, Carcass Weight and Backfat Thickness on Quality and Quantity of Belly and Bacon Yields	16
III. THE RELATIONSHIP OF SEX CONDITION, CARCASS WEIGHT AND BACKFAT THICKNESS ON PORK CARCASS QUALITY AND CUTABILITY	20

CHAPTER	PAGE
III. (Continued)	
Summary	20
Introduction.	22
Materials and Methods	23
Results and Discussion	24
Conclusion	31
IV. THE RELATIONSHIP OF SEX CONDITION, CARCASS WEIGHT AND BACKFAT THICKNESS TO COMPOSITION, COOKING, HISTOLOGICAL AND PALATABILITY TRAITS OF PORK LOIN CHOPS	35
Summary.	35
Introduction.	36
Materials and Methods	37
Results and Discussion.	39
Conclusion	47
V. EFFECT OF SEX CONDITION, CARCASS WEIGHT AND BACKFAT THICKNESS ON PORK CARCASS VALUE AND YIELD OF FRESH AND PROCESSED WHOLESALE CUTS	49
Summary.	49
Introduction.	50
Materials and Methods	51
Results and Discussion	52
Conclusion	61
VI. GENERAL CONCLUSION	62

CHAPTER	PAGE
LITERATURE CITED	64
VITA	71



LIST OF TABLES

TABLE		PAGE
1.	Experimental Design	21
2.	Means of <u>Longissimus</u> Measurements and Pork Carcass Quality Characteristics as Determined by Hot Carcass Weight, Average Backfat Thickness and Sex Condition	25
3.	R-Squared Values Between Hot Carcass Weight, Average Backfat Thickness and Sex Condition and Various Carcass Measurements and Characteristics	28
4.	Mean Percentages of Wholesale Cuts as Determined by Hot Carcass Weight, Average Backfat Thickness and Sex Condition.	30
5.	Means of Various Carcass Characteristics as Determined by Hot Carcass Weight and Average Backfat Thickness of Barrow and Gilt Carcass Combined	32
6.	Means of Composition, Cooking Losses, Histological and Palatability Traits of Pork Loin Chops and Lean Percentages of Selected Bacon Slices.	40
7.	R-Squared Values Between Palatability Traits and Various Carcass, Histological, Composition and Cooking Characteristics	45

TABLE	PAGE
8. Mean Weights of Fresh Pork Cuts from Barrow and Gilt Carcasses Varying in Weight and Average Backfat Thickness.	54
9. Mean Monthly Prices of Fresh Pork Cuts from May 1, 1981-April 30, 1982	56
10. Mean Value of Fresh Pork Cuts from Barrow and Gilt Carcasses Varying in Weight and Average Backfat Thickness.	57
11. Relative Value of Pork Carcasses on a Percentage Basis for Various Carcass Weights and Last Rib Backfat Measurements	58
12. Mean Processing Weights of Hams and Bellies from Barrow and Gilt Carcasses Varying in Weight and Average Backfat Thickness.	60

CHAPTER I

INTRODUCTION

Several recent events have resulted in an interest in alternative or heavier market weights for swine in the United States. Increases in fixed costs in both farrowing and finishing operations in the 1970's along with sharp fluctuations in grain prices, the ever-increasing costs of energy and spiraling interest rates have caused many producers great concern and stirred interest in profitability of heavier market hogs within limitations of acceptable quality and cutability. Also favoring increased market weights of hogs is the increasing popularity of restructured pork products and the recent advances in the boxed pork industry which can more than double the normal shelf life of conventionally handled fresh pork and, thereby, aid in the merchandising of such products.

Present-day hogs have illustrated the potential to produce heavyweight carcasses of superior quality (within the limitations of the animal's inherent genetics), provided that backfat deposition is satisfactorily controlled. Economic advantages may be possible for both packers and producers through the extension of finishing periods in order to produce hogs with heavier carcasses while at least maintaining, or, possibly, improving meat quality.

This study with conventional and heavy weight market hog carcasses was conducted to determine: (1) whether significant qualitative or quantitative differences exist between normal and heavyweight

market hog carcasses; and, (2) the relative value of such heavyweight carcasses.

This thesis was organized to contain a literature review followed by three chapters, each representing a scientific journal article, which, with minor modification can be submitted for publication. The final part of the thesis is a general summary and conclusion for the entire study.

CHAPTER II

REVIEW OF LITERATURE

I. THE RELATIONSHIP OF SEX CONDITION, LIVE ANIMAL WEIGHT, CARCASS WEIGHT AND BACKFAT THICKNESS ON PORK CARCASS QUALITY AND CUTABILITY

Quality

Pork quality, according to Sebranek (1981), differs with the varying segments of the swine industry, i.e., the producer is concerned with the traits of live weights, dressing percent, degree of muscling and absence of fat. Packers and processors focus on muscle firmness, meat color and yields or weight of cuts produced. Retailers are primarily concerned with lean appearance, storage stability and water losses or weep in packages as are consumers, who also desire the satisfaction attributes of tenderness, juiciness, flavor, ease of preparation and minimal shrinkage. Bray (1966) defines fresh meat quality as those factors associated with the palatability of fresh and cured products and economic losses during processing and distribution.

Quality attributes consisting of lean color score, lean firmness score and amount of marbling (according to Wisconsin Pork Quality Standards, 1963) were generally affected by age only between 200 and 240 days of age (125 to 148 kg slaughter weight), according to Berry, Smith, Hillers and Kroening (1970). O'Grady (1966) also observed a significant increase in amounts of intramuscular fat with increasing slaughter weight; however, Martin, Sather, Fredeen

and Jolly (1980) found that variation in carcass weight had no meaningful influence on marbling but did indicate significant linear correlations between increasing carcass weights and darker meat color and greater incidence of PSE (pale, soft and exudative muscle) scores (for barrows only). Usborne, Kemp and Moody (1968) reported a significant ($P < .05$) curvilinear relationship among weight groups of 20 half-sib Hampshire barrows (86 ± 2 , 100 ± 2 , 113 ± 2 and 127 ± 2 kg) to lean color and firmness with the 127 kg group having pale, soft pork, while Berry et al. (1970) observed that lean quality attributes exhibited low relationships with most of the other carcass traits.

Cutability

Smith, King and Carpenter (1978) state that objective determinations of cutability are dependent upon the percent of carcass weight in trimmed ham and loin or the percent of carcass weight in the four trimmed lean cuts (ham, loin, picnic shoulder and Boston butt) as determined by a prediction equation incorporating carcass length, average backfat thickness, and loin eye area with approximately 70 percent accuracy. Many studies have been conducted in the area of pork quality and cutability as influenced by alternate or heavier market weights for swine (Braude, Townsend and Harrington, 1963; Buck, 1963; O'Grady, 1966; Usborne et al., 1968; Richmond and Berg, 1971; Dumont, Roy and Desmoulin, 1974; Hovorka and Pavlik, 1974; Wajda, 1975; and Martin et al., 1980). In general, all of these studies reported overly fat carcasses at heavy slaughter weights with the exception of Martin et al. (1980) who found slaughter weight

of gilts could increase up to 126 kg with no adverse effect on carcass lean yield, but slaughter weights in excess of 90 kg in barrows resulted in decreased carcass lean yield.

Braude et al. (1963), Buck (1963), O'Grady (1966), Usborne et al. (1968), Richmond et al. (1971), Dumont et al. (1974), Hovorka (1974), Wajda (1975), Neely, Johnson and Walters (1979) and Martin et al. (1980) all reported an increase in average backfat with increasing slaughter weights with gilts being significantly trimmer than barrows. When leanness of carcass and economics are of major concern, optimal slaughter weights are 90 to 100 kg with possible extensions for gilts of superior merit (Braude et al., 1963; Buck, 1963; Richmond et al., 1971; Hovorka et al., 1974; Wajda, 1975; Neely et al., 1979; Martin et al., 1980; and Jolly, Sather, Patterson, Sonntag, Martin and Fredeen, 1980). According to Buck (1963), as live weights increased from 200 to 260 lb. (91 to 118 kg) as much lean as fat is put on the shoulder and ham, but more fat is put on the back and belly. Cross, Carpenter and Palmer (1970) observed that muscling score and lumbar lean width were significantly associated with percent fat ($P < .05$) and carcass lean ($P < .01$) while Cross, Smith, Carpenter and Kotula (1975) reported that unadjusted and subjectively adjusted (by use of other visual indices of carcass fatness) backfat thickness measures were not different for predicting percentages of the regular trimmed four lean cuts ($r = -.88$ and $r = -.89$, respectively). Cross et al. (1970) also reported that an average of three backfat measurements (taken opposite the first and last

ribs and the last lumbar vertebra) was more highly associated with carcass percentage fat, percent lean and the percent of the trimmed four lean cuts than a five measure backfat average (as before plus midway between the first and last ribs and midway between last rib and last lumbar vertebra). Smith and Carpenter (1973) observed that subcutaneous fat thickness measured at three locations (one-fourth, one-half and three-fourths the longitudinal axis) opposite the longissimus muscle at the 10th rib and averaged was the single measurement which was most closely related to percentages of separable lean and the percent four lean cuts.

Berry, Smith, Hillers and Kroening (1970), in a study consisting of two trials of 40 Yorkshire pigs, each representing chronological ages of 120, 160, 200 and 240 days, reported that certain carcass characteristics (size, weight, length and depth) were significantly affected by increasing chronological age and slaughter weights. The same conclusions were made by Neely et al. (1979) in a study involving 200 barrows and gilts (Durocs, Hampshires and Yorkshires) slaughtered at 100, 113 and 127 kg live weight and Martin et al. (1980) in a study utilizing a total of 126 gilt and 132 barrow carcasses slaughtered over a weight range of 73 to 137 kg.

Martin et al. (1980) observed that as carcass weight increased, there was a significant increase in loineye area up to 137 kg live weight. This is in agreement with Neely et al. (1979), Berry et al. (1970) and other researchers studying the traditional, lighter-weight market hog (approximately 90 kg). Cross et al. (1970) reported

that subjective muscling scores, as outlined by the U.S.D.A. Standards for Grades of Barrow and Gilt Carcasses (1968), were significantly associated with percentage fat ($P < .05$) and percentage lean ($P < .01$). Also noted was a nonsignificant correlation between muscling score and percent trimmed lean cuts.

Buck (1963) compared weights of the four lean cuts (ham, loin, picnic shoulder and Boston butt) and reported that weights of the combined cuts as a percentage of the side weight did not change much between slaughter weights of 150, 200 and 260 lb., although carcasses became less lean as slaughter weights increased; this was more observable for barrow carcasses than gilt carcasses in the 200 to 260 lb. slaughter weight range. Also noted in this study was the fact that as much lean as fat was put on in the shoulder and ham, but more fat than lean was put on the loin and belly in the 200 to 260 lb. slaughter weight range, and, for all cuts and both sexes, the percentage of lean meat added in the range of 200 to 260 lb. live weight was less than that for the 150 to 200 lb. live weight range. Berry et al. (1970) found percentages of ham and loin were significantly decreased by increasing chronological age from 120 to 240 days and slaughter weight from 62 to 148 kg with the highest degree of leanness found in carcasses of pigs slaughtered at 120 days of age and 62 kg slaughter weight. According to Richmond et al. (1971), carcasses from gilts slaughtered at 114 kg live weight were equal in composition to barrows slaughtered at 91 kg (when fed the same rations). In a study conducted by Dumont et al. (1974), incorporating large white

boars, it was reported that with increasing slaughter weights of 80, 100, 120 and 140 kg, the average percentage of muscle in the ham decreased from 62.9, 63.0, 63.1 to 60.8, respectively. Hovorka et al. (1974) reported an increase in dressing percentage from 80 to 120 kg live weight, but a decrease in the percent yield of the four lean cuts was also observed. Wajda (1975) also noted a decreased percentage of lean meat upon increasing slaughter weights of 300 hogs from 100 to 130 kg in 10 kg increments. Neely et al. (1979), in a study involving 200 barrows and gilts with two degrees of fatness and three slaughter weights (100, 113 and 127 kg) reported that, while the 100 and 113 kg groups had similar percentages of the four lean cuts, the 127 kg group tended to exhibit lower percentages of the closely trimmed lean cuts. Martin et al. (1980) noted the following observations: growth of carcass and primal cuts was linear over the entire weight studied (73 to 137 kg live weight); expressed as a percentage of side weight, shoulder and ham decreased and loin and belly increased as live weight increased; accumulation of lean, fat and bone was linear with lean accumulation continuing uninterrupted for both sexes (barrow and gilt) up to 137 kg, however, slaughter weights in excess of 90 kg for barrows and 126 kg for gilts would not be economically advantageous to the producer.

II. THE RELATIONSHIP OF SEX CONDITION, CARCASS WEIGHT AND BACKFAT THICKNESS TO COMPOSITION, COOKING, HISTOLOGICAL AND PALATABILITY TRAITS OF PORK LOIN CHOPS

Composition

Saffle and Bratzler (1959) used 75 carcasses from hogs that weighed 186-214 lbs. and divided them into three groups on the basis of backfat (1.0 to 1.3, 1.3 to 1.6, 1.6 to 1.9 inch average backfat). They reported a low but highly significant correlation between taste panel scores of pork loin chops and specific gravity as well as ether extract. O'Grady (1966) observed a significant increase ($P < .05$) of fat (intramuscular fat) within lean meat with percentages of fat ranging from 11.62% to 13.92% in weight groups ranging from 81 to 102 kg, respectively. However, Usborne et al. (1968) reported there were no significant differences among weight groups (84 to 129 kg) with respect to percents water, ether extract and ash. Skelley and Handlin (1971) noted that specific gravity, as well as age, carcass length, longissimus area and percent loin were negatively related to marbling in the longissimus; also backfat was related ($P < .01$) to both carcass firmness and iodine number. Skelley, Handlin and Bonnette (1973), conversely, reported, in a study of 263 pork carcasses, that iodine number was negatively related to firmness ($P < .01$) and marbling ($P < .05$) but was highly related to percent moisture ($P < .01$) and percent ether extract ($P < .01$). Percent moisture, pH, percent expressible water and percent ether extract had no significant effect upon acceptability of cooked pork chops. According to Martin and

Fredeen (1974), correlations among measures of carcass composition and pork quality were low and nonsignificant.

Usborne et al. (1968) reported that percent collagen nitrogen decreased linearly ($P < .05$) as live weight increased. Collagen was extracted by the combined procedures of Hartley and Hall (1949). No significant difference in percent total fibrillar protein nitrogen, soluble fibrillar nitrogen, non-protein nitrogen or residual connective tissue nitrogen was observed.

Cooking

Kauffman, Carpenter, Bray and Hoekstra (1964) reported an increase in fat content in pork loin muscles was accompanied by lower curing and cooking shrinkages and greater carcass fatness. In cured pork, the curing process elevated palatability scores and lowered cooking shrinkages to a level that minimized the effect of intramuscular fat.

