SPECIFIC GRAVITY AND CHEMICAL COMPOSITION OF THE UNTRIMMED HAM AS RELATED TO LEANNESS OF PORK CARCASSES

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James Franke Price

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By

James Franke Price

AN ABSTRACT

Submitted to the College of Agriculture of
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THESIS ABSTRACT

In this study, thirty-six hogs having an average weight of 199.2 pounds were probed and slaughtered. Weights and measurements were taken to obtain dressing percentage, carcass length, backfat thickness, percentage primal and lean cuts, percentage fat and lean trim, specific gravity of the carcass, specific gravity of the ham, and lean area of the loin. The right ham was boned and ground five times with subsequent analysis for water, ether extract and protein.

Most of the items were compared as estimates of pork carcass value by means of correlation analyses.

A high relationship existed between ham and carcass specific gravity. Either right ham or carcass specific gravity was more reliable as an index of ether extract, water or protein, when taken singly or as total chemical composition, than as an index of cut-out, loin lean area or linear carcass measurements. Also, specific gravity showed a closer relationship with the size of the lean area of the loin than did live probe, backfat thickness or length. However, specific gravity was not significantly related to dressing percentage.

The various cut-out percentages were not as closely associated with the lean area of the loin measured at either the tenth or last rib as with specific gravity. Although the area at the tenth rib was closely associated with lean area of the loin at the last rib, cut-out was more closely predicted by the tenth rib cross section. Lean area of the loin was not significantly related to backfat thickness.

Carcass length showed a greater relationship with ham specific gravity than with any other measure. Length per se was not a reliable measure of carcass cut-out. Although the area of lean in the loin was more closely predicted by carcass length than by backfat thickness, the relationship was not high.

The live probe estimate of backfat thickness seemed to be a valid one due to the highly significant relationship between the two. However, live probe was a more reliable index of specific gravity or carcass cut-out than was backfat thickness. Both live probe and backfat thickness showed a closer relationship with the cut-out values than did specific gravity. It was postulated that specific gravity was a more reliable index of such desirable traits as large loin eyes and small inter-muscular fat deposits than was live probe or backfat thickness.

A higher correlation coefficient indicated that the multiple relationship of live probe and carcass length was a more reliable measure of carcass cut-out than any other measure tested, but no practical information was obtained over the use of live probe alone. Live probe and length as a combined factor was a valid estimation of cut-out. However, specific gravity may be a more reliable index of the consumer desirability of the individual cuts after they are trimmed. Proof of this theory was indicated by the high relationship between the specific gravity measures and combined chemical composition of the ham.

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INTRODUCTION

The surplus lard problem has resulted in emphasis being placed on the production of leaner, meatier hogs. Evaluation and certification programs have brought about a need for simple, accurate methods for estimating the desirable traits of swine to serve as a guide to the producer in selecting and raising "meat type" hogs.

The long used method of evaluating swine for market according to their weight seems valid on the surface. Margerum (20) reported that hogs in the 180-220 pound weight range had an average of 78 percent of their value in the leaner cuts and 16 percent in fat or lard, while hogs in the 270-300 pound range had only 65 percent of their value in the leaner cuts and 28 percent in the fat. However, a study of individual swine and their carcasses will show an equally wide variation within the weight ranges.

Hetzer et al. (15) found that the predictive value of a series of external live measures was not as great as desired, and proved to be of little practical value in evaluating leanness in swine. However, other studies (14) (12) (16) (27) have shown that certain carcass measures prove to be good methods of pork carcass evaluation. Length of carcass and backfat thickness are criteria now incorporated in the U.S. Grade Standards for grading pork carcasses.

However, other desirable traits such as large loin muscle areas, small amounts of intermuscular fat deposits and meaty hams and shoulders are not predicted as closely as desired by backfat thickness and length.