Histological

A low but highly significant correlation was found by Saffle et al. (1959) between muscle fiber extensibility and shear values, marbling and taste panel scores. Marcy (1976), in a study involving 36 pork loins, reported nonsignificant differences between fiber types (straight, slightly wavy, wavy and very wavy), but the number of giant fibers was highly significant ($P < .01$) for both quality level and enzymatic activity (number of giant fibers in DFD longissimus was significantly ($P < .05$) more abundant than in both normal and PSE

quality levels). Waviness of muscle fibers was found to be non-significant for both quality level and enzymatic activity. Elson (1961) studied the influence of age on several muscle characteristics and reported that mean fiber area increased with age while the muscle water content decreased. In studying porcine muscle during the 24 hour chilling period, Cassens, Briskey and Hoekstra (1963a) noted that normal muscle exhibited a gradual disruption of sarcoplasmic components with very little change in the myofibrils, while PSE muscle revealed a rapid disruption of sarcoplasmic components and some disorganization of the myofilaments, and DFD muscle revealed a high degree of organization and preservation of myofibrillar structure. Cassens et al. (1963b) observed a contracted state in PSE muscle with only a small portion of the I band visible at the time of death, but a complete banding pattern was shown in the muscle at 24 hours post-mortem. A summary of Staun's (1963) findings in a study using Danish Landrace pigs is as follows: the number and diameter of muscle fibers differed in pigs of different races; the diameter of fibers was influenced by the age and weight of the animals; the number of muscle fibers apparently remained unchanged during the growth period; no significant difference in the number and diameter of muscle fibers from gilts, boars and castrates of the same race were found when the animals were slaughtered at a 90 kg live weight; and, the number and diameter of muscle fibers were found to be different in various muscles from the same pig. Soft and pale fibers, displaying contraction knots with the usual absence of cross striation and fibers

oriented longitudinally were reported by Schilling and Millo (1964). Schilling (1966) observed that meat with thicker muscle fibers contained more intramuscular fat, was tougher and had higher cooking losses due to its watery structure. Fibers with wide cross-striation were found in lean and tender muscle samples. In a study utilizing 18 Yorkshire barrows allotted to three treatments of equal grain levels (corn, barley and wheat), Berry and Kroening (1967) reported that average muscle fiber diameter for barley and wheat-fed hogs was significantly ($P < .01$) higher than corn fed hogs, but there was no significant differences among sample locations for muscle fiber diameter. Parks (1974) in a study involving 26 Duroc and crossbreed hogs, observed that longer carcasses contained a higher percentage of white fibers than red fibers, a higher percentage of red fibers may tend to indicate a somewhat larger loin eye, and a highly significant correlation was found between the percentages of muscle fibers and live weight. Anderson and Parrish (1972) presented excellent characterizations and classifications of muscle fibers as red, white or intermediate while Swatland and Cassens (1973) and Merkel (1971) observed white myofibers were greater in diameter than intermediate fibers, which, in turn, were greater in diameter than red fibers (98 to 113 μ ; 80 to 112 μ ; 74 to 99 μ , respectively) which tended to become hypertrophied in PSE animals. Cassens, Marple and Eikelenboom (1975) reported the following observations: meatier hogs have a smaller number of fibers/cm²; diameter and number of fibers influence the quality of meat; size of muscle fibers varies in different breeds; and, light

fibers with a large diameter and a lack of muscle tenderness were common to animals with PSE musculature as well as to those with muscular carcasses.

Palatability

Saffle et al. (1959) observed highly significant differences for taste panel scores between groups of carcasses varying in backfat from 1.0 to 1.9 inches, with higher mean values for chops from the fatter carcasses, but no significant differences were found for either hams or bacon. Also noted were low but highly significant correlations between taste panel scores of loin chops and shear force and muscle fiber extensibility. According to Murphy and Carlin (1961) in a study of 96 paired loins from carcasses ranging in average backfat from 1.0 to 2.3 inches in 0.1 inch increments and from hogs with live weights of 215 to 230 lb., the degree of marbling in pork loin chops increased slightly as backfat increased, but backfat did not have a significant effect on tenderness, juiciness or flavor of braised pork chops, although marbling did have a significant positive effect on both tenderness and juiciness of pork chops. These results were also reported by Onate and Carlin (1963) who used 48 loins from carcasses ranging in backfat from 1.0 to 2.3 inches in increments of 0.1 inch. It was observed by Kauffman et al. (1964) in a study utilizing pork loin and ham muscles from a total of 439 carcasses, that greater quantities of intramuscular fat were associated with higher flavor, tenderness and, especially, higher juiciness ratings of the cooked fresh product. Carpenter, Kauffman,

Bray and Weckel (1965a) studied in 64 loin sections the effects of variations in color, weight and intramuscular fat content and reported that tenderness was not significantly influenced by color, irrespective of age, origin, pigment content and exudation state, but tenderness did improve with higher intramuscular fat scores and a decrease in loin weight. Darker color was associated with higher juiciness ratings and lower cooking shrinkage. Hiner, Thornton and Alsmeyer (1965) studied the effects of breed and fatness on palatability and quantity of pork using loins from 119 Duroc and 111 Yorkshire pigs and reported that correlations among quantity indices (breed, sex and fatness) and eating quality were not related. Bray (1966) stated that: intramuscular fat or marbling affects the palatability of fresh pork considerably more than that of cured pork; marbling in pork chops is more highly associated with juiciness than tenderness or flavor; and, marbling apparently influences the palatability of fresh pork roasts less than that of pork chops. Usborne et al. (1966) reported differing results from a study in which loins from lighter hogs had a significantly better flavor ($P < .05$), juiciness ($P < .01$) and overall satisfaction ($P < .05$) and no difference in tenderness in pork roasts prepared at a constant cooking time. According to Rhodes (1970), varying the backfat on hogs in the range of 10 to 40 mm thickness had no significant effect on panel scores for texture and juiciness and did not support the contention that fatness in the carcass is associated with tenderness in the lean meat. Skelley and Handlin (1971) reported a paler color of lean and lower sensory juiciness

scores with increases in weight ($P < .05$) but no difference in palatability or tenderness due to breed, sex or carcass measurements. Skelley et al. (1973) observed a significant relationship between pH values and palatability scores but no significant effects of carcass quality factors or chemical analysis factors upon acceptability of cooked pork chops. Wachholz, Kauffman, Henderson and Lochner (1978) performed a consumer discrimination study involving pork color (PSE, normal and DFD chops) and reported results which suggest that some consumers may actively select for "normal" pork color, but that others are either unaware of this quality attribute or may actually prefer PSE and DFD pork.

Saffle et al. (1959) reported highly significant correlations between taste panel scores and shear values as well as highly significant correlations between muscle fiber extensibility and shear values. Usborne et al. (1968) observed a significant linear relationship among Warner-Bratzler Shear (WBS) values with heavy hogs (125 to 129 kg live weight) being the most tender ($P < .05$). No significant difference in WBS values due to breed, sex or carcass measurements was reported by Skelley et al. (1971), while Skelley et al. (1973) observed that taste panel scores and shear values were all highly related among themselves. Tenderness (shear values) increased with increased muscle/bone ratio and decreased backfat according to Martin and Fredeen (1974).

The basis of color in heme-pigmented muscle food of mammalian, avian and marine origin, according to Giddings (1977), resides in

the physiochemical/electromagnetic properties of the oxygen-carrying heme protein, myoglobin. Data obtained by Carpenter, Kauffman, Bray and Weckel (1965b) showed highly significant relationships of subjective color scores with Hunter L color-difference meter values but a surprisingly nonsignificant relationship of pH to the Hunter color-difference meter since subjective color score was related to both pH ($r = 0.30$) and the Hunter color-difference meter. Higher Hunter L values (lighter color) were associated with loins with greater marbling scores. On the basis of subjective color-structure scores, Martin et al. (1974), in a study of 146 barrows, 192 gilts and 120 boars (all approximately 90 kg), found eleven and three percent of the population were classified PSE and DFD, respectively (no difference in frequencies among sexes). Increasing values for color structure score were accompanied by significant ($P < .05$) increases in pH, color brightness and marbling score. Color brightness was not influenced by fat or muscling category, and averages for subjective color structure scores did not show a consistent pattern in relation to total backfat, but tended to decrease slightly as muscle/bone ratio increased.

III. EFFECT OF SEX CONDITION, CARCASS WEIGHT AND BACKFAT THICKNESS OF QUALITY AND QUANTITY OF BELLY AND BACON YIELDS

Carpenter, Kauffman, Bray and Weckel (1963) conducted a study involving 227 pork carcasses varying in weight (<125 lb, 155 to 170 lb., >200 lb. and 280 to 320 lb.), chronological age (4 to 42 months) and loin intramuscular fat (five degrees) and concluded that 36 to

42 mo. bacon was less tender with no effect on juiciness scores. Bellies shrank approximately 13 percent during curing, smoking and skinning processes with differences in shrinkage due to weight and age groups with lean bacon shrinking significantly less than fat bacon. Kemp, Moody and Fox (1969), in a study utilizing hams and bellies from 74 hogs selected on the basis of fatness and quality, observed that as quality improved, yield improved in the three fatness levels (<3.3 cm, 3.3 to 4.1 cm, >4.1 cm), yield of lean was significantly lower and yield of fat significantly greater as quality improved and fatness increased. However, yield of cooked bacon was not significantly affected by quality or fatness. Schroder and Rust (1974) reported a highly significant ($P < .01$) difference existing from anterior to posterior ends of the belly. Average backfat thickness possessed the highest of the significant ($P < .01$) correlation carcass measurements as related to percentage of moisture, fat and protein of the belly. Fredeen, Martin, Harbison and McAndrews (1975a) studied belly composition in relation to specific gravity of the cured belly and weight and backfat measurements of the carcasses were evaluated on 730 carcasses. The following observations were made: substantial sex differences were observed with boars ($n = 109$) having 4.5 percent less fat in the belly than gilts ($n = 379$) and gilts had 2.7 percent less fat than castrates ($n = 242$); percent fat in the belly increased in a linear fashion with increasing backfat thickness with the change consistent for each sex across carcass weight range (56 to 90 kg); and, carcass weight, backfat thickness and percentage fat in the

belly were directly related to belly weight expressed as a proportion of carcass weight and inversely related to percentage curing shrink. Fredeen et al. (1975b) observed that statistical analyses did not identify any interactions between sex and fat, sex and weight or weight and fat over the total range of carcass weight (55 to 94 kg) and backfat thickness (40 to 110mm). Fredeen, Martin and McAndrews (1975) also concluded that potential fat to lean ratios can be predicted from knowledge of carcass backfat, and the accuracy of estimation can be further improved by adding specific gravity to the estimation equation. Smith, West and Carpenter (1975) reported that the most desirable bacon in fresh appearance, cooked appearance and palatability (using consumer preference studies of 1186 shoppers and a 21 member laboratory panel) contained more than 40 percent muscle and had "good" distribution of muscle and fat. Lighter weight (4.1 to 5.0 kg) bellies had higher lean to fat ratios than heavier weight (5.0 to 5.9 kg) bellies and yielded much higher proportions of desirable bacon slices. According to Stiffler, Chant, Kinsman and Kotula (1975), processing shrinkage decreased as weight increased and as leanness decreased in a study of 100 commercial bellies, consisting of five groups (leanest = 1; fattest = 5). Chant, Stiffler, Kinsman and Kotula (1976) reported that flavor appeared to account for the larger proportion of variability in acceptability of bacon, with leanness and saltiness of lesser concern. Jabaay, Forrest, Aberle, Courtenay and Judge (1976) observed that bacon lean to fat ratio was positively related ($P < .01$) to other measures of carcass muscularity (percent

ham, loin and longissimus area). Bacons derived from animals with low backfat thickness tended to be leaner; however, they were also very thin in the flank area, making them less desirable for processing into sliced bacon. McMillin, Judge, Forrest, Anderson and Aberle (1977), in a study with carcasses selected for average backfat thickness of 2.6, 3.6 or 4.6 cm and hot carcass weights of 63.5, 72.5 or 81.5 kg, reported that belly and bacon yields, as well as curing yields, increased with increasing backfat thickness and carcass weight, with backfat thickness having a greater effect. Percentage lean in bacon decreased as carcass fatness increased, while carcass weight had no influence on percentage lean. Lean distribution in sliced bacon was not correlated with either carcass weight or backfat thickness, but a significant correlation with longissimus area was observed. Fredeen (1980) examined the relationship of belly yields and dimensions to carcass measurements in a population of 1,798 pork carcasses ranging in carcass weight from 55 to 104 kg and subcutaneous fat (the sum of minimum backfat and maximum loin fat) ranging from 26 to 98 mm and reported that carcass weight was the primary determinant of belly weight ($R^2 = .77$ to $.87$) and depth ($R^2 = .61$), with gilts having a larger depth to thickness ratio than barrows and barrows having greater thickness measurements and belly yields. Belly yields were negatively correlated ($r = -.6$) with measures of carcass lean.

CHAPTER III

THE RELATIONSHIP OF SEX CONDITION, CARCASS WEIGHT AND BACKFAT THICKNESS ON PORK CARCASS QUALITY AND CUTABILITY

I. SUMMARY

Evaluations of quality and cutability were performed on 96 pork carcasses (48 barrows and 48 gilts) varying in average backfat thickness (1.52 to 2.29 cm, 2.54 to 3.30 cm and 3.56 to 4.32 cm) and hot carcass weight (66 to 75 kg, 75 to 84 kg, 84 to 93 kg and 93 to 102 kg) with a moderately thick muscling score being the minimum amount of muscling acceptable (Table 1).

Marbling and lean firmness scores were nonsignificant ($P < .01$) with respect to average backfat thickness and hot carcass weight. Barrows had significantly higher ($P < .01$) marbling scores than gilts.

Visual lean color scores were highly significant with respect to Hunter L values ($P < .0001$) and Hunter b values ($P < .01$) but non-significant with respect to Hunter a values.

Longissimus areas for trimmer carcasses (1.52 to 2.29 cm) were significantly greater ($P < .01$) while significant differences ($P < .01$) due to sex condition were observed for only the second and tenth rib measurements; no significant differences were noted with respect to hot carcass weight.

Percent ham, percent loin, percent picnic shoulder, percent belly, percent of the four lean cuts, percent primal cuts and percent

TABLE 1
EXPERIMENTAL DESIGN (n=96)

Hot Carcass Wt. ^a (kg)	Fat Thickness (cm)					
	1.52 - 2.29		2.54 - 3.30		3.56 - 4.32	
	Barrow	Gilt	Barrow	Gilt	Barrow	Gilt
66-75	4	4	4	4	4	4
75-84	4	4	4	4	4	4
84-93	4	4	4	4	4	4
93-102	4	4	4	4	4	4

^aModerately thick = minimum muscling score.

ham-loin were all nonsignificant with respect to hot carcass weight and sex condition with the exception of percent lean cuts which was significantly different ($P < .05$) with respect to sex condition with gilts having higher percentages of ham, loin, Boston butt and picnic shoulder. Heavier carcasses ($P < .01$) and trimmer carcasses ($P < .001$) were significantly greater with respect to Boston butt.

II. INTRODUCTION

Many studies have been conducted in the area of pork quality and cutability as influenced by alternate or heavier market weights for swine (Braude et al., 1963; Buck, 1963; O'Grady, 1966; Usborne et al., 1968; Richmond et al., 1971; Dumont et al., 1974; Hovorka et al., 1974; Wajda, 1975 and Martin et al., 1980). In general, these investigations reported overly fat carcasses at heavy slaughter weights with barrows being fatter than gilts. Martin et al., (1980) observed that feeding gilts up to 126 kg live weight had no adverse effects on carcass lean yield, but slaughter weights in excess of 90 kg in barrows resulted in decreased carcass lean yield. Also observed was the fact that meat quality was at least maintained and possibly improved as heavier carcass weights were reached.

This study was conducted to determine the effect of sex condition, hot carcass weight and average backfat thickness on pork carcass quality and cutability.

III. MATERIALS AND METHODS

Forty-eight barrow and forty-eight gilt carcasses (n=96) were selected from a local Knoxville, Tennessee packing plant on the basis of hot carcass weight and average backfat thickness (an average of three measurements taken opposite the first rib, last rib and last lumbar vertebra). The carcasses represented live slaughter hogs of an approximate 200 to 300 lb. (91 to 136 kg) weight range and an average backfat thickness of 0.6 to 1.7 inches (1.5 to 4.3 cm). Only carcasses with moderately thick muscling (U.S.D.A. muscling scores) or better were selected. The carcasses were chilled (30°F) approximately 18 hours and then the left side of each carcass was transported to The University of Tennessee, Knoxville Meat Laboratory where they were assigned a U.S.D.A. carcass grade by trained University of Tennessee personnel. Carcass data for carcass length (measured from the anterior edge of the first rib to the edge of the anterior lobe of the symphysis pubis), sex condition (barrow or gilt), hot and cold carcass weights, backfat measurements (taken opposite the first rib, last rib, last lumbar vertebra and over the longissimus muscle at the fifth and tenth ribs), longissimus area (measured at the second, fifth and tenth ribs using an Iowa State University Pork Loin Eye Grid), U.S.D.A. muscling scores (minimum of moderately thick), marbling scores (at tenth rib), lean color (at tenth rib) and lean firmness (according to Iowa State University Standards for Pork Color, Firmness and Marbling, Pm-452) were collected.