The swine breeder is being encouraged to select for the leaner, more valuable hog. A study of various certification programs points out a need for more accurate pork carcass evaluation. It has been postulated that chemical analysis of the entire carcass might be the most accurate evaluation of leanness. This, of course, renders the carcass useless for usual means of consumption, and proves time consuming and expensive even in experimentation. Various studies (28) (22) of other indices of pork carcass value have been undertaken, including the specific gravity of the entire carcass and chemical analysis of sample cuts. Some of these methods prove to be cumbersome and wasteful. The use of specific gravity of a single cut seemed to be a simple evaluation method. Therefore, this study was undertaken to determine the accuracy of this method in evaluating pork carcass leanness by testing its association with other measures.

REVIEW OF LITERATURE

Weight and Linear Measurements

Although heavy weight hogs proved to yield a higher dressing percentage, Loeffel *et al.* (18) found that as pigs progressed in weight from 160 to 400 pounds, the thickness of fatback increased from 0.69 inch to 2.44 inches, and percentage of lean cuts decreased. However, the predictive value of weight *per se* as to leanness proved inadequate when working in a narrow weight range.

Accurate visual evaluation of leanness in the live hog proved to be most difficult. McMeekan (19) found that certain external carcass measures that could be estimated by visual observation were mainly indicative of over-all skeletal development and gave little promise in predicting carcass composition. In 1953, Bratzler and Margerum (6) studying the relationship between live hog scores and carcass measurements, concluded that some training and experience was necessary to grade live hogs accurately. In their study, a closer estimation of length and backfat thickness was obtained with lighter weight pigs. Estimation of preferred cut yield proved to be most difficult. It might be concluded from their study that live hog evaluations proved inadequate for accurate estimation of pork carcass value.

Hankins *et al.* (12) found that backfat thickness was more highly related to percentage fat than were weight and linear measures.

Live Probe

Hazel and Kline (14) developed the live probe method for estimation of backfat thickness. They found a correlation coefficient of +.81 between live probe and actual backfat measures. The average of four live probes was more highly correlated with area of loin eye, lean ham area and percentage primal cuts than was actual backfat thickness, using an average of four measures made opposite the first, seventh and last ribs and the last lumbar vertebra. Pearson et al. (22) reported a higher correlation between live probe and the specific gravity of the carcass than between actual backfat thickness and specific gravity. Also, live probe was more highly related to the specific gravity of individual cuts than was backfat thickness. However, live probe was not as highly associated with specific gravity as was lean cuts or primal cuts on the live basis.

Backfat Thickness and Length

Studying the relationship between a series of carcass measures and percentage fat in the edible portion of pork carcasses, Hankins and Ellis (12) found a correlation coefficient of +.77 between the percentage fat and backfat thickness at the seventh vertebra. In this study, backfat thickness was more highly correlated with percentage fat than any other measure tested, which included weight and linear carcass measures. However, Warner et al. (25) correlated percentage fat cuts with percentage fat in the edible portions as determined by chemical analysis. They also correlated percentage fat cuts and percentage lean cuts together with percent fat in the edible portion. It was concluded that these measures were more reliable than percentage belly or backfat thickness.

A high correlation (+.95) between backfat thickness and weight of fat was obtained by McMeekan (19). Hazel and Kline (14) found live probe to be highly correlated with average backfat thickness, while other measures of leanness were more highly related to live probe than to backfat thickness.

While there was no correlation between uniformity of backfat and percentage primal cuts, Aunan and Winters (2) concluded that average backfat thickness was associated with fat and lean content of the carcass, percentage primal cuts and dressing percentage. Weight per inch of length divided by the backfat thickness as an index for carcass evaluation was stated to be a good index of carcass value. These workers concluded that conventional measures of backfat thickness and length were indications of lean and fat content of pork carcasses. Data obtained by Pearson et al. (22) showed that both backfat thickness and length of carcass were better measures of leanness for lighter weight pigs than those on the heavy end of the market weight range. However, no information was found on backfat thickness and length combined, as a measure of leanness.