Each side was identically fabricated into the five primal cuts (ham, loin, belly, picnic shoulder and Boston butt) as well as other miscellaneous cuts (feet, spareribs and neckbones) according to the cutting procedures as described in the U.S.D.A. (1967) Cutting and Trimming Instructions for Pork Carcasses with the exceptions that the jowl was removed and weighed to provide a more uniform carcass and external fat in excess of .25 in. (.64 cm) was trimmed from all wholesale cuts. Weights of both trimmed and untrimmed wholesale cuts, as well as miscellaneous cuts, were obtained and recorded. Percent cooler shrinkage was calculated for each carcass. Materials and Methods for Chapter IV and Chapter V are identical with the above Materials and Methods with the appropriate additions.

All data were analyzed by analysis of variance with sex condition, carcass weight and average backfat thickness as fixed (independent) variables (Snedecor and Cochran, 1967).

IV. RESULTS AND DISCUSSION

Means for longissimus area measured at the second rib (Table 2) were nonsignificant ($P < .01$) with respect to hot carcass weights, but there were significant differences ($P < .001$) in average backfat thickness with the trimmer hogs (1.52 to 2.29 cm) having larger longissimus areas, and gilts having larger ($P < .001$) longissimus areas than barrows. Carcasses in the 93 to 102 kg hot carcass weight group had greater ($P < .001$) longissimus areas measured at the fifth rib than the lighter weight carcasses. Also, the trimmer carcasses

TABLE 2
MEANS OF LONGISSIMUS MEASUREMENTS AND PORK CARCASS QUALITY CHARACTERISTICS AS DETERMINED BY HOT CARCASS WEIGHT, AVERAGE BACKFAT THICKNESS AND SEX CONDITION

Variable	Hot carcass weight (kg)									
	66-75			75-84			84-93			93-102
	Average backfat (cm) ^a 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Overall 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Average backfat (cm) ^a 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Overall 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Average backfat (cm) ^a 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Overall 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Average backfat (cm) ^a 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Overall 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Average backfat (cm) ^a 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b	Overall 1.52-2.29 2.30-3.30 3.56-4.32 Mean ^b
Longissimus area (cm²):										
2nd rib:										
Barrow ^c :	5.03 ^a	4.45 ^{ab}	4.85 ^a	4.76 ^a	4.60 ^a	4.00 ^{ab}	4.13 ^a	4.29 ^a	5.05 ^a	4.47 ^a
Gilt ^c :	5.92 ^a	5.33 ^{ab}	3.76 ^a	5.00 ^a	4.30 ^a	5.65 ^{ab}	5.61 ^a	5.21 ^a	7.34 ^a	6.05 ^a
5th rib:										
Barrow ^c :	7.09 ^a	7.26 ^a	6.76 ^a	7.04 ^a	7.75 ^a	7.14 ^a	7.34 ^a	7.42 ^a	7.70 ^a	7.47 ^a
Gilt ^c :	8.64 ^a	7.11 ^a	6.96 ^a	7.57 ^a	9.22 ^a	7.77 ^a	7.65 ^a	8.26 ^a	9.53 ^a	8.53 ^a
10th rib:										
Barrow ^c :	10.64 ^a	11.66 ^{ab}	10.16 ^a	10.82 ^a	13.41 ^a	11.40 ^{ab}	10.82 ^a	11.89 ^a	12.27 ^a	11.80 ^a
Gilt ^c :	13.79 ^a	11.30 ^{ab}	11.71 ^a	12.27 ^a	13.31 ^a	11.94 ^{ab}	11.03 ^a	12.10 ^a	13.46 ^a	13.13 ^a
Marbling score:										
Barrow ^c :	6.45 ^a	6.25 ^a	6.35 ^a	6.35 ^a	4.35 ^a	5.38 ^a	5.19 ^a	4.90 ^a	4.45 ^a	4.92 ^a
Gilt ^c :	3.00 ^a	4.78 ^a	4.63 ^a	4.13 ^a	3.85 ^a	4.80 ^a	5.50 ^a	4.72 ^a	5.20 ^a	5.28 ^a
Lean firmness^d:										
Barrow ^c :	2.50 ^a	3.08 ^a	3.56 ^a	3.05 ^a	3.00 ^a	3.00 ^a	3.13 ^a	3.04 ^a	3.38 ^a	3.00 ^a
Gilt ^c :	2.65 ^a	3.10 ^a	3.15 ^a	3.02 ^a	3.15 ^a	3.38 ^a	3.13 ^a	3.23 ^a	3.13 ^a	3.17 ^a
Lean color:										
Barrow ^c :	47.70 ^a	44.40 ^a	45.04 ^a	45.75 ^a	43.40 ^a	45.05 ^a	47.15 ^a	45.23 ^a	45.19 ^a	46.59 ^a
Gilt ^c :	7.10 ^a	6.89 ^a	7.80 ^a	7.30 ^a	9.90 ^a	6.03 ^a	7.00 ^a	7.90 ^a	10.34 ^a	8.23 ^a
Barrow ^c :	10.28 ^a	8.56 ^a	9.50 ^a	9.45 ^a	8.76 ^a	9.54 ^a	9.86 ^a	9.30 ^a	11.16 ^a	10.38 ^a
Gilt ^c :	10.28 ^a	8.56 ^a	9.50 ^a	9.45 ^a	8.76 ^a	9.54 ^a	9.86 ^a	9.30 ^a	11.16 ^a	10.38 ^a

^acm.

^bcm.

^cQuotient significant difference between barrows and gilts, ($P < 0.01$).

^dLean firmness scores according to Iowa State University Standards for Pork Color, Firmness, and Marbling (1 = pale, soft and watery; 3 = normal grayish-pink; 5 = dark and firm).

^e1 = pale; 2 = slightly pale; 3 = normal; 4 = slightly dark; 5 = dark.

^fMeans in a row having different superscripts are significantly different ($P < 0.01$) due to differences in average backfat thickness. ^gMeans in a row having different superscripts are significantly different ($P < 0.01$) due to differences in hot carcass weight.

(1.52 - 2.29 cm) had larger ($P < .001$) longissimus areas measured at the fifth rib but no significant difference was noted due to sex condition. Longissimus areas at the tenth rib were also larger in the heavier carcasses (93 to 102 kg) ($P < .0001$) and in the trimmer carcasses (1.52 - 2.29 cm average backfat thickness) ($P < .01$). Significant differences ($P < .01$) with respect to sex condition were also observed with gilts having larger longissimus areas than barrows. These results agree with the research of Berry et al. (1970), Neely et al. (1979) and Martin et al. (1980).

Mean marbling scores (Table 2) were not significantly different with respect to average backfat thickness or hot carcass weight, nor were lean firmness scores. Barrows had higher ($P < .01$) marbling scores than gilts and there was a significant ($P < .05$) hot carcass weight x sex interaction. Lean firmness scores were significantly different with respect to backfat x hot carcass weight ($P < .05$) and backfat x sex ($P < .05$) interactions (Table 2). These results disagree with the findings of O'Grady (1966) but do agree with the research of Martin et al. (1980).

Mean values for visual lean color scores were not significantly different between the average backfat thicknesses, hot carcass weights or sex conditions as were mean values for Hunter L color-difference measurements (Table 2). Hunter L values were significant ($P < .05$) with respect to backfat x hot carcass weight interactions. Means for Hunter a color difference values were higher ($P < .01$) (redder) in the 93 to 102 kg carcasses than the 66 to 75 kg carcasses.

Trimmer carcasses (1.52 to 2.29 cm) had greater ($P < .001$) Hunter a color (redder) values than carcasses with 2.54 to 4.32 cm average backfat thickness. Hunter a values were also significantly different ($P < .05$) with respect to backfat x sex and backfat x hot carcass weight interactions. Mean values for Hunter b color-difference measurements were not different statistically for average backfat thickness, hot carcass weight or sex condition. Hunter b values were significantly different (more yellow) with respect to hot carcass weight at $P < .05$. Visual lean color scores had a highly significant relationship to Hunter L (higher L values denoted lighter color) values ($P < .0001$, $r^2 = .44$) and Hunter b (higher b values denote a more yellow color) values ($P < .01$, $r^2 = .28$) but were not significantly related to Hunter a values. These findings agree with data obtained by Carpenter et al. (1965b) who reported highly significant relationships of subjective color scores with Hunter L color-difference meter values.

R-squared values presented in Table 3 summarize relationships between average backfat thickness, hot carcass weight and sex condition and various carcass measurements and characteristics. Noteworthy are the significant relationships of backfat with respect to muscling score ($P < .05$) and Hunter a value ($P < .05$). Average backfat thickness was more closely related to the fat thickness at the last rib ($r^2 = 0.82$) and last lumbar vertebra ($r^2 = 0.86$) than any other single fat thickness measurements. It was also noted that hot carcass weight was closely related to carcass length ($P < .01$, $r^2 = 0.70$)

TABLE 3

R-SQUARED VALUES BETWEEN HOT CARCASS WEIGHT,
AVERAGE BACKFAT THICKNESS AND SEX CONDITION
AND VARIOUS CARCASS MEASUREMENTS AND
CHARACTERISTICS

	Backfata	Hot carcass weight	Sex condition
Length	0.46 ^e	0.70 ^c	0.44 ^e
Backfat thickness:			
1st rib	0.77 ^d	0.14 ^e	0.11 ^e
5th rib	0.65 ^d	0.23 ^e	0.18 ^e
10th rib	0.68 ^d	0.22 ^e	0.25 ^e
Last rib	0.82 ^d	0.14 ^e	0.11 ^e
Last lumbar	0.86 ^d	0.14 ^e	0.08 ^e
Average ^a	1.00	0.33 ^e	0.35 ^e
Muscling score ^b	0.13 ^b	0.10 ^e	0.09 ^e
Longissimus area:			
2nd rib	0.51 ^e	0.40 ^e	0.38 ^e
5th rib	0.38 ^e	0.48 ^e	0.34 ^e
10th rib	0.52 ^e	0.71 ^c	0.51 ^e
Marbling score	0.27 ^e	0.21 ^e	0.41 ^b
Lean firmness	0.11 ^e	0.03 ^e	0.08 ^e
Lean color (visual)	0.11 ^e	0.13 ^e	0.12 ^e
Hunter L value	0.73	0.66 ^e	0.67 ^e
Hunter a value	0.70 ^b	0.59 ^e	0.64 ^e
Hunter b value	0.45 ^e	0.43 ^e	0.35 ^e

^aAverage of backfat measurements taken opposite first rib, last rib and last lumbar vertebra.

^b $p < .05$.

^c $p < .01$.

^d $p < .0001$.

^eNonsignificant.

and tenth rib longissimus area ($P < .01$, $r^2 = 0.71$) and sex condition was related to marbling score ($P < .05$, $r^2 = 0.41$).

Mean percentages of wholesale cuts presented in Table 4 show that percent ham, percent loin, percent picnic shoulder, and percent belly were not significantly different ($P < .01$) with respect to hot carcass weight. However, percent Boston butt was significantly different ($P < .01$) with respect to hot carcass weight with carcasses weighing 93 to 102 kg having significantly greater percentages of Boston butt. Percent Boston butt was also highly significant ($P < .001$) with respect to average backfat thickness with trimmer carcasses (1.52 to 2.29 cm) having higher percentages of Boston butt, and sex condition ($P < .01$), with gilts having a higher percentage of Boston butt than barrows. Values for percent loin and percent belly were nonsignificant ($P < .01$) with respect to average backfat thickness or sex condition. Percent ham was significantly different ($P < .0001$) with respect to average backfat thickness with trimmer hogs (1.52 to 2.29 cm) having greater percentages of ham. No significant difference was noted due to sex condition. Percent picnic shoulder was also significantly different ($P < .0001$) with respect to average backfat thickness with fatter carcasses (3.56 to 4.32 cm) having lower percentages of picnic shoulder than trimmer carcasses (1.52 to 3.30 cm). Percent lean cuts, percent primal cuts and percent ham-loin displayed non-significant differences with respect to hot carcass weight. Percent lean cuts was higher ($P < .05$) in gilts but percent primal cuts and percent ham-loin were nonsignificant with respect to sex condition.

TABLE 4
MEAN PERCENTAGES OF WHOLESALE CUTS AS DETERMINED BY HOT CARCASS WEIGHT,
AVERAGE BACKFAT THICKNESS AND SEX CONDITION

Wholesale Cut	Sex (S) ^a	66-75					75-84					84-93					93-102				
		Average backfat (cm)					Average backfat (cm)					Average backfat (cm)					Average backfat (cm)				
		1.52-2.25	2.54-3.30	3.56-4.32	4.54-5.29	Overall	1.52-2.25	2.54-3.30	3.56-4.32	4.54-5.29	Overall	1.52-2.25	2.54-3.30	3.56-4.32	4.54-5.29	Overall	1.52-2.25	2.54-3.30	3.56-4.32	4.54-5.29	Overall
Barrows:		23.3 ^a	20.8 ^a	20.9 ^a	21.0 ^a	21.4 ^a	22.1 ^a	22.0 ^a	22.2 ^a	22.3 ^a	22.4 ^a	22.6 ^a	22.7 ^a	22.8 ^a	22.9 ^a	23.0 ^a	22.6 ^a	22.7 ^a	22.8 ^a	22.9 ^a	23.0 ^a
Gilts:		24.3 ^a	21.7 ^a	22.1 ^a	22.7 ^a	23.0 ^a	22.1 ^a	22.0 ^a	22.2 ^a	22.3 ^a	22.4 ^a	22.6 ^a	22.7 ^a	22.8 ^a	22.9 ^a	23.0 ^a	22.6 ^a	22.7 ^a	22.8 ^a	22.9 ^a	23.0 ^a
Loin (S) ^b																					
Barrows:		21.0 ^a	22.5 ^a	20.0 ^a	21.2 ^a	21.2 ^a	21.4 ^a	20.9 ^a	21.0 ^a	21.1 ^a	21.2 ^a	21.3 ^a	21.4 ^a	21.5 ^a	21.6 ^a	21.7 ^a	21.3 ^a	21.4 ^a	21.5 ^a	21.6 ^a	21.7 ^a
Gilts:		22.0 ^a	20.6 ^a	20.4 ^a	21.3 ^a	21.2 ^a	21.5 ^a	20.6 ^a	21.1 ^a	20.9 ^a	21.0 ^a	21.1 ^a	21.2 ^a	21.3 ^a	21.4 ^a	21.5 ^a	21.1 ^a	21.2 ^a	21.3 ^a	21.4 ^a	21.5 ^a
Boston butt (S) ^c																					
Barrows:		7.0 ^a	7.5 ^a	6.9 ^a	7.4 ^a	7.4 ^a	7.4 ^a	6.1 ^a	7.5 ^a	7.2 ^a	7.3 ^a	7.4 ^a	7.5 ^a	7.6 ^a	7.7 ^a	7.8 ^a	7.4 ^a	7.5 ^a	7.6 ^a	7.7 ^a	7.8 ^a
Gilts:		8.4 ^a	7.9 ^a	7.7 ^a	8.0 ^a	8.0 ^a	8.1 ^a	7.5 ^a	7.9 ^a	7.7 ^a	7.8 ^a	7.9 ^a	8.0 ^a	8.1 ^a	8.2 ^a	8.3 ^a	7.9 ^a	8.0 ^a	8.1 ^a	8.2 ^a	8.3 ^a
Picnic shoulder (S) ^d																					
Barrows:		11.0 ^a	10.3 ^a	10.2 ^a	10.9 ^a	11.5 ^a	11.3 ^a	10.7 ^a	11.2 ^a	11.1 ^a	11.2 ^a	11.3 ^a	11.4 ^a	11.5 ^a	11.6 ^a	11.7 ^a	11.3 ^a	11.4 ^a	11.5 ^a	11.6 ^a	11.7 ^a
Gilts:		11.2 ^a	11.3 ^a	10.7 ^a	11.1 ^a	10.9 ^a	10.8 ^a	10.2 ^a	10.4 ^a	10.3 ^a	10.4 ^a	10.5 ^a	10.6 ^a	10.7 ^a	10.8 ^a	10.9 ^a	10.5 ^a	10.6 ^a	10.7 ^a	10.8 ^a	10.9 ^a
Belly (S) ^e																					
Barrows:		10.2 ^a	12.5 ^a	12.0 ^a	11.6 ^a	11.1 ^a	11.9 ^a	13.3 ^a	12.1 ^a	11.0 ^a	11.9 ^a	11.9 ^a	12.1 ^a	12.2 ^a	12.3 ^a	12.4 ^a	12.0 ^a	12.1 ^a	12.2 ^a	12.3 ^a	12.4 ^a
Gilts:		10.9 ^a	11.4 ^a	11.6 ^a	11.2 ^a	11.3 ^a	11.3 ^a	11.6 ^a	11.7 ^a	11.8 ^a	11.9 ^a	12.0 ^a	12.1 ^a	12.2 ^a	12.3 ^a	12.4 ^a	12.0 ^a	12.1 ^a	12.2 ^a	12.3 ^a	12.4 ^a
Lean cuts (S) ^{f,g,h}																					
Barrows:		63.5 ^a	61.1 ^a	58.1 ^a	60.9 ^a	62.0 ^a	62.0 ^a	56.1 ^a	61.2 ^a	62.1 ^a	62.2 ^a	62.3 ^a	62.4 ^a	62.5 ^a	62.6 ^a	62.7 ^a	62.3 ^a	62.4 ^a	62.5 ^a	62.6 ^a	62.7 ^a
Gilts:		66.6 ^a	61.5 ^a	60.9 ^a	63.0 ^a	63.0 ^a	61.1 ^a	56.7 ^a	61.2 ^a	62.0 ^a	62.1 ^a	62.2 ^a	62.3 ^a	62.4 ^a	62.5 ^a	62.6 ^a	62.3 ^a	62.4 ^a	62.5 ^a	62.6 ^a	62.7 ^a
Primal cuts (S) ^{i,j}																					
Barrows:		73.6 ^a	73.6 ^a	70.1 ^a	72.4 ^a	73.9 ^a	74.6 ^a	71.4 ^a	73.3 ^a	73.1 ^a	73.2 ^a	73.3 ^a	73.4 ^a	73.5 ^a	73.6 ^a	73.7 ^a	73.3 ^a	73.4 ^a	73.5 ^a	73.6 ^a	73.7 ^a
Gilts:		77.1 ^a	72.0 ^a	72.7 ^a	74.2 ^a	75.1 ^a	73.3 ^a	70.3 ^a	72.9 ^a	73.1 ^a	73.2 ^a	73.3 ^a	73.4 ^a	73.5 ^a	73.6 ^a	73.7 ^a	73.3 ^a	73.4 ^a	73.5 ^a	73.6 ^a	73.7 ^a
Ham-Loin (S) ^k																					
Barrows:		44.7 ^a	43.2 ^a	41.0 ^a	43.0 ^a	43.0 ^a	43.4 ^a	40.3 ^a	42.5 ^a	42.5 ^a	42.6 ^a	42.7 ^a	42.8 ^a	42.9 ^a	43.0 ^a	43.1 ^a	42.7 ^a	42.8 ^a	42.9 ^a	43.0 ^a	43.1 ^a
Gilts:		47.0 ^a	42.3 ^a	42.5 ^a	44.0 ^a	44.0 ^a	44.4 ^a	41.3 ^a	43.2 ^a	43.2 ^a	43.3 ^a	43.4 ^a	43.5 ^a	43.6 ^a	43.7 ^a	43.8 ^a	43.4 ^a	43.5 ^a	43.6 ^a	43.7 ^a	43.8 ^a

^aSee 4.

^bSee 12.

^cClean cuts (S) = Ham (S) + Loin (S) + Boston Butt (S) + Picnic Shoulder (S).

^dPrimal cuts (S) = Ham (S) + Loin (S) + Boston Butt (S) + Picnic Shoulder (S) + Belly (S).

^ePercentage of chilled side weight.

^fMeans in a row having different superscripts are significantly different (P < .01) due to differences in average backfat thickness.

^gMeans in a row having different superscripts are significantly different (P < .01) due to differences in hot carcass weight.

Percent lean cuts, percent primal cuts and percent ham-loin were all significantly different ($P < .0001$) with respect to average backfat thickness with trimmer carcasses (1.52 to 2.29 cm) having greater percentages of the wholesale cuts. These results are in accordance with studies performed by Buck (1963), Berry et al. (1970) and Martin et al. (1980).

Table 5 contains means of various carcass characteristics as determined by hot carcass weight and average backfat thickness regardless of sex condition.

IV. CONCLUSION

Longissimus areas measured at the second, fifth and tenth ribs increased nonsignificantly with respect to hot carcass weight with the exception of the fifth and tenth rib measurements for the 93 to 102 kg weight group which were significantly greater. Longissimus areas for trimmer carcasses (1.52 to 2.29 cm) were significantly greater while significant differences due to sex condition were observed for only the second and tenth rib measurements.

Marbling scores were not significantly different with respect to average backfat thickness or hot carcass weight, but barrows had significantly higher marbling scores than gilts. Also noted were significant differences between marbling and hot carcass weight x sex interaction.

Lean firmness scores also were not significantly different with respect to average backfat thickness or hot carcass weight as

TABLE 5
MEANS OF VARIOUS CARCASS CHARACTERISTICS AS DETERMINED BY HOT CARCASS WEIGHT AND AVERAGE BACKFAT THICKNESS OF BARROW AND GILT CARCASSES COMBINED

Variable	Hot carcass weight (kg)											
	66-75			75-84			84-93			93-102		
	Average backfat (cm) ^a 1.52-2.25 2.54-3.30 3.56-4.32	Overall Mean ^b	Average backfat (cm) ^a 1.52-2.25 2.54-3.30 3.56-4.32	Overall Mean ^b	Average backfat (cm) ^a 1.52-2.25 2.54-3.30 3.56-4.32	Overall Mean ^b	Average backfat (cm) ^a 1.52-2.25 2.54-3.30 3.56-4.32	Overall Mean ^b	Average backfat (cm) ^a 1.52-2.25 2.54-3.30 3.56-4.32	Overall Mean ^b	Average backfat (cm) ^a 1.52-2.25 2.54-3.30 3.56-4.32	Overall Mean ^b
Hot carcass wt. (kg)	70.3 ^a	72.2 ^a	70.3 ^a	71.0 ^a	79.2 ^a	78.1 ^a	86.4 ^a	87.0 ^a	86.4 ^a	95.4 ^a	94.3 ^a	95.0 ^a
Chilled side wt. (kg)	34.4 ^a	35.7 ^a	34.2 ^a	34.6 ^a	38.5 ^a	37.9 ^a	42.4 ^a	43.5 ^a	42.3 ^a	46.4 ^a	45.5 ^a	46.4 ^a
Length (cm)	80.3 ^a	79.2 ^a	74.9 ^a	78.2 ^a	82.0 ^a	82.3 ^a	83.1 ^a	84.3 ^a	82.6 ^a	87.1 ^a	84.0 ^a	85.6 ^a
Backfat thickness (cm):												
1st rib	3.40 ^a	4.09 ^a	5.03 ^a	4.17 ^a	3.07 ^a	4.01 ^a	3.53 ^a	4.27 ^a	5.21 ^a	3.50 ^a	4.34 ^a	4.45 ^a
5th rib	1.50 ^a	1.93 ^a	2.74 ^a	2.00 ^a	1.55 ^a	1.96 ^a	1.64 ^a	2.41 ^a	2.90 ^a	1.60 ^a	2.00 ^a	2.13 ^a
10th rib	1.52 ^a	2.34 ^a	3.30 ^a	2.33 ^a	1.75 ^a	2.41 ^a	2.00 ^a	2.97 ^a	3.63 ^a	1.75 ^a	2.51 ^a	2.64 ^a
Last rib	1.70 ^a	2.51 ^a	3.40 ^a	2.53 ^a	2.05 ^a	2.82 ^a	1.85 ^a	2.72 ^a	3.43 ^a	1.91 ^a	2.64 ^a	2.64 ^a
Last lumbar	1.55 ^a	2.51 ^a	3.71 ^a	2.59 ^a	1.73 ^a	2.44 ^a	1.57 ^a	2.57 ^a	3.53 ^a	1.65 ^a	2.67 ^a	2.51 ^a
Average ^c	2.25 ^a	3.05 ^a	4.04 ^a	3.12 ^a	2.25 ^a	3.10 ^a	2.31 ^a	3.10 ^a	4.00 ^a	2.30 ^a	3.23 ^a	3.20 ^a
Muscling score ^d	13.0 ^a	13.1 ^a	11.4 ^a	12.5 ^a	12.5 ^a	13.0 ^a	12.5 ^a	12.4 ^a	12.3 ^a	13.4 ^a	14.0 ^a	14.0 ^a
U.S.D.A. grade	1.0 ^a	1.0 ^a	2.0 ^a	1.3 ^a	1.0 ^a	1.0 ^a	1.0 ^a	1.0 ^a	1.0 ^a	1.0 ^a	1.0 ^a	1.1 ^a

^acm.

^bmm.

^cMeasured over middle of longissimus muscle.

^dAverage of measurements at first rib, last rib and last lumbar vertebra.

Muscling scores with 1 = very thin; 2 = very thin; 3 = very thin; 4 = slightly thin; 5 = thin; 6 = slightly thin; 7 = thin; 8 = thin; 9 = thin; 10 = thin; 11 = thin; 12 = thin; 13 = thin; 14 = thin; 15 = thin; 16 = very thin; 17 = very thin; 18 = very thin; 19 = very thin; 20 = very thin.

Means in a row having different superscripts are significantly different (P < 0.01) due to differences in average backfat thickness.

Means in a row having different superscripts are significantly different (P < 0.01) due to differences in hot carcass weight.

well as sex condition. Significant differences were observed between lean firmness and backfat x hot carcass weight and backfat x sex interactions.

Visual lean color values, Hunter L values and Hunter a values all were nonsignificant with respect to average backfat thickness, hot carcass weight or sex condition. Hunter a values were significantly different for trimmer carcasses (1.52 to 2.29 cm) which had higher Hunter a values. Hunter a values were significantly different with respect to hot carcass weight with heavier carcasses having higher Hunter a values. Hunter a values were nonsignificant for sex condition, but there were significant differences with respect to backfat x sex and backfat x hot carcass weight interactions. Visual lean color scores were highly significant with respect to Hunter L and Hunter b values.

R-squared values for backfat and marbling, backfat and muscling score, hot carcass weight and carcass length and sex condition and marbling score were all low but significantly different.

Percent ham, percent loin, percent picnic shoulder and percent belly as well as percent lean cuts, percent primal cuts and percent ham-loin were nonsignificant with respect to hot carcass weight. Of all the wholesale cuts, only the Boston butt was significantly different with respect to sex condition with gilts having higher percentages of Boston butt than barrows. Percent lean cuts were significantly different with respect to average backfat thickness with trimmer carcasses possessing higher percentages of the four lean

cuts. Percent primal cuts were significantly lower for fatter carcasses (3.56 to 4.32 cm) with percent ham-loin following the same pattern.

CHAPTER IV

THE RELATIONSHIP OF SEX CONDITION, CARCASS WEIGHT AND BACKFAT THICKNESS TO COMPOSITION, COOKING, HISTOLOGICAL AND PALATABILITY TRAITS OF PORK LOIN CHOPS

I. SUMMARY

Composition, cooking, histological and palatability traits of pork loin chops were evaluated with respect to average backfat thickness (1.52 to 2.29 cm, 2.54 to 3.30 cm and 3.56 to 4.32 cm), hot carcass weight (66 to 75 kg, 75 to 84 kg, 84 to 93 kg and 93 to 102 kg) and sex condition (48 barrow and 48 gilt carcasses, $n=96$). Fatter carcasses (3.56 to 4.32 cm) had significantly lower ($P<.01$) water percentages. Mean values for percent fat (on both a wet and dry basis) were significantly lower ($P<.0001$) for trimmer carcasses (1.52 to 3.30 cm) than for fatter carcasses (3.56 to 4.32 cm).

Percent nonvolatile cooking losses were significantly lower ($P<.001$) for trimmer carcasses (1.52 to 2.29 cm) but were nonsignificant for hot carcass weight or sex condition while percent volatile and percent total cooking losses were nonsignificant with respect to average backfat thickness, hot carcass weight and sex condition.

Mean fiber diameter (μ) was significantly different ($P<.05$) only with respect to a backfat x sex interaction.

Lower flavor, juiciness, tenderness and overall acceptability scores were observed for pork loin chops from trimmer carcasses ranging from 1.52 to 2.29 cm in average backfat ($P<.0001$).

No significant differences were noted for hot carcass weight or sex condition.

R-squared values were low for backfat thickness, Warner-Bratzler Shear, fiber diameter, percent fat (wet basis) and volatile, non-volatile and total cooking losses with respect to palatability traits, but all were highly significant ($P < 0.0001$).

II. INTRODUCTION

Many, and often conflicting, studies have been conducted to study the effects of sex condition, carcass weight and backfat thickness on various composition, cooking, histological and palatability traits of pork loin chops. Usborne et al. (1968) reported no significant differences among weight groups (84 to 129 kg) with respect to percents water, ether extract and ash, and Martin et al. (1974) observed that correlations among measures of carcass composition and pork quality were low and not significant. However, O'Grady (1966) and Kauffman et al. (1964) observed increases in intramuscular fat content with increasing carcass fatness. Saffle et al. (1959) and Kauffman et al. (1964) observed that greater quantities of intramuscular fat were associated with higher flavor, tenderness, and especially, juiciness ratings of cooked fresh product while Murphy et al. (1961), Onate et al. (1963) and Rhodes (1970) reported that varying backfat in hogs did not have a significant effect on tenderness, juiciness or flavor of cooked product. Muscle color

studies were performed by Kauffman et al. (1965b) and Martin et al. (1974) with particular attention being paid to the DFD (dark, firm, dry) and PSE (pale, soft, exudative) problems of fresh product. Elson (1961), Staun (1963) and Cassens et al. (1975) all reported that muscle fiber diameter increases with age and varies from breed to breed.

This study was conducted to determine the effects of sex condition, hot carcass weight and average backfat thickness (taken opposite the first rib, last rib and last lumbar vertebra) on composition, cooking, histological and palatability traits of pork loin chops.

III. MATERIALS AND METHODS

Materials and methods for Chapter IV are identical to those outlined in Chapter III with the following additional experimental procedures.

Six chops were removed from each loin for further evaluation. Chop 1, taken from the tenth rib was used for taste panel training while Chop 2, removed immediately posterior to Chop 1, was used in actual taste panel and color studies. Both chops were one-inch (2.54 cm) in thickness and were cooked to 75°C (167°F) internal temperature in a Despatch (Style 154R) rotary hearth, convection type oven set at 177°C (350°F). Chop samples from the longissimus (approximately 1.27 cm x 1.27 cm) were served to an experienced sensory evaluation panel comprised of University of Tennessee faculty

and graduate students and were evaluated, using a nine point scale, for tenderness (1 = extremely tough, 9 = extremely tender), juiciness (1 = extremely dry, 9 = extremely juicy), flavor desirability (1 = extremely undesirable, 9 = extremely desirable) and overall acceptability (1 = extremely undesirable, 9 = extremely desirable).

Color of uncooked Chop 1 was subjectively evaluated by a trained University of Tennessee faculty member/graduate student using Iowa State University Standards for Pork Color, Firmness and Marbling, Pm-452 and objectively evaluated using a Hunter Lab Color/Difference Meter (Model D25D2) standardized using Standard No. C2-140 L_L, a_L and b_L values.

Chop 3, removed immediately posterior to Chop 2, was also one inch (2.54 cm) thick and was used to determine an objective tenderness measurement. Chop 3 was also cooked by the aforementioned modified oven broiling method to an internal temperature of 75°C (167°F). Chops were allowed to cool to room temperature, at which time five cores (1.27 cm or 0.5 in. diameter) were removed from each chop and objectively evaluated for tenderness using a Warner-Bratzler Shear. Also, volatile, non-volatile and total cooking losses were obtained from Chop 3.

Chop 4 (1.0 in or 2.54 cm thick), removed immediately posterior to Chop 3, was stripped of all external fat and epimysium tissue surrounding the longissimus muscle and powdered with liquid nitrogen in a high speed blender. Triplicate powdered samples weighing approximately 2.0 grams each were dried in a vacuum oven at 70°C

under a pressure of 25 inches Hg for 5 hours. After drying, the samples were weighed to determine sample moisture content and then put into a Soxhlet apparatus and extracted in anhydrous ethyl ether for 24 hours. Samples were then removed from the Soxhlet, and after the ether was allowed to evaporate, were again dried at 70°C at 25 in Hg vacuum for 5 hours, weighed, and percent fat was obtained as described by A.O A C. (1975).