Area of Lean in the Loin

According to Stothart (24), the area of the loin muscle as estimated by the product of length times width of the muscle was found to decrease as the shoulder fat depth increased. Aunan and Winters (1) concluded that the area of lean of the loin, with the effect of carcass weight removed, was indicative of the relative amounts of lean in the carcass. However, the area of lean in the loin was not correlated with lean content per se, but was related to carcass length.

Brown et al. (7) found a higher correlation (+.84) between specific gravity of the carcass and percentage lean cuts than between specific gravity and lean area of the loin (+.51). However, a significant correlation of specific gravity with loin lean area was reported by Whiteman and Whatley (27). Their study also pointed out that lean areas measured with a polar planimeter gave a higher correlation with other measures of leanness than did areas of lean determined by the product of length times width of the muscle in cross section. Fredeen et al. (10) found a high correlation (+.794) between lean area of the ham and loin lean area.

Studying the relationship between loin areas of the same side at the tenth and last ribs and percentage lean cuts and percentage loin, Kline and Hazel (16) stated that variation between sides was extremely small, and that the area at the tenth rib was consistently smaller than that at the last rib. However, there was no difference in the two area measurements as related to lean cuts.

As a loin index, McMeekan (19) found that two times the length plus the width of the eye muscle was highly correlated (+.93) with weight of lean. The loin index obtained in this way was more highly correlated with weight of lean than was loin area determined by the product of length times width.

Separable Fat, Lean and Bone

Warner et al. (25) in 1934 stated that the percentage fat in the edible portion of pork, as determined by physical separation, was highly correlated with percentage fat cuts combined with percentage lean cuts as a single measure, and was a more reliable measure of fatness than percentage belly and fatback. This paralleled findings of Hankins and Ellis (12) who reported a correlation of +.77 between percentage fat in the edible portions and backfat thickness at the seventh thoracic vertebra.

A relatively complete study of the variations of muscle, fat and bone of swine carcasses, as determined by physical separation, was carried out by Aunan and Winters (1). They found that correlations between the lean content of the loin and lean content of the carcass were positive and highly significant. Correlations between lean content of the ham and lean content of the picnic and belly were highly significant, as were fat content of the loin and fat content of the primal cuts. Bone content of the ham was also highly related to bone content of the primal cuts. Interestingly, a correlation of +.731 was found between the bone content and lean content. This was substantiated by Fredeen *et al.* (9), who found that bone content of the ham was positively associated with measures of lean indicating that large hams which carried a greater percentage bone were also leaner. However, Whiteman *et al.* (28) stated that 78% of the variance of specific gravity of the ham was independent of percentage bone. Fredeen *et al.* (9) also found a high negative correlation between weight of lean and weight of fat in the ham. Weight of lean in the ham was positively associated with other measures of carcass leanness. In this study, the percentage weight in the proximal portion of the hams was negatively correlated with leanness, and conversely, an increase in the weight of the shank portion was accompanied with an increase in weight of lean.

A subsequent study by Aunan and Winters (2) on physical separation for measuring relative amounts of fat and lean tissues in pork carcasses showed that a core sample from the 5th-6th rib area was the best index of lean tissue.

Cut-out

Percentage lean cuts and percentage primal cuts represent the high priced, readily salable portion of the pork carcass, and are often used as a basis against which other measures of leanness or value are compared. Little data was found relating these measures with actual chemical composition, but most comparisons have been with other measures of leanness.

Hankins and Hiner (13) used primal cut-out as a basis to rank three breeds of hogs on their relative desirability. Aunan and Winters (1) found a high primal cut-out was positively associated with high lean content of pork, and negatively with backfat thickness. Specific gravity was more highly correlated with primal cuts than it was with backfat in a study conducted by Brown _et al._ (7).