Chops 5 and 6 (0.5 in or 1.27 cm thick) were utilized in the histological study of muscle fiber diameter, as described by the combined procedures of Hiner, Hankins and Sloane (1953); Swanson, Kline and Goll (1965); Tendick (1966) and Tuma, Venable, Wrihtier and Henrickson (1962), using a light microscope (15x) and a 10x ocular micrometer (150x total magnification).

All chops, upon removal, were wrapped in O₂ barrier freezer wrap and frozen at -22°F (-30°C) for approximately 24 hours and then stored at 0°F (-18°C) until analyses were performed.

All data were analyzed by analysis of variance with sex condition, carcass weight and average backfat thickness as fixed (independent) variables (Snedecor and Cochran, 1967).

IV. RESULTS AND DISCUSSION

Mean percent water was not significantly different ($P < .01$) for hot carcass weights or sex condition, but a significant ($P < .01$) difference was observed among average backfat thickness groups (Table 6) with fatter (3.56 to 4.32 cm) carcasses having lower water

TABLE 6
MEANS OF COMPOSITION, COOKING LOSSES, HISTOLOGICAL AND PALATABILITY TRAITS OF PORK LOIN CHOPS
AND LEAN PERCENTAGES OF SELECTED BACON SLICES

Variable	Hot carcass weight (kg)									
	66-75			75-84			84-93			93-102
	Average backfat (cm) ^a		Overall	Average backfat (cm) ^a		Overall	Average backfat (cm) ^a		Overall	Average backfat (cm) ^a
Water (%)	1.52-2.29	2.54-3.30	2.56-4.32	1.52-2.29	2.54-3.30	2.56-4.32	1.52-2.29	2.54-3.30	2.56-4.32	Overall
Fat (%)	74.3 ^a	74.3 ^a	73.6 ^a	74.2 ^a	74.0 ^a	73.4 ^a	74.4 ^a	73.3 ^a	72.9 ^a	74.4 ^a
Meat basis	2.7 ^a	2.7 ^a	3.9 ^a	2.5 ^a	3.1 ^a	3.1 ^a	2.7 ^a	3.5 ^a	4.2 ^a	3.5 ^a
Dry basis	10.5 ^a	10.5 ^a	14.5 ^a	9.7 ^a	11.9 ^a	14.3 ^a	10.6 ^a	12.1 ^a	15.6 ^a	13.1 ^a
Cooking losses (%)										
Volatiles	16.4 ^a	17.9 ^a	15.6 ^a	16.7 ^a	16.9 ^a	16.5 ^a	21.4 ^a	16.2 ^a	14.7 ^a	17.4 ^a
Nonvolatiles	4.2 ^a	5.7 ^a	6.3 ^a	4.5 ^a	5.8 ^a	6.5 ^a	4.9 ^a	6.3 ^a	6.2 ^a	5.6 ^a
Total	20.6 ^a	23.6 ^a	21.9 ^a	21.2 ^a	22.7 ^a	23.0 ^a	26.3 ^a	22.5 ^a	21.0 ^a	23.0 ^a
Fiber diameter (%)	72.2 ^a	74.2 ^a	70.7 ^a	72.4 ^a	78.1 ^a	67.6 ^a	71.4 ^a	76.5 ^a	72.5 ^a	75.0 ^a
Palatability Traits ^c										
Flavor d	5.7 ^a	6.3 ^a	6.4 ^a	5.6 ^a	6.1 ^a	5.8 ^a	5.6 ^a	6.3 ^a	5.8 ^a	5.6 ^a
Juiciness ^d	5.7 ^a	5.9 ^a	6.3 ^a	5.9 ^a	6.0 ^a	5.8 ^a	5.6 ^a	6.3 ^a	5.8 ^a	5.6 ^a
Tenderness	4.7 ^a	5.0 ^a	6.4 ^a	5.6 ^a	5.8 ^a	5.4 ^a	4.6 ^a	6.1 ^a	5.2 ^a	5.3 ^a
Overall Acceptability	5.2 ^a	6.1 ^a	6.3 ^a	5.6 ^a	5.9 ^a	5.6 ^a	5.7 ^a	6.1 ^a	5.6 ^a	5.6 ^a
Bacon Slice Percent Lean										
Slice 1	62.3 ^a	54.7 ^a	45.7 ^a	54.3 ^a	54.6 ^a	45.9 ^a	52.4 ^a	60.4 ^a	51.5 ^a	55.1 ^a
Slice 2	50.2 ^a	46.3 ^a	37.6 ^a	44.5 ^a	49.5 ^a	42.4 ^a	48.6 ^a	43.2 ^a	45.1 ^a	45.6 ^a
Slice 3	43.4 ^a	43.2 ^a	34.2 ^a	40.3 ^a	45.4 ^a	35.2 ^a	42.2 ^a	43.8 ^a	44.9 ^a	45.0 ^a
Slice 4	55.4 ^a	46.6 ^a	35.9 ^a	47.3 ^a	53.4 ^a	45.5 ^a	49.9 ^a	52.5 ^a	47.2 ^a	47.3 ^a

^ans=1.

^bns=24.

^cElectronically undesirable; dry, tough, undesirable; 5=acceptable; 9=extremely desirable, juicy, tender, desirable.

^dns=112.

^ens=336.

ns=ns in a row having different superscripts are significantly different (P<0.01) due to differences in average backfat thickness.
ns=ns in a row having different superscripts are significantly different (P<0.01) due to differences in hot carcass weight.

percentages. Mean values for percent fat on both a wet and dry basis were not significantly different ($P < .01$) for hot carcass weights or sex condition, but were significantly lower ($P < .0001$) for trimmer carcasses (1.52 cm to 3.30 cm) and higher ($P < .0001$) in carcasses possessing a greater amount of average backfat (3.56 cm to 4.32 cm) (Table 6). These findings agree with Usborne et al. (1968) who reported that there was no significant differences among weight groups (84 to 129 kg) with respect to percents water, ether extract and ash.

Mean percent volatile and total cooking losses did not vary significantly ($P < .01$) with respect to average backfat thickness, mean hot carcass weights or sex. Mean percent nonvolatile cooking losses were not significantly different ($P < .01$) among hot carcass weights and sex condition, but were significantly lower ($P < .001$) for trim carcasses (1.52 to 2.29 cm) compared to carcasses possessing 2.54 to 4.32 cm average backfat (Table 6).

Mean fiber diameters (μ) were not significantly different ($P < .05$) with respect to average backfat thickness, hot carcass weights or sex, but a significant ($P < .05$) interaction was observed between backfat and sex (Table 6). Staun (1963) reported no significant difference in the number and diameter of muscle fibers from gilts, boars or castrates, but did note that fiber diameter was influenced by the age and weight of the individual animal as well as breed.

Mean values for flavor, juiciness, tenderness and overall acceptability ratings were not significantly different ($P < .01$) for

hot carcass weights or sex condition, but were significantly different ($P < .0001$) for average backfat thickness groups with loin chops from trimmer (1.52 to 2.29 cm) carcasses having lower palatability ratings than loin chops from carcasses of average backfat thickness ranging from 2.54 to 4.32 cm (Table 6). Saffle et al. (1959), Kauffman et al. (1964) and Bray (1966) reported similar results concerning higher palatability scores with increased backfat and greater quantities of intramuscular fat. Conversely, Hiner et al. (1965) reported that correlations among quantity indices (breed, sex and fatness) and eating quality were not related. Usborne et al. (1966) reported that loins from lighter hogs had significantly better flavor ($P < .05$), juiciness ($P < .01$) and overall satisfaction with no difference in tenderness, and Rhodes (1970) reported results that did not support the contention that fatness in the carcass is associated with tenderness in lean meat.

Percentage lean in bacon slices taken from four identical locations in each belly (first slice removed most anterior; second slice removed at a point 33% from anterior edge of cooked belly; third slice removed at a point 67% from anterior edge of cooked belly; fourth slice removed most posterior) was not significantly different ($P < .01$) with respect to average backfat thickness, hot carcass weight or sex condition, but was significantly different with average backfat thickness at $P < .05$, (Table 6). Bacon slice 1, removed most anterior, had a lower ($P < .05$) percent lean as average backfat thickness increased, while bacon slice 2, removed at a point 33% of the belly

length from the anterior edge, was nonsignificant at $P < .05$. Bacon slice 3, removed at a point 67% of the belly length from the anterior edge, and bacon slice 4, removed most posterior also had a lower ($P < .05$) percent lean as average backfat increased (Figure 1). These results are in agreement with Fredeen et al. (1975a) (1975b), Smith et al. (1975) and McMillin et al. (1977).

R-squared values (Table 7) between palatability traits and various carcass, histological, composition and cooking characteristics were not significant for either hot carcass weight or sex condition (.00 for each palatability trait versus backfat and hot carcass weight). Although R-squared values were low for flavor, juiciness, tenderness and overall acceptability (.02, .02, .03 and .03, respectively) with respect to backfat, all were highly significant ($P < .0001$). Murphy et al. (1961) and Rhodes (1970) reported conflicting results while other researchers reported similar results regarding greater quantities of intramuscular fat associated with greater amounts of carcass backfat (Kaufmann et al., 1964; Hiner et al., 1965; and Usborne et al., 1966).

Although small, R-squared values for both Warner-Bratzler Shear and fiber diameter were highly significant ($P < .0001$) for flavor, juiciness, tenderness and overall acceptability but were not significant for average backfat thickness, hot carcass weight or sex condition (Table 7). These results agree with the findings of Saffle et al. (1959) and Skelley et al. (1971, 1973) who reported that shear values and taste panels had highly significant correlations.

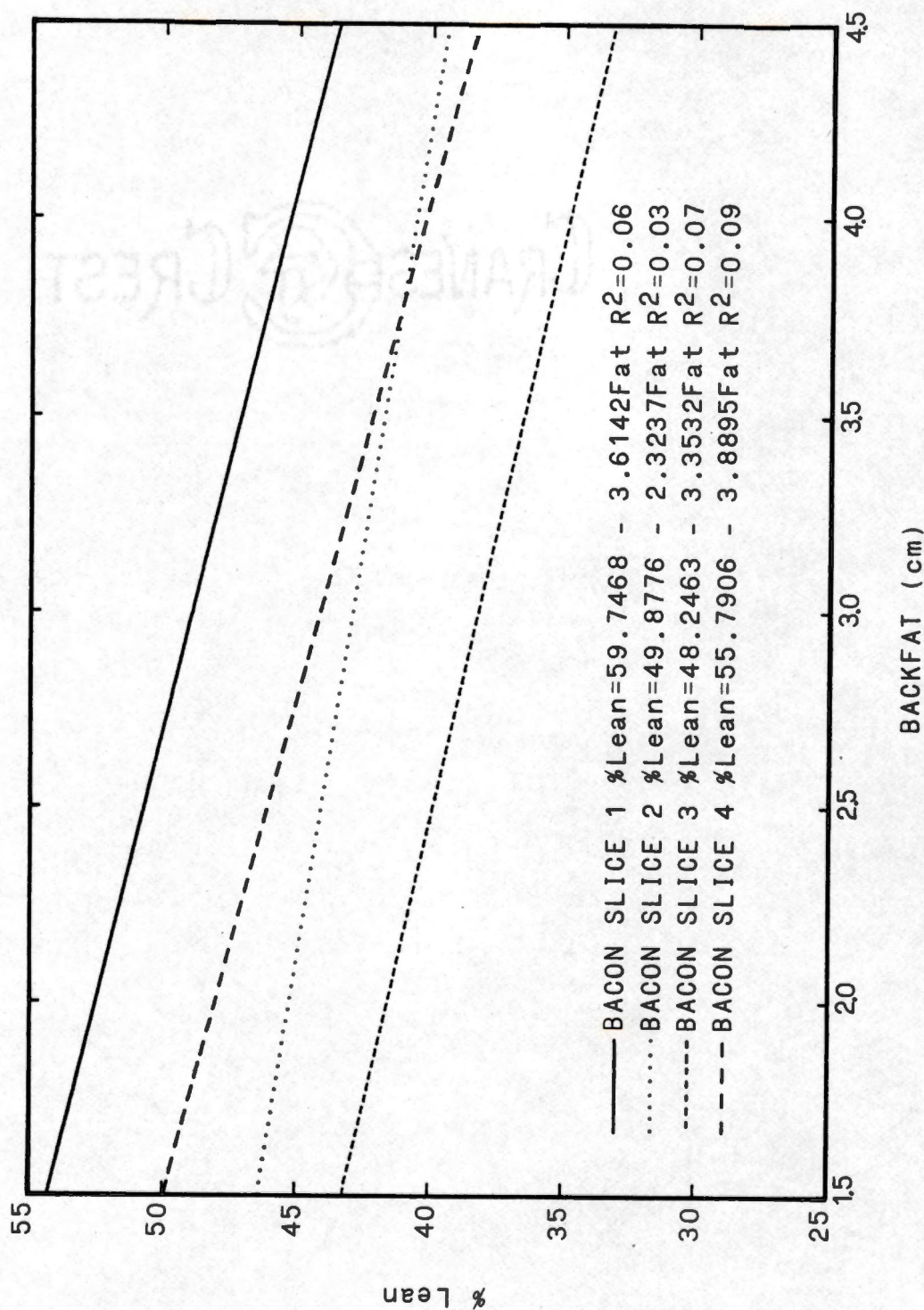


Figure 1. Relationship of Percent Lean in Bacon Slices as Affected by Average Backfat Thickness.^a

^aAverage of three measurements taken opposite the first rib, last rib and last lumbar vertebra.

NOTE: Bacon slice 1 removed most anterior; bacon slice 2 removed at a point 33% of the belly length from the anterior edge; bacon slice 3 removed at a point 67% of the belly length from the anterior edge; bacon slice 4 removed most posterior.

TABLE 7

R-SQUARED VALUES BETWEEN PALATABILITY TRAITS AND
VARIOUS CARCASS, HISTOLOGICAL, COMPOSITION AND
COOKING CHARACTERISTICS

Characteristic	Flavor	Juiciness	Tenderness	Overall Acceptability
Backfat thickness	0.02 ^a	0.02 ^a	0.03 ^a	0.03 ^a
Hot carcass weight	0.00 ^b	0.00 ^b	0.00 ^b	0.00 ^b
Sex	0.00 ^b	0.00 ^b	0.00 ^b	0.00 ^b
Warner-Bratzler Shear	0.15 ^a	0.20 ^a	0.35 ^a	0.27 ^a
Fiber diameter	0.15 ^a	0.22 ^a	0.37 ^a	0.29 ^a
Fat percentage (wet basis)	0.15 ^a	0.19 ^a	0.34 ^a	0.26 ^a
Cooking losses:				
Volatile	0.18 ^a	0.22 ^a	0.38 ^a	0.29 ^a
Nonvolatile	0.16 ^a	0.21 ^a	0.35 ^a	0.27 ^a
Total	0.18 ^a	0.22 ^a	0.37 ^a	0.28 ^a

^a $p < .0001$.

^bNonsignificant.

Skelley et al. (1971) also observed no significant difference in Warner-Bratzler Shear (WBS) values due to breed, sex or carcass measurements. It must be noted that even though there was no significant difference ($P < .05$) between WBS and hot carcass weight there was a significant difference ($P < .05$) between WBS and backfat x hot carcass weight interaction. Fiber diameter also displayed a significant difference ($P < .05$) between hot carcass weight x sex interaction.

Fat percentage (wet basis), or marbling, as determined by ether extract, had highly significant differences ($P < .0001$) in relation to all palatability scores but possessed low R-squared values (Table 7). There were no significant differences ($P < .01$) for fat percentage due to hot carcass weight or sex condition, but average backfat thickness was highly significant ($P < .0001$) with respect to fat percentage. O'Grady (1966) reported conflicting results, but the findings of Usborne et al. (1968) are in accordance with these results.

R-squared values (Table 7) were low for volatile, nonvolatile and total cooking losses, but all were highly significant ($P < .0001$) with respect to all palatability traits. Volatile cooking losses were nonsignificant ($P < .05$) for average backfat thickness, hot carcass weight and sex condition as were total cooking losses although total cooking losses were significantly different ($P < .05$) for backfat x sex interactions. Nonvolatile cooking losses were also highly significant ($P < .0001$) with respect to all palatability scores as well as being significant ($P < .05$) for backfat x sex interaction.

V. CONCLUSION

Percent water decreased with increased average backfat thickness but remained fairly constant for all hot carcass weights and sex condition. Percent fat (on both a wet and dry basis), or marbling, increased with increasing average backfat thickness and was also fairly constant for hot carcass weight and sex condition.

Volatile, nonvolatile and total cooking losses were constant over all hot carcass weights and volatile and total cooking losses were not significantly different with respect to average backfat thickness or sex condition. Nonvolatile cooking losses also were non-significant with respect to sex condition, but trimmer carcasses (1.52 to 2.29 cm) had significantly lower nonvolatile cooking losses.

Mean fiber diameters (μ) did not vary significantly with respect to average backfat thickness, hot carcass weight or sex condition, but a significant ($P < .05$) interaction was observed between fiber diameter and average backfat thickness x sex.

Flavor, juiciness, tenderness and overall acceptability were not significantly different with respect to hot carcass weight or sex condition, but trimmer (1.52 to 2.29 cm) carcasses had significantly lower palatability traits with respect to all carcass weights.

Percent lean in various bacon slices was nonsignificant with respect to hot carcass weights and sex condition, but was significantly different ($P < .05$) with respect to average backfat thickness with bacon slices 1 and 4 containing greater percentages of lean than bacon slice 2 which contained greater percentages of lean than bacon slice 3.

R-squared values were low but were highly significant for palatability characteristics and backfat thickness, Warner-Bratzler Shear, fiber diameter, percent fat (wet basis) and volatile, non-volatile and total cooking losses of pork loin chops. R-squared values were nonsignificant between palatability traits and hot carcass weight and sex condition.

CHAPTER V

EFFECT OF SEX CONDITION, CARCASS WEIGHT AND BACKFAT THICKNESS ON PORK CARCASS VALUE AND YIELD OF FRESH AND PROCESSED WHOLESALE CUTS

I. SUMMARY

Pork carcasses (n=96; 48 barrows and 48 gilts) ranging in average backfat thickness (1.52 to 2.29 cm, 2.54 to 3.30 cm and 3.56 to 4.32 cm) and hot carcass weight (66 to 75 kg, 75 to 84 kg, 84 to 93 kg and 93 to 102 kg) were fabricated, and yields of fresh and processed whole-sale cuts were determined and carcass value was calculated. Mean weights for all the wholesale cuts increased in a linear fashion with respect to hot carcass weight ($P < .01$) with no significance attributed to sex condition. Ham, Boston butt and picnic shoulder weights were significantly lower ($P < .01$) for fatter carcasses (3.56 to 4.32 cm) while loin and belly weights were nonsignificant with respect to average backfat thickness.

Trimmer carcasses (1.52 to 2.29 cm) of equal weights generally had greater values than fatter carcasses (2.54 to 4.32 cm) within all hot carcass weight groups.

Hams from heavier carcasses (93 to 102 kg) had significantly greater ($P < .001$) cooking losses as did hams from trimmer carcasses (1.52 to 2.29 cm). Significant ($P < .001$) interactions were observed between ham cooking losses and backfat x hot carcass weight, as well

as hot carcass weight x sex ($P < .01$) and backfat x hot carcass weight x sex ($P < .01$).

Bellies from trimmer carcasses (1.52 to 2.29 cm) had highly significant ($P < .0001$) and greater cooking losses than fatter carcasses. Gilts had significantly greater ($P < .05$) cooking losses than barrows, and no significant difference was observed with respect to hot carcass weight.

II. INTRODUCTION

Investigations have been conducted to determine the various effects of sex condition, carcass weight and backfat thickness on quality and quantity of belly and bacon yields. Fredeen et al. (1975a) and Fredeen (1980) reported substantial sex differences with boars having 4.5 percent less fat in the belly than gilts and gilts 2.7 percent less fat than castrates, with gilts having a larger depth to thickness ratio than barrows and barrows having greater thickness measurements and belly yields. Stiffler et al. (1975) and McMillin et al. (1977) reported that belly and bacon yields, as well as curing yields, increased with increasing backfat thickness and carcass weight while Smith et al. (1975) observed that lighter weight (4.1 to 5.0 kg) bellies had higher lean to fat ratios than heavier weight (5.0 to 5.9 kg) bellies and yielded much higher proportions of desirable bacon slices. Fredeen et al. (1975a), McMillin et al. (1977) and Fredeen (1980) observed that carcass weight was the primary determinant to belly weight and belly yields increased with increasing carcass weights.

This study was conducted to determine the effects of sex condition, hot carcass weight and average backfat thickness (taken opposite the first rib, last rib and last lumbar vertebra) on quality and quantity of fresh and processed wholesale cuts as well as relative carcass values.

III. MATERIALS AND METHODS

Materials and Methods for Chapter V are identical to those outlined in Chapter III with the following additional experimental procedures.

In addition to untrimmed and collared weights, hams were also weighed as boneless, trimmed hams, and after being pumped to 16 percent of boneless, trimmed weight with a curing solution composed of 38.5 lb. curing grade salt, 6.5 lb. sugar and 2.5 lb. Prague curing power/40 gallons water. Also, a soaked weight in brine after a six day soaking time and a cooked weight was recorded. Boneless, trimmed hams were zip-netted, pumped, soaked and cooked to an internal temperature of 66°C (152°F) in an Alkar temperature/humidity controlled food processing oven, allowed to chill at 40°F (4.5°C) for approximately 24 hours and weighed again. Smokehouse losses (shrink) were then calculated.

Untrimmed and trimmed (commercially "squared-up") weights were obtained on the pork bellies of each side in addition to weights after soaking for five days in the same curing brine as the hams. Bellies (skin on) were cooked to an internal temperature of 128°F

(53°C) in an Alkar temperature/humidity controlled food processing oven, allowed to chill at 40°F (4.5°C) for approximately 24 hours and weighed again. Bellies were then skinned and divided into three equal length sections and sliced. Slices from anterior and posterior ends of the belly, as well as slices from one-third posterior and one-third anterior of anterior and posterior ends of the belly, respectively, were removed and tracings of cross sections of lean and fat of each slice were made on Aquabee Acetate Paper (.003 Matte). Lean and total areas were determined using a compensating polar planimeter, and lean to fat ratios were then established. Smokehouse losses (shrink) were calculated upon obtainment of final cooked and chilled weights.

In order to determine value of respective pork wholesale and miscellaneous cuts as determined by weight or cut, monthly average prices of each cut were computed over one year's time using "The Yellow Sheet" of the National Provisioner Daily Market Service as a reference.

All data were analyzed by analysis of variance with sex condition, carcass weight and average backfat thickness as fixed (independent) variables (Snedecor and Cochran, 1967).

IV. RESULTS AND DISCUSSION

Mean ham weights (trimmed, bone-in) were significantly different ($P < .0001$) with respect to hot carcass weight and hams from trimmer hogs (1.52 to 2.29 cm) had significantly higher ($P < .0001$)

mean weights than hams from carcasses ranging from 2.54 to 4.32 cm in average backfat thickness (Table 8). No significant difference ($P < .05$) due to sex condition was observed. Mean loin (trimmed) weights were not significantly different between the two lighter weight groups, but were higher in the 84 to 93 kg group ($P < .01$). Mean loin (trimmed) weights for the 93 to 102 kg group were heavier ($P < .01$) than any of the other weight groups. There was no significant difference ($P < .05$) associated with trimmed loin weights and average backfat thickness or sex condition (Table 8). Mean Boston butt (trimmed) weights followed the same pattern as loin weights with respect to hot carcass weight ($P < .0001$) and showed significant differences ($P < .01$) due to average backfat thickness and a significant difference ($P < .05$) due to sex condition with weights for Boston butts being greater for gilts than barrows (Table 8). Mean weights for picnic shoulders (trimmed) increased ($P < .0001$) with hot carcass weights, and picnic shoulders from trimmer carcasses (1.52 to 3.30 cm) were heavier ($P < .0001$) than picnic shoulders from carcasses ranging from 3.56 to 4.32 cm in average backfat (Table 8). There was no significant difference due to sex condition. Mean belly weights (trimmed) increased ($P < .01$) as hot carcass weight increased and were also significantly heavier ($P < .05$) for barrow carcasses. No significant difference in belly weights (trimmed) was observed at $P < .01$ for average backfat thickness, but there was a significant difference at $P < .05$. Other mean miscellaneous cut weights and level of significance are also reported in Table 8.

TABLE 8
MEAN WEIGHTS OF FRESH PORK CUTS FROM BARRON AND GILT CARCASSES VARYING
IN WEIGHT AND AVERAGE BACKFAT THICKNESS

Cut (lbs.)	Net carcass weight (lb)								
	66-75		75-84		Overall Mean ^b				
	1.52-2.25 Average backfat (cm) ^a 2.54-3.30	3.56-4.32 Overall Mean ^b	1.52-2.25 Average backfat (cm) ^a 2.54-3.30	3.56-4.32 Overall Mean ^b					
Ham (trimmed, bone-in)	18.2 ^a	16.2 ^a	19.0 ^a	17.2 ^a	18.6 ^{1/2}	20.2 ^a	19.1 ^a	22.0 ^a	21.0 ^a
Loin (trimmed)	16.0 ^a	17.0 ^a	18.0 ^a	17.0 ^a	17.5 ^a	18.3 ^a	20.0 ^a	21.0 ^a	22.1 ^a
Boston Butt (trimmed)	6.2 ^a	5.5 ^a	6.0 ^a	6.5 ^a	6.6 ^a	7.0 ^a	7.0 ^a	8.2 ^a	8.5 ^a
Picnic Shoulder (trimmed)	8.0 ^a	7.0 ^a	9.0 ^a	8.0 ^a	9.1 ^a	10.0 ^a	10.0 ^a	11.1 ^a	11.0 ^a
Belly (trimmed)	7.0 ^a	9.0 ^a	8.0 ^a	10.0 ^a	9.0 ^a	10.1 ^a	11.1 ^a	11.0 ^a	11.6 ^a
Spareribs (trimmed)	2.0 ^a	2.0 ^a	2.0 ^a	2.0 ^a	2.0 ^a	3.0 ^a	3.0 ^a	3.3 ^a	3.5 ^a
Neck	2.0 ^a	2.0 ^a	2.0 ^a	3.1 ^a	3.3 ^a	3.0 ^a	3.0 ^a	4.0 ^a	3.9 ^a
Neckbones	2.0 ^a	1.0 ^a	2.1 ^a	2.1 ^a	2.7 ^a	2.5 ^a	2.5 ^a	2.0 ^a	2.7 ^a
Feet	2.0 ^a	2.0 ^a	2.0 ^a	2.0 ^a	2.7 ^a	3.2 ^a	3.0 ^a	3.3 ^a	3.1 ^a
Sausage Triad (50% Lean)	16.0 ^a	18.0 ^a	17.0 ^a	20.0 ^a	19.4 ^a	22.1 ^a	21.0 ^a	22.5 ^a	23.6 ^a

^alb.

^blb-oz.

^cSternum removed.
^dComposed of loin, boneless picnic shoulder, belly and ham trimmings and all fat trim (5 lean varied from approximately 30%-50%).

Mean monthly prices of fresh pork cuts from May 1, 1981 through April 30, 1982, were averaged and reported in Table 9. The National Provisioner Daily Market Service was used as a reference. The yearly averages were used to calculate mean value of fresh pork cuts tabulated in Table 10. It should be noted that these values are based solely on yearly market prices for the various cuts and not on superior carcass merit. Table 11 shows relative carcass values on a percentage basis with 230 to 240 lb. (104 to 109 kg) live hogs with 1.0 in. (2.54 cm) backfat at the last rib used as a standard (100%). The last rib measurement was chosen with relative ease of obtainment in mind concerning the packer and the fact that this measurement is a relatively high indicator ($P < .0001$, $r^2 = .44$) of percent of the four lean cuts. These percentages are based on actual average yearly prices (May 1981-April 1982) for all the major wholesale and miscellaneous cuts. Viscera or drop value as well as energy and labor costs are not represented in these percentage values. It is interesting to note that trimmer, lighter carcasses are worth more than the traditional standard carcasses, but even more interesting that trimmer, heavier (291 to 300 lbs. or 132 to 136 kg; 0.8 in. or 2.32 cm) live hogs are also worth more than the standard carcasses, and this value difference is negligible even in fatter (1.4 in. or 3.56 cm), heavier (291 to 300 lbs. or 132 to 136 kg) live hogs. It must be realized that the wholesale cuts from these heavier carcasses are discounted by packers and, even with these discounts, the value of such carcasses is the same as, or greater, than traditional carcasses.

TABLE 9

MEAN MONTHLY PRICES OF FRESH PORK CUTS FROM MAY 1, 1981-APRIL 30, 1982^a

	May '81	June '81	July '81	Aug. '81	Sept. '81	Oct. '81	Nov. '81	Dec. '81	Jan. '82	Feb. '82	Mar. '82	Apr. '82	AVG.
SKND Hams, f. f.a. or fresh:													
14/Down	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.
14/17	70.8	77.0	82.2	84.4	84.5	84.6	86.6	88.8	73.6	78.9	90.0	84.9	82.2
17/20	68.2	78.3	83.0	84.3	81.8	80.9	82.7	82.9	73.0	79.3	86.3	83.0	80.3
20/26	67.3	78.5	83.0	84.4	81.6	79.3	78.4	77.3	72.5	78.9	84.2	80.8	78.9
26/30	65.2	72.0	79.4	80.0	81.6	77.0	73.6	71.4	69.2	75.0	80.4	78.7	75.3
26/up, 2s incl.	64.5	71.1	78.4	79.0	80.9	76.3	71.1	67.0	68.1	72.5	76.8	77.7	73.6
Picnics, f. f.a. or fresh:													
4/8	47.7	60.8	57.4	59.0	56.8	56.2	49.7	47.3	54.7	55.1	53.1	55.9	54.5
8/up, 2s incl.	46.0	55.5	56.2	58.4	56.5	55.0	46.5	42.3	49.2	52.6	52.7	55.0	52.2
Bellies, Green, Sq. Cut sals, f. f.a. or fresh:													
8/10	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.	n.q.
10/12	40.4	50.5	51.2	52.7	56.7	52.4	51.9	45.1	55.0	62.5	58.1	65.9	53.5
12/14	36.3	55.5	55.2	59.7	60.3	56.2	54.0	50.4	61.1	67.5	66.2	72.1	57.9
14/16	45.4	55.6	55.8	61.3	61.5	57.0	54.0	50.4	61.5	68.0	66.3	73.6	59.2
16/18	43.8	54.5	54.8	61.0	61.1	56.0	54.6	47.9	59.4	66.5	64.7	75.4	58.3
18/20	40.3	52.8	51.5	57.8	58.7	53.2	51.2	43.9	56.2	63.4	62.4	70.0	55.1
20/25	37.1	46.4	46.1	53.1	56.8	50.6	48.4	40.8	51.5	60.8	57.7	67.7	51.4
Fresh Pork:													
Loins, 14/down	94.0	100.0	105.5	104.9	99.0	99.5	91.7	85.9	104.9	101.4	94.4	102.7	98.7
Loins, 14/17	93.0	99.0	104.4	103.9	104.3	98.6	90.2	84.5	103.9	100.1	93.3	101.6	98.1
Loins, 17/22	86.4	93.7	101.1	100.9	100.3	94.8	84.3	80.4	94.5	93.3	90.5	97.1	93.1
Loins, 22/up	78.3	81.0	77.0	87.3	88.4	91.7	81.6	76.9	86.6	85.1	83.7	94.5	84.3
B. butts 4/8 boxed	75.2	77.7	91.2	89.8	84.9	78.1	70.9	67.1	79.4	76.9	74.4	84.8	79.2
B. butts 8/up	69.0	70.4	82.5	82.8	83.8	79.3	71.0	60.1	73.7	77.0	72.6	83.9	75.5
Sknd. Shldr. 16/down	62.1	67.8	74.8	74.5	71.5	68.0	61.3	58.3	69.1	68.0	65.9	72.0	67.8
Frozen Pork:													
Spareribs 3-1/2/down	111.3	118.2	125.0	114.6	104.4	86.9	87.1	87.4	102.9	110.8	115.3	125.5	107.5
Spareribs 3-1/2/5-1/2	96.5	102.0	103.7	99.8	97.9	78.8	75.6	74.5	82.4	94.1	99.6	110.3	92.9
Spareribs 5-1/2/up	60.0	60.0	59.9	61.0	61.0	61.0	57.0	56.4	56.0	58.2	63.7	74.1	60.7
Neckbones (carlot)	11.9	15.8	16.5	20.4	23.0	21.4	21.1	16.0	17.9	21.6	22.3	19.1	18.9
Feet front, toes on	15.2	15.9	16.1	17.7	18.1	15.9	15.9	15.6	18.6	26.6	23.2	18.4	18.1
Fresh Saus. Materials													
50% lean tags.	40.9	48.0	50.1	50.2	54.1	43.6	41.8	35.4	42.6	49.7	47.8	53.9	46.5
80% lean tags.	73.4	83.9	81.0	88.6	87.7	77.4	71.4	67.0	74.5	81.7	76.9	84.0	79.0

^aMidwest River Area, cents per pound, split of closing prices taken from the National Provisioner Daily Market Service.

b.n.q. = none quoted.