Brown _et al._ (7), also, found that lean cut-out was more highly correlated with specific gravity than was backfat thickness, or area of loin eye. Similarly, Whiteman _et al._ (28) found a correlation coefficient of $+.868$ between lean cuts and specific gravity. Kline and Hazel (16) reported an association of lean cuts and area of loin eye. Pearson et al. (22) found that lean cut-out was not as highly related to backfat or length as it was to specific gravity.

Chemical Analysis

Chemical analysis of a representative cut was postulated by Warner et al. (25) to be the most accurate measure of fatness followed by percentage fat or lean cuts and carcass measures, respectively. Chemical analysis was used (28) as a basis for comparison and its accuracy assumed to be most logical. Whiteman et al. (28) and Brown et al. (7) used chemical analysis of crude protein, water and ether extract as a basis for evaluating specific gravity as a measure of leanness.

Kraybill, Hankins and Bitter (17) found that an estimation of body fat in cattle by injection of antipyrine in vivo agreed well with fat content as determined by direct analyses.

Specific Gravity

Probably the first studies of the specific gravity of the animal body were carried out with humans in the interest of medical science. Boyd (5) reported that the specific gravity of the human body increases rectilinearly with stature and age. It was further stated that during quiet respiration human specific gravity ranged from 1.05 to 1.015, and that inspiration had a greater effect on the variance than did expiration. In a hypothetical case, she estimated that doubling the average adult weight of fat lowered the specific gravity 6 percent. It was further observed that a more accurate estimation of the effect of obesity on specific gravity was obtained by hypothetically increasing the weight of the supporting tissue, panniculus adiposus, along with the weight of fat. In these studies, Boyd used the method of hydrostatic weighing to obtain specific gravity measures.

Behnke _et_ _al_. (3) stated that the presence of an indeterminant amount of excess adipose tissue rendered difficult any precise computation of metabolic rate, or any dosage on the basis of body weight, and thus they undertook a study of body specific gravity as a measure of obesity. The data obtained supported the concept that the comparatively low specific gravity of fat makes body specific gravity a valid estimation of fat content. They concluded that the fundamental biologic characteristics of corporeal density can be accurately measured within 0.004 units by a method of hydrostatic weighing, if corrections are made for the residual lung volume. Also, it was found that fat and bone seemed to be the chief determinants of body specific gravity, and that variations in percentage bone in relation to body weight was not expected to produce deviations more than 0.013 units. Since the amount of bone is relatively constant, Behnke and his associates concluded that specific gravity served as a good measure of body fat.

Testing the relationship between specific gravity of the human body and body water as determined by injection of antipyrine, Messinger and Steele (21) stated that body water and body fat can be calculated from body specific gravity with considerable accuracy. Using independent methods of measuring, an inverse relationship between percent body fat and percent body water was found. They postulated the following equations for calculating body fat and water.

$$\text{Percent fat} = 100\left[\text{body wt.} - \frac{\text{wt. of body water}}{0.73}\right]$$

$$\text{Percent water} = 100\left[4.424 - \frac{4.061}{\text{specific gravity}}\right]$$

Following previous studies, Rathbun and Pace (23) undertook a study of the determination of fat content of eviscerated guinea pigs by specific gravity, using the water displacement principle. They determined that variations in body fat are the chief determinants of body specific gravity. The specific gravity increased as body fat decreased. It was also stated that in hydrostatic weighing determinations, sometimes called water displacement, variations in water temperature produced a negligible effect. An equation for calculating percent fat in eviscerated guinea pigs was proposed.

$$\text{Percent fat} = 100\left[\frac{5.362}{\text{specific gravity}} - 4.880\right]$$

Since body specific gravity seemed a valid measure of body fat, it has been employed by various workers, Whiteman _et al._ (26) and Brown _et al._ (7) as a measure of pork carcass fat content.

Brown _et al._ (7) found that specific gravity values for pork were lower and less variable as compared with guinea pigs and men. Positive, highly significant correlations were found between the specific gravity of the carcass and area of loin eye (+.46), percentage primal cuts (+.68), percent lean cuts (+.84) and carcass length (+.56). Brown and co-workers also obtained negative, highly significant correlations between specific gravity and average backfat thickness (-.68), percentage fat cuts (-.78) and carcass weight (-.42). In this study percentage lean cuts was more highly correlated with specific gravity (+.84) than was backfat thickness (-.72) or area of loin eye (+.51). Similarly, percentage fat cuts was more highly associated with specific gravity than was backfat or area of loin eye.

From data obtained from a second group of hogs, Brown *et al.* (7) found that specific gravity was more highly correlated with percentage primal cuts, percentage lean cuts, percentage fat cuts, ether extract and crude protein than was backfat thickness. The entire side was boned and ground for chemical analysis. Correlations of specific gravity with percentage lean cuts were higher than those of lean cuts with percentage protein. Percentage fat cuts was more highly associated with specific gravity than with ether extract. A high correlation was obtained between specific gravity and percentage protein (+.95) and ether extract (-.95). Multiple correlations indicated that specific gravity combined with various measures of leanness were no better than specific gravity alone. It was postulated that carcass fatness might be determined more accurately before the carcass was cut, using specific gravity, than by percentage fat cuts.

Whiteman, Whatley and Hillier (28) obtained significant correlation coefficients between carcass specific gravity and percentage moisture (+.832), protein (+.820) and ether extract (-.808) of the ham. A multiple correlation coefficient indicated that 83 percent of the variation of specific gravity was dependent upon percentages of the three chemical components measured. The unaccounted for variation of specific gravity was probably due to sampling error according to these workers. On testing two determinations on each of two samples, they stated that 8 percent of the variation in percentage moisture, and 11.3 percent of the variation in protein were due to sampling errors.

Data from Whiteman and co-workers' study (28) showed that both percentage lean and fat was much more closely associated with specific gravity than was percentage bone. Seventy-eight percent of the variance of specific gravity was independent of percentage bone. However, data from two other groups of hogs indicated that the specific gravity of the half carcass was highly correlated with percentage bone. It was pointed out that the relationship was not as great when percentage lean cuts was held constant, and that selection pressure would not be great due to a covariance with lean cuts.

Highly significant correlation coefficients of +.869, +.888 and +.689 were found with specific gravity of the carcass and lean cuts, percentage weight ham and loin, and loin lean area, respectively. Also a correlation coefficient of +.942 was obtained between the specific gravity of the half carcass and the specific gravity of the ham. Therefore, they concluded that the tissues of the ham were indicative of the proportions of the respective tissues in the entire carcass, and that specific gravity measured the proportion of tissues very closely.

Whiteman and Whatley (28) found a significant correlation between specific gravity of the pork carcass and area of loin eye at the last rib. However, Fredeen et al. (9) appraising methods of ham evaluation, noted that specific gravity of the ham was not as highly correlated with other measures of ham leanness as was percentage area of lean in the cut surface of the ham.

Pearson *et al.* (22) correlated the specific gravity of the entire carcass with specific gravity of several single and paired cuts, and with a series of carcass measures. They found lean cuts minus fat trim was more highly correlated with specific gravity of the carcass than were other carcass measures. Also, significant positive correlations were found when specific gravity was correlated with lean cuts on both live and carcass bases, primal cuts on both bases, area of loin eye at the tenth and last ribs, and carcass length. Carcass specific gravity was negatively correlated with backfat thickness, percentage fat trim and live probe. No significant relationship was found between carcass specific gravity and dressing percentage or lean trimmings.

Comparing carcass specific gravity with the specific gravity of paired hams, loins and shoulders, Pearson *et al.* (22) obtained correlation coefficients of +.94, +.96 and +.92, respectively. Specific gravities of single cuts were also highly correlated with carcass specific gravity, with coefficients of +.93, +.91 and +.87 for the ham, loin, and shoulder, respectively. For any single cut, the ham was more highly correlated with carcass specific gravity. On the other hand, the paired loins showed the highest correlation of the paired cuts. This work suggested that the specific gravity of the single ham was a better indication of carcass specific gravity, since difficulty in determining loin specific gravity was encountered due to the greater bouyancy. It was indicated that specific gravity of the single ham was the most reliable index of carcass specific gravity.