TABLE 10
MEAN VALUES OF FRESH PORK CUTS FROM BARROW AND GILT CARCASSES VARYING IN
WEIGHT AND AVERAGE BACKFAT THICKNESS

Cut	64-75					75-84					84-93					93-102				
	Average backfat (in)					Average backfat (in)					Average backfat (in)					Average backfat (in)				
	1.52-2.29	2.54-3.30	3.56-4.32	Overall	Mean ^a	1.52-2.29	2.54-3.30	3.56-4.32	Overall	Mean ^a	1.52-2.29	2.54-3.30	3.56-4.32	Overall	Mean ^a	1.52-2.29	2.54-3.30	3.56-4.32	Overall	Mean ^a
Ham	14.37	13.81	12.99	13.72	15.74	14.86	14.61	14.61	15.07	16.73	15.58	15.34	15.34	15.00	16.70	17.20	17.20	17.20	17.20	17.20
Gilts:	14.00	13.73	13.65	14.00	15.74	14.78	13.81	13.81	14.78	16.25	16.49	15.34	15.34	16.03	18.94	18.23	18.23	18.23	18.12	18.12
Loie	15.60	16.85	14.81	15.75	17.13	16.66	15.70	16.66	16.50	17.32	17.78	17.50	17.50	17.53	19.92	18.34	19.14	19.14	19.13	19.13
Gilts:	15.11	15.50	15.11	15.57	16.39	16.66	16.60	16.60	16.50	17.78	19.46	15.98	15.98	17.74	19.18	19.83	19.92	19.92	19.64	19.64
Boston butt	4.67	4.83	4.12	4.54	5.15	5.39	4.75	4.75	5.10	5.66	5.57	5.23	5.23	5.49	6.57	6.26	6.34	6.34	6.39	6.39
Gilts:	4.83	4.75	4.51	4.70	5.39	4.91	4.87	4.87	4.99	6.12	6.49	5.62	5.62	6.08	6.57	6.42	6.42	6.42	6.47	6.47
Picnic shoulder	4.33	4.33	4.21	4.27	5.22	4.91	4.75	4.75	4.96	5.59	5.27	4.85	4.85	5.24	6.00	5.64	5.22	5.22	5.62	5.62
Gilts:	4.44	4.34	4.18	4.39	4.70	4.33	4.38	4.38	4.47	5.43	5.53	4.80	4.80	5.25	6.37	5.90	5.27	5.27	5.85	5.85
Belly	n-q, f	5.40	n-q, f	5.40	n-q, f	5.30	8.05	8.05	5.60	5.51	5.94	5.99	5.99	5.81	6.05	6.31	5.89	5.89	6.08	6.08
Gilts:	n-q, f	n-q, f	n-q, f	n-q, f	n-q, f	5.40	n-q, f	n-q, f	5.40	5.30	5.30	5.30	5.30	5.31	5.51	5.94	6.21	6.21	5.89	5.89
Spencer ribs	3.01	2.80	2.69	2.83	3.44	3.33	2.80	2.80	3.22	3.62	3.44	3.23	3.23	3.43	3.25	3.34	3.44	3.44	3.44	3.44
Gilts:	3.33	2.80	2.80	2.90	3.23	2.90	2.90	2.90	3.01	3.44	3.53	2.90	2.90	3.29	3.62	3.76	3.66	3.66	3.66	3.66
Neckbones	0.40	0.32	0.20	0.33	0.43	0.40	0.32	0.32	0.38	0.53	0.43	0.38	0.38	0.45	0.47	0.45	0.45	0.43	0.43	0.43
Gilts:	0.43	0.34	0.32	0.36	0.34	0.38	0.32	0.32	0.35	0.51	0.49	0.42	0.42	0.47	0.62	0.59	0.59	0.59	0.59	0.59
Feet	0.51	0.43	0.43	0.46	0.51	0.52	0.49	0.49	0.51	0.62	0.54	0.51	0.51	0.56	0.60	0.58	0.58	0.57	0.57	0.57
Gilts:	0.45	0.47	0.40	0.44	0.51	0.47	0.42	0.42	0.47	0.54	0.52	0.51	0.51	0.52	0.58	0.52	0.52	0.54	0.54	0.54
Sausage trim ^b (500 lbs)	12.04	7.53	12.69	10.75	13.86	7.91	9.58	9.58	10.45	9.53	10.93	10.60	10.60	10.35	11.67	9.67	12.51	12.51	11.28	11.28
Gilts:	10.09	11.00	13.16	11.55	14.23	8.00	10.42	10.42	12.22	11.07	9.21	11.72	11.72	10.67	9.58	9.90	12.42	12.42	10.63	10.63
Total value ^c	54.23	56.30	52.22	54.48	61.48	59.28	55.15	55.15	55.97	65.11	65.48	63.70	63.70	64.76	73.23	67.79	70.66	70.66	70.56	70.56
Gilts:	54.54	55.53	54.13	54.07	60.53	57.83	57.60	57.60	58.65	66.44	67.02	63.23	63.23	65.56	70.97	71.09	72.19	72.19	71.42	71.42

^aSmaller value calculated for mean weights of fresh pork cuts; prices used were yearly (May 1981-April 1982) averages for individual cuts.

^bn-q.

^cn-12.

^dComposed of joint, boneless picnic shoulder, belly and ham trimmings and all fat trim (it lean varied from approximately 300-500).

^eCombined cut values for carcasses within backfat and hot carcass weight subcells (value computed on side, net total carcass, basis).
^fPrices of square cut seedless bellies weighing less than 10 lbs. were not quoted; these bellies were treated as sausage trim in computation of total carcass value.

TABLE 11
RELATIVE VALUE^a OF PORK CARCASSES ON A PERCENTAGE BASIS FOR VARIOUS CARCASS
WEIGHTS AND LAST RIB BACKFAT MEASUREMENTS

Estimated live wt. (kg) ^b	Carcass wt. (kgs)	Last rib fat thickness (cm)											
		1.27	1.52	1.78	2.03	2.29	2.54	2.79	3.05	3.30	3.56	3.81	4.06
90.7-95.3	66.2-69.4			105			101			105	97		
95.7-99.8	69.9-73.0			104	103		102		100				100
100.2-104.3	73.5-76.2		101			101	102	100	97	100		96	
104.8-108.9	76.7-79.4			100	100	105	100 ^c	100	102		99		
109.3-113.4	79.8-82.6			102		103			99	96	99		
113.9-117.9	83.0-86.2		100	99		105		99	100	100	101	99	95
118.4-122.5	86.6-89.4								98	99	97		
122.9-127.0	89.8-92.5		99		99		99	102					
127.5-131.5	92.9-96.2	98		100	101	91	99	97	99	97		102	102
132.0-136.1	96.6-99.3				102			96			100		

^aValue based on YELLOW SHEET yearly average prices (May '81-April '82); value computed from ham + loin + Boston butt + picnic shoulder + belly (all trimmed) + spare ribs + neckbones + sausage trim + feet. Value does not include viscera (drop) value or energy and labor costs. No adjustments made for superior or inferior muscling.

^bBased on 73% dressing percentage.

^cStandard with a \$68.79/cwt value.

Mean cooking losses or percent shrink are reported for hams and bellies in Table 12. Mean cooking losses of hams were significantly different ($P < .001$) between carcasses weighing 66 to 93 kg and 93 to 102 kg with the hams from the 93 to 102 kg group displaying greater cooking losses. Mean ham cooking losses were also significantly different ($P < .0001$) for carcasses having 1.52 to 2.29 cm average backfat and carcasses possessing 2.54 to 4.32 cm average backfat. Also noted were significant ($P < .001$) interactions between ham cooking losses and backfat x hot carcass weight, as well as hot carcass weight x sex and backfat x hot carcass weight x sex interactions ($P < .01$).

Mean cooking losses, or percent shrink, for bellies were not significantly different ($P < .05$) with respect to hot carcass weight. Cooking losses were highly significant ($P < .0001$) between carcasses of 1.52 to 2.29 cm average backfat and 2.54 to 4.32 cm average backfat, with the trimmer carcasses having greater cooking losses. Also noted were significant differences ($P < .05$) due to sex condition with gilts having greater cooking losses than barrows. These results agree with the findings of Fredeen et al. (1975a), Fredeen et al. (1975b), Chant et al. (1976) and McMillin et al. (1977) who reported that belly and bacon yields, as well as curing yields, increased with increasing backfat thickness and carcass weight, with backfat thickness having a greater effect.

TABLE 12
MEAN PROCESSING WEIGHTS OF HAMS AND BELTIES FROM BARROW AND GILT CARCASSES VARYING
IN WEIGHT AND AVERAGE BACKFAT THICKNESS

Cut	66-75					75-84					84-93					93-102				
	Average backfat (cm) ^a					Average backfat (cm) ^a					Average backfat (cm) ^a					Average backfat (cm) ^a				
	1.52-2.25	2.26-3.30	3.31-4.32	4.33-5.34	5.35-6.36	1.52-2.25	2.26-3.30	3.31-4.32	4.33-5.34	5.35-6.36	1.52-2.25	2.26-3.30	3.31-4.32	4.33-5.34	5.35-6.36	1.52-2.25	2.26-3.30	3.31-4.32	4.33-5.34	5.35-6.36
Ham:																				
Untrimmed	18.5 ^a	17.2 ^a	16.0 ^a	17.7 ^a	20.7 ^a	18.5 ^a	18.2 ^a	19.3 ^a	18.6 ^a	20.0 ^a	22.0 ^a	20.0 ^a	20.0 ^a	20.0 ^a	20.0 ^a	25.1 ^a	23.6 ^a	22.5 ^a	23.7 ^a	22.7 ^a
Trimmed	18.2 ^a	16.7 ^a	16.2 ^a	17.0 ^a	19.6 ^a	18.5 ^a	17.7 ^a	18.6 ^a	20.0 ^a	20.2 ^a	20.1 ^a	19.1 ^a	20.1 ^a	20.1 ^a	20.1 ^a	23.9 ^a	22.4 ^a	21.8 ^a	22.7 ^a	22.7 ^a
Boneless	12.3 ^a	11.4 ^a	11.0 ^a	11.0 ^a	13.5 ^a	12.6 ^a	11.9 ^a	12.7 ^a	13.0 ^a	13.5 ^a	13.0 ^a	13.0 ^a	13.0 ^a	13.0 ^a	13.0 ^a	16.1 ^a	15.1 ^a	12.9 ^a	14.7 ^a	14.7 ^a
Pumped ^c	14.0 ^a	12.7 ^a	12.3 ^a	13.0 ^a	15.4 ^a	14.4 ^a	13.4 ^a	14.4 ^a	15.5 ^a	15.2 ^a	15.5 ^a	13.3 ^a	13.3 ^a	13.3 ^a	13.3 ^a	18.4 ^a	17.3 ^a	15.0 ^a	16.9 ^a	16.9 ^a
Soaked ^d	12.7 ^a	11.6 ^a	11.7 ^a	12.1 ^a	14.0 ^a	13.2 ^a	12.4 ^a	13.2 ^a	14.2 ^a	14.1 ^a	14.2 ^a	12.3 ^a	12.3 ^a	12.3 ^a	12.3 ^a	17.0 ^a	16.1 ^a	14.0 ^a	15.7 ^a	15.7 ^a
Cooked ^e	9.0 ^a	9.2 ^a	9.1 ^a	9.4 ^a	10.2 ^a	10.5 ^a	9.9 ^a	10.1 ^a	10.5 ^a	11.2 ^a	11.2 ^a	9.6 ^a	9.6 ^a	9.6 ^a	10.4 ^a	11.9 ^a	11.9 ^a	11.1 ^a	11.5 ^a	11.5 ^a
Cooking loss(%)	22.2 ^a	22.2 ^a	22.2 ^a	22.4 ^a	27.5 ^a	20.3 ^a	23.1 ^a	23.6 ^a	26.0 ^a	20.6 ^a	21.4 ^a	22.7 ^a	22.7 ^a	22.7 ^a	22.7 ^a	30.0 ^a	28.6 ^a	21.1 ^a	26.4 ^a	26.4 ^a
Belly:																				
Untrimmed	11.3 ^a	13.3 ^a	13.0 ^a	12.7 ^a	13.6 ^a	14.5 ^a	16.1 ^a	14.7 ^a	14.5 ^a	17.1 ^a	16.0 ^a	16.1 ^a	16.1 ^a	16.1 ^a	16.1 ^a	15.9 ^a	16.2 ^a	17.2 ^a	16.4 ^a	16.4 ^a
Trimmed	7.0 ^a	9.4 ^a	9.0 ^a	8.7 ^a	9.5 ^a	10.0 ^a	10.5 ^a	10.5 ^a	10.5 ^a	11.1 ^a	11.1 ^a	10.9 ^a	10.9 ^a	10.9 ^a	10.9 ^a	11.4 ^a	11.4 ^a	11.3 ^a	11.5 ^a	11.5 ^a
Soaked ^d	8.1 ^a	9.6 ^a	9.6 ^a	9.1 ^a	9.6 ^a	10.4 ^a	10.9 ^a	10.3 ^a	10.5 ^a	11.6 ^a	11.6 ^a	11.6 ^a	11.6 ^a	11.6 ^a	11.6 ^a	12.1 ^a	12.2 ^a	11.0 ^a	12.0 ^a	12.0 ^a
Cooked ^e	6.0 ^a	8.4 ^a	8.4 ^a	7.9 ^a	8.5 ^a	9.1 ^a	9.6 ^a	9.1 ^a	8.9 ^a	10.3 ^a	10.3 ^a	10.6 ^a	10.6 ^a	10.6 ^a	10.6 ^a	10.3 ^a	10.5 ^a	10.5 ^a	10.4 ^a	10.4 ^a
Cooking loss(%)	15.2 ^a	12.4 ^a	12.4 ^a	13.5 ^a	13.6 ^a	11.0 ^a	11.7 ^a	12.4 ^a	15.6 ^a	11.2 ^a	11.2 ^a	12.4 ^a	12.4 ^a	12.4 ^a	12.4 ^a	14.7 ^a	13.8 ^a	10.6 ^a	13.1 ^a	13.1 ^a

^acm.

^bcm.

^cChopped to 165 of trimmed, boneless weight.

^dSoaked in curing brine approximately 7 days.

^eSoaked to internal temperature of 66°C (152°F).

^fSoaked in curing brine approximately 5 days.

^gSoaked to internal temperature of 53°C (128°F).

^hMeans in a row having different superscripts are significantly different (P<.01) due to differences in average backfat thickness.

ⁱMeans in a row having different superscripts are significantly different (P<.01) due to differences in hot carcass weight.

V. CONCLUSION

Mean weights for all wholesale cuts increased in a linear fashion with increasing hot carcass weights with no significance attributed to sex condition. Loin and belly weights were not significantly different with respect to average backfat thickness, while ham, Boston butt and picnic shoulder weights were lower for the fatter (3.56 to 4.32 cm) carcasses.