EXPERIMENTAL PROCEDURES

Experimental Animals

A total of thirty-six hogs was used in this study, coming from the Michigan Agricultural Experiment Station Farm and ranging in weight from 177 to 249 pounds, with an average weight of 199.2 pounds. There were 15 Durocs, 7 Chester Whites, 12 Hampshires and 2 Yorkshire-Chester White crossbred pigs. These hogs came from a variety of feeding programs. Some came off different feeding experiments, while others were raised under normal farm conditions. No attempt was made to segregate the groups according to their nutritional background.

The hogs were weighed and taken off feed approximately 24 hours prior to slaughter, but allowed free access to water. The weight taken just prior to slaughter was used as the slaughter weight and used in computing dressing percentage, as well as both percentage lean and primal cuts on the live basis.

Live Probe

Prior to slaughter, the approximate backfat thickness was estimated by the live probe method similar to the procedure described by Hazel and Kline (14). A total of 6 probes was made with a 1/4" by 6" steel ruler to the nearest 0.1 of an inch. The sites of probing were approximately 1½ inches off the midline on each side of the backbone just behind the shoulders, over the middle of the back, and just posterior to the center of the loin. An average of the 6 probes was used as the live probe measure of backfat thickness.

Slaughter Procedure

All animals were slaughtered in the University Meats Laboratory using packer style dress; i.e., head off, jowls attached, leaf-fat removed, hams faced but with the facing left attached. The carcasses were chilled at approximately 35°F for 48 hours before they were cut and specific gravity determinations made.

Carcass Measurements

The leaf-fat and kidney were removed and the chilled carcass weighed to the nearest 0.5 pound for calculation of dressing percentage. However, the weight of the leaf and kidney was included in "fat trim". Length of carcass was measured from the anterior edge of the first rib to the anterior tip of the aitch bone. Backfat measurements were taken opposite the first, seventh and last ribs, and opposite the last lumbar vertebra and averaged for mean backfat thickness, which was used in all comparisons. Backfat thickness and length of carcass measurements were taken with a centimeter steel tape and the reading was recorded to the nearest millimeter. All millimeter measures were multiplied by 0.03937 to convert to inches, which are reported in this study.

Area of Lean

Tracings of the lean area cross section of the right loin were made just anterior to both the 10th and last ribs. The areas of lean were measured by means of a K & B compensating polar planimeter, using the average of three measures which did not vary over 0.1 square inch.

Calculations

Dressing percentage was computed by conventional methods, using the chilled carcass weight and slaughter weight. As the right ham was ground for chemical analysis without trimming, the weight of the left skinned ham was doubled. The sum of the calculated value for the skinned hams, both trimmed loins, both New York shoulders and both trimmed bellies was used in computing percentage primal cuts on both live and carcass bases. Percentage lean cuts was computed on both live and carcass bases by omitting the bellies from the weight of primal cuts to obtain the weight of lean cuts.

Cutting Procedure

The carcasses were broken into rough cuts using conventional procedures similar to those outlined by Cole (8) with some variations. The hind foot was removed by sawing through the boney projection inside the hock, while the fore foot was removed approximately 1/2 inch above the knee joint. The ham was taken off by sawing across the 4th sacral vertebra perpendicular to the hind shank. After cutting through the meaty portion of the loin end the knife was angled toward the hock, rounding the ham, and leaving the flank meat on the rough belly. A 2½ rib shoulder was removed perpendicular to the general line of the back. The jowl was removed from the rough shoulder cutting parallel to the loin cut about 1½ inch to 2 inches posterior to the indentation where the ear was removed. The rough loin and belly were separated, cutting from a point just below the psoas major muscle on the loin end to a point approximately 1 inch below the juncture of the ribs and backbone on the blade end and following the general curvature of the back in order to get a uniform loin thickness. The ribs were lifted from the rough belly, cutting through the secondary flank muscle and as close under the ribs as possible. The belly was then trimmed by cutting through the teat line and squaring at the flank end.

All cuts were trimmed with the exception of the right ham, leaving approximately 1/4 inch of fat covering on the ham and loin. A New York style shoulder was made, trimming through the false lean, leaving approximately 1/4 inch of fat covering. Fat trimmings included all cutting fat in addition to the leaf fat and kidney, while the lean trimmings were composed of small pieces of lean removed during trimming. Both fat and lean trimmings were weighed. No attempt was made to keep weights on the remaining miscellaneous cuts.

Specific Gravity Determinations

The individual sides were weighed on platform scales to the nearest 0.1 pound just prior to weighing the carcass under water. The hydrostatic weighing procedure for determining the specific gravity of carcasses as outlined by Rathbun and Pace (23) was used. Under water weights were made with a gram balance read to the nearest gram. Due to the inadequate size of the scalding tank used for weighing in water, the feet had to be removed and weighed separately under water, this weight being added back to the under water carcass weight.

All untrimmed cuts with the exception of the belly were weighed in air to the nearest 0.1 pound and in water to the nearest gram. A second set of weights was taken on the right ham using a 25 gallon earthenware crock for under water weights. The weight of the hook and string used to connect the cuts to the balance had to be counterbalanced, and the balance was checked at frequent intervals during a series of determinations.

Specific gravity was computed, using the following formula:

$$\frac{\text{wt. in air in grams}}{\text{wt. in air (gms) - wt. in water (gms)}} = \text{Specific Gravity}$$

The weights in air which were recorded in pounds, were converted to grams by multiplying the weights in pounds by 454.

Preparation of Samples for Chemical Analysis

After specific gravity determinations were made on the untrimmed right ham, it was boned and skinned, taking care to remove all the flesh possible from the bone and skin. The bone, skin, and boneless meat, which included fat and lean, were weighed separately. The boneless meat was then ground through a 3/32 inch grinding head five times with subsequent mixing after each grinding. This method of preparing the sample had been previously shown to give satisfactory mixing, Benne (4). A sample of the ground ham was then placed in a sample bottle for later chemical analysis. The grinder was cleansed thoroughly and dried after each ham was ground.

Chemical Analysis

Approximately 60-72 hours after grinding, the sample was analyzed for moisture, protein and ether extract. The analyses were made by the Department of Agricultural Chemistry using procedures as outlined by Benne (4).

A clean Gooch crucible was placed in a small clean beaker and dried to a constant weight. A small sample of meat was placed in the crucible and the sample plus the beaker and crucible were weighed to the nearest 0.0001 gram. Then the weight of the sample was obtained by difference. The sample was placed in a drying oven for 25 hours at 100° - 105°C. After cooling in a desiccator, the beaker, crucible and contents were re-weighed to get the amount of moisture loss by difference.

The remaining dried sample in the Gooch crucible was then placed on a Bailey-Walker extractor. Any fat that had melted or splattered into the beaker was washed out with anhydrous ether. The sample was extracted for 16 hours with anhydrous diethyl ether, then the beaker, crucible and contents were heated in an oven for 2 hours. These were then cooled in a desiccator and reweighed to obtain the weight of the ether extract by difference, from which the percentage ether extract was calculated.

To obtain percentage protein, a sample of meat weighing approximately 1.5 grams was weighed to the nearest 0.0001 gram on a small piece of tared, nitrogen-free parchment paper. After weighing, the sample was rolled in the paper and dropped into a Kjeldahl flask. Percentage protein was then determined by standard procedures.