Trimmer carcasses (1.52 to 2.29 cm) of equal weights generally had greater values than fatter carcasses (2.54 to 4.32 cm) within all hot carcass weight groups. Carcass values were based on yearly (May 1, 1981-April 30, 1982) averages of the different cuts and not on superior carcass merit. On a percentage basis, trimmer, heavier carcasses were as valuable or more valuable than traditional carcasses and this value was maintained even as carcass fatness increased.

Mean cooking losses for hams generally decreased with increased carcass fatness but increased with increasing hot carcass weights. There were no significant differences due to sex condition. Mean cooking losses for bellies significantly decreased with increasing carcass fatness but were not significantly different with respect to hot carcass weight or sex condition.

CHAPTER VI

GENERAL CONCLUSION

Within the backfat groups (1.52 to 2.29 cm, 2.54 to 3.30 cm and 3.56 to 4.32 cm) and hot carcass weights (66 to 75 kg, 75 to 84 kg, 84 to 93 kg and 93 to 102 kg) studied, carcass quality was maintained, suggesting that carcass quality is not a major concern with increasing slaughter weights of market hogs. Percentages of the four lean cuts (ham, loin, Boston butt and picnic shoulder) increased in a linear fashion with only the Boston butt showing significant differences with respect to increasing fatness. Percentage lean measured in bacon slices from various locations in the belly were significant only with respect to average backfat thickness which suggests that bellies will maintain acceptable quality at heavier slaughter weights as long as backfat deposition is controlled.

As average backfat thickness increased on pork carcasses, percent water decreased and percent fat (marbling) increased, as expected. Percent nonvolatile cooking losses were significantly lower for loin chops from the trimmer carcasses while percent volatile and percent total cooking losses were nonsignificant with respect to average backfat thickness, hot carcass weight and sex condition.

Trimmer carcasses had significantly lower flavor, juiciness, tenderness and overall acceptability scores for all hot carcass weight groups, but were still of acceptable quality.

Weights of ham, Boston butt and picnic shoulder were significantly lower for fatter carcasses while loin and belly weights were nonsignificant with respect to average backfat thickness which further implies that bellies of heavier hogs will still be of acceptable quality when deposition of backfat is controlled. Bellies from fatter carcasses had significantly lower cooking losses with gilts having greater cooking losses than barrows. Ham cooking losses were greater for the trimmer as well as the heavier carcasses which might be of some concern to the packer/processor with respect to slaughter of heavier market hogs. Value of heavier carcasses, calculated as a percentage of the value of a traditional carcass, was the same or greater (in many cases) even with packer discounts for the heavier wholesale cuts. This would imply that heavier market hogs producing carcasses of superior merit would be profitable for both the packer and the producer. Further research involving production/economics of extended slaughter weights for market hogs would serve to strengthen the motives for extended or heavier market weights for swine.

LITERATURE CITED

CRAMER
EST

LITERATURE CITED

- Anderson, L. D. and F. C. Parrish, Jr. 1972. Histochemical, organoleptic and tenderness properties of porcine muscle. Presented 25th Annual Reciprocal Meat Conf. Meat Science Foundation, Ames, Iowa.(176)
- Anonymous. 1963. Pork quality standards. Special Bull. 9. Wis. Agr. Exp. Sta.
- Anonymous. 1969. Standards for pork color, firmness and marbling. Pm-452. Iowa State Coop. Ext. Serv., Ames.
- Anonymous. 1972. Instructional manual for: Hunterlab digital color difference meter, MODEL 025D2M/L.
- Anonymous. May 1981 to May 1982. "The Yellow Sheet." The National Provisioner Daily Market and News Service. Chicago, Illinois.
- A.O.A.C. 1975. "Official Methods of Analysis," 12th Ed. Association of Official Analytical Chemists, Washington, D. C.
- Berry, B. W. and G. H. Kroening. 1967. Effect of ration and sample location on porcine muscle fiber diameter and tenderness. J. Anim. Sci. 26:892.
- Berry, B. W., G. C. Smith, J. K. Hillers and G. H. Kroening. 1970. Effects of chronological age on live and carcass characteristics of Yorkshire swine. J. Anim. Sci. 31:856. ✓
- Braude, R., M. J. Townsend and G. Harrington. 1963. A comparison of litter-mate pigs slaughtered at 200 and 260 lb. J. Agr. Sci. 61:209. ✓
- Bray, R. W. 1966. Pork quality-definition, characteristics and significance. J. Anim. Sci. 25:839.
- Buck, S. F. 1963. A comparison of pigs slaughtered at three different weights. I. Carcass quality and performance. J. Agr. Sci. (Camb.) 60:19. ✓
- Carpenter, Z. L., R. G. Kauffman, R. W. Bray and K. G. Weckel. 1963. Factors influencing quality in pork. B. Commercially cured bacon. J. Food Sci. 28:578.

- Carpenter, Z. L., R. G. Kauffman, R. W. Bray and K. G. Weckel. 1965a. Interrelationships of muscle color and other pork quality traits. *Food Technol.* 19:1421.
- Carpenter, Z. L., R. G. Kauffman, R. W. Bray and K. G. Weckel. 1965b. Objective and subjective measures of pork quality. *Food Technol.* 19:1424.
- Cassens, R. G., E. J. Briskey and W. G. Hoekstra. 1963a. Electron microscopy of post-mortem changes in porcine muscle. *J. Food Sci.* 28:680.
- Cassens, R. G., E. J. Briskey and W. G. Hoekstra. 1963b. Electron microscopy of post-mortem changes in porcine muscle. *J. Food Sci.* 28(6):684.
- Cassens, R. G., D. N. Marple and G. Eikelenboom. 1975. Animal physiology and meat quality. *Adv. Food. Res.* 21:116.
- Chant, J. L., Jr., D. M. Stiffler, D. M. Kinsman and A. W. Kotula. 1976. Chemical and sensory aspects of commercial bacon. *J. Anim. Sci.* 43:989.
- Cross, H. R., J. W. Carpenter and A. Z. Palmer. 1970. Pork carcass muscling: fat, lean and bone ratios. *J. Anim. Sci.* 30:866.
- Cross, H. R., G. C. Smith, Z. L. Carpenter and A. W. Kotula. 1975. Relationship of carcass scores and measurements to five end-points of lean cut yields in barrow and gilt carcasses. *J. Anim. Sci.* 41:1318.
- Dumont, B. L., G. Roy and B. Desmoulin. 1974. Development of the composition of the ham with increasing slaughter weight in large white boars. *Anim. Breed. Abstr.* 42:562.
- Elson, C. E. 1961. Influence of age on characteristics of porcine muscle. M. S. Thesis, Iowa State University Libr., Ames.
- Fredeen, H. T. 1980. Yields and dimensions of pork bellies in relation to carcass measurements. *J. Anim. Sci.* 51:59.
- Fredeen, H. T., A. H. Martin, D. S. Harbison and J. G. McAndrews. 1975a. Criteria of belly bacon desirability. I. Fat-lean ratio of the pork belly in relation to backfat, carcass weight and specific gravity. *Can. J. Anim. Sci.* 55:641.
- Fredeen, H. T., A. H. Martin, D. S. Harbison and J. G. McAndrews. 1975b. Criteria of belly bacon desirability. IV. Market index as a guide to carcass potential for bacon production. *Can. J. Anim. Sci.* 55:673.

- Fredeen, H. T., A. H. Martin and J. G. McAndrews. 1975. Criteria of belly bacon desirability. III. Within belly variance in chemical and physical characteristics. *Can. J. Anim. Sci.* 55:661.
- Giddings, G. G. 1977. The basis of color in muscle foods. *J. Food Sci.* 42:288.
- Hartley, L. M. and J. L. Hall. 1949. Rapid determination of collagen in beef by waring blender and centrifuge technique. *Food Res.* 14:195.
- Hiner, R. L., O. G. Hankins and H. S. Sloane. 1953. Fiber diameter in relation to tenderness of beef muscles. *Food Res.* 18:364.
- Hiner, R. L., J. W. Thornton and R. H. Alsmeyer. 1965. Palatability and quantity of pork as influenced by breed and fatness. *J. Food Sci.* 30:550.
- Hovorka, F. and J. Pavlik. 1974. Biological aspects of the determination of the optimum slaughter weight of pigs. *Anim. Breed. Abstr.* 42:9.
- Jabaay, R. W., J. C. Forrest, E. D. Aberle, H. V. Courtenay and M. D. Judge. 1976. Bacon quality criteria and associated carcass traits. *J. Food Sci.* 41:431.
- Jolly, R. W., A. P. Sather, R. D. Patterson, B. H. Sonntag, A. H. Martin and H. T. Fredeen. 1980. Alternative market weights for swine: Production economics. *J. Anim. Sci.* 51:804.
- Kauffman, R. G., Z. L. Carpenter, R. W. Bray and W. G. Hoekstra. 1964. Biochemical properties of pork and their relationship to quality. II. Intramuscular fat. *J. Food Sci.* 29:70.
- Kemp, J. D., W. G. Moody and J. D. Fox. 1969. Effect of fatness and fresh pork quality on yield and quality of bacon and yield of ham. *J. Anim. Sci.* 28:612.
- Marcy, J. E. 1976. Certain chemical, physical and histochemical characteristics of three quality levels of porcine longissimus. M. S. Thesis, The University of Tennessee, Knoxville.
- Martin, A. H. and H. T. Fredeen. 1974. Pork quality in relation to carcass fatness and muscling. *Can. J. Anim. Sci.* 54:137.
- Martin, A. H., A. P. Sather, H. T. Fredeen and R. W. Jolly. 1980. Alternative market weights for swine. II. Carcass composition and meat quality. *J. Anim. Sci.* 50:699.

- McMillin, K. W., M. D. Judge, J. C. Forrest, V. L. Anderson and E. D. Aberle. 1977. Relationships of bacon quality to pork carcass traits. *J. Anim. Sci.* 45:1023.
- Merkel, R. A. 1971. The relationship of some cardiovascular and haematological parameters to porcine muscle quality. *Proc. 2nd Int. Symp. Condition Meat Quality Pigs*, Zeist, Pudoc, Wageningen.
- Murphy, M. O. and A. F. Carlin. 1961. Relation of marbling, cooking yield and eating quality of pork chops to backfat thickness on hog carcasses. *Food Technol.* 15:57.
- Neely, J. D., R. K. Johnson and L. E. Walters. 1979. Efficiency of gains and carcass characteristics of swine of two degrees of fatness slaughtered at three weights. *J. Anim. Sci.* 48:1049. ✓
- O'Grady, J. F. 1966. Effects of sex, plane of feed and slaughter weight on the performance, carcass measurements, and carcass and joint composition of bacon pigs. *Irish J. Agr. Res.* 5:197. ✓
- Onate, L. U. and A. F. Carlin. 1963. Relation of physical and sensory evaluations of pork loin quality to backfat thickness. *Food Technol.* 17:123.
- Parks, J. D. 1974. The relationship between porcine longissimus dorsi histological traits and carcass and performance characteristics. M. S. Thesis, The University of Tennessee, Knoxville.
- Rhodes, D. N. 1970. Meat quality: Influence of fatness of pigs on the eating quality of pork. *J. Sci. Fd. Agric.* 21:572.
- Richmond, R. J. and R. T. Berg. 1971. Tissue development in swine as influenced by live weight, breed, sex and ration. *Can. J. Anim. Sci.* 51:31.
- Saffle, R. L. and L. J. Bratzler. 1959. The effect of fatness on some processing and palatability characteristics of pork carcasses. *Food Technol.* 13:236.
- Schilling, E., A. Millo. 1964. Chemical and histological changes in post-mortem muscles and their relationships to meat characteristics. II. Histological and histochemical research on muscular fibers post-mortem. *Z. Tierzuchter Zuchtungsbiol.* 80:146.
- Schilling, Von Erich. 1966. Muskelstruktur und Fleischqualitata. *Zeitschrift fur Tierzuchtung und Zuchtungsbiologie.* Band 82, Heft 3. S219.

- Schroder, B. G. and R. E. Rust. 1974. Composition of pork bellies. II. Compositional variation between and within animals and their relationship of various carcass measurements with the chemical components of the belly. *J. Anim. Sci.* 39:1037.
- Sebranek, J. G. 1981. Pork quality: A research review. NPPC, Iowa.
- Skelley, G. C. and D. L. Handlin. 1971. Pork acceptability as influenced by breed, sex, carcass measurements and cutability. *J. Anim. Sci.* 32:239.
- Skelley, G. C., D. L. Handlin and T. E. Bonnette. 1973. Pork acceptability and its relationship to carcass quality. *J. Anim. Sci.* 36:488.
- Smith, G. C. and Z. L. Carpenter. 1973. Evaluation of factors associated with the composition of pork carcasses. *J. Anim. Sci.* 36:493.
- Smith, G. C., R. L. West and Z. L. Carpenter. 1975. Factors affecting desirability of bacon and commercially processed pork bellies. *J. Anim. Sci.* 41:54.
- Smith, G. C., G. T. King and Z. L. Carpenter. 1978. *Laboratory Manual for Meat Science* (2nd ED.). American Press, Boston, Massachusetts.
- Snedecor, G. W. and W. G. Cochran. 1967. *Statistical Methods* (6th ED.). Iowa State College Press, Ames.
- Staun, H. 1963. Various factors affecting number and size of muscle fibers in the pig. *Acta. Agriculture Scandianvica*, XIII 3:293.
- Stiffler, D. M., J. L. Chant, Jr., D. M. Kinsman and A. W. Kotula. 1975. Indices of leanness in commercial bacons. *J. Anim. Sci.* 41:1611.
- Swanson, L. A., E. A. Kline and S. E. Goll. 1965. Variability of muscle fiber size in bovine longissimus dorsi. *J. Anim. Sci.* 24:97.
- Swatland, H. J. and R. G. Cassens. 1973. Observations on the post-mortem histochemistry of myofibers from stress susceptible pigs. *J. Anim. Sci.* 37:885.
- Tendick, E. W. 1966. The effects of breed on muscle fiber diameter and its relationship to palatability. M. S. Thesis, The University of Tennessee, Knoxville.

- Tuma, H. J., J. H. Venable, P. R. Wriether and R. L. Henrickson.
1962. Relationship of fiber diameter to tenderness and meatiness
as influenced by bovine age. J. Anim. Sci. 21:33.
- United States Department of Agriculture. 1967. Cutting and Trimming
Instructions for Pork Carcasses. Consumer and Marketing Service,
Livestock Division, Washington, D. C.
- United States Department of Agriculture. 1968. Official United
States Standards for Grades of Barrow and Gilt Carcasses
Consumer and Marketing Service, Livestock Division, Washington,
D. C.
- Usborne, W. R., J. D. Kemp and W. G. Moody. 1968. Effect of live
weight on quality, proximate composition, certain protein
components and free amino acids of porcine muscle. J. Anim.
Sci. 27:584.
- Wachholz, D., R. G. Kauffman, D. Henderson and J. V. Lochner. 1978.
Consumer discrimination of pork color at the market place.
J. Food Sci. 43:1150
- Wajda, S. 1975. Carcass quality of pigs slaughtered at different
weights. Anim. Breed. Abstr. 43:139. ✓

VITA

Mark Stephen Franzreb, son of Mr. and Mrs. John K. Franzreb, was born March 6, 1958 in Knoxville, Tennessee. He graduated from Roane County High School, Kingston, Tennessee, in June of 1976. He enrolled in the College of Agriculture, The University of Tennessee, Knoxville in September of 1976 and received his Bachelor of Science in Agriculture majoring in Food Technology and Science, in June of 1980, graduating with honors. In August of 1981 he accepted a graduate research assistantship at The University of Tennessee, Knoxville in Food Technology and Science, with a minor in Animal Science, and began his pursuit towards a Master's Degree, which was obtained in August of 1982. He is a member of Phi Eta Sigma, Gamma Beta Phi, Alpha Zeta, Gamma Sigma Delta and Phi Tau Sigma honor societies, American Meat Science Association, American Society of Animal Science and the Institute of Food Technologists professional societies, as well as Alpha Gamma Rho Fraternity.