Statistical Analysis

All correlation coefficients were computed by the methods described by Goulden (11). Linear equations and "r" values were obtained as outlined below:

Simple correlations

$$y = a + b\,x$$

$$b = \frac{\Sigma xy}{\Sigma x^2} \qquad r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}}$$

$$a = \bar{Y} - b\,\bar{X}$$

Corrected values -

$$\Sigma y^2 = \Sigma Y^2 - \frac{(\Sigma Y^2)}{N}$$

$$\Sigma x^2 = \Sigma X^2 - \frac{(\Sigma Y)^2}{N}$$

$$\Sigma xy = \Sigma XY - \frac{\Sigma X \Sigma Y}{N}$$

Standard deviation

$$S_x = \sqrt{\frac{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}{n}}$$

Multilinear correlations

$$y = a + bX_1 + CX_2 - - - - \text{etc.}$$

$$a = \bar{Y} - b\bar{X}_1 - c\bar{X}_2 - - - - \text{etc.}$$

$$R = \sqrt{ry_1\sqrt{\frac{\Sigma x^2}{\Sigma y^2}} \cdot b + ry_2\sqrt{\frac{\Sigma x_2{}^2}{\Sigma y^2}} \cdot C - - - \text{etc.}}$$

Corrected values were obtained as above.

RESULTS AND DISCUSSION

The various measurements with their means, standard deviations, standard errors and symbols are shown in Table 1. The symbols given in Table 1 were used in subsequent tables. The number of highly significant correlation coefficients found between the specific gravity of the carcass and other measures of leanness or fatness, as shown in Table 2, indicated that specific gravity was a reliable measure of leanness. Much of the data obtained as to the reliability of carcass specific gravity as a measure of pork carcass leanness agreed well with data obtained by Pearson et al. (22). The specific gravity of the carcass showed a higher relationship with the specific gravity of the untrimmed ham than with any other measure, with a correlation coefficient of +.862. This indicated that 74 percent of the variation in carcass specific gravity was accounted for by a similar variation in ham specific gravity. Although specific gravity of the other cuts was not tested with carcass specific gravity, the high correlation indicated that the specific gravity of the ham was a valid estimation of carcass specific gravity. This agreed with previous work of Whiteman et al. (28) and Pearson et al. (22).

Nearly identical correlation coefficients were obtained between carcass specific gravity and lean cuts on the live basis (+.669) and between the former and lean cuts minus fat trim (+.670). The specific gravity of the carcass showed higher association with lean cuts minus fat trim and lean cuts on the live basis than with any other cut-out measure, with loin area, or with any of the linear measurements. Specific gravity of the ham was equally related to lean cuts on the live basis and lean cuts minus fat trim. However, it was more highly associated with primal cuts on the live basis than with any other cut-out measurement.

Table 1. MEANS, STANDARD DEVIATIONS, AND STANDARD ERRORS FOR VARIOUS MEASUREMENTS

	Symbol	Mean	Standard Deviation	Standard Error
Live weight - shrunk (lbs.)[1]	--	199.22	18.32	3.05
Specific gravity - carcass	SGc	1.0267	0.0059	0.0010
Specific gravity - right ham	SGrh	1.0422	0.0068	0.0011
Ether extract (% in ham)	E.E.	37.38	3.61	0.60
Water (% in ham)	Wat.	48.38	2.74	0.46
Crude protein (% in ham)	Prot.	14.05	0.88	0.15
Lean cuts - live basis (%)	LCL	34.95	2.05	0.34
Lean cuts - carcass basis (%)	LCC	46.70	2.83	0.47
Primal cuts - live basis (%)	PCL	46.22	2.08	0.35
Primal cuts - carcass basis (%)	PCC	61.75	2.90	0.48
Lean cuts minus fat trim (%)[2]	LC-FT	21.09	5.35	0.89
Fat trimmings (%)[2]	FT	25.60	2.81	0.47
Backfat thickness (in.)[3]	BF	1.78	.195	0.03
Live probe (in.)[4]	LP	1.73	.23	0.04
Carcass length (in.)	Len	28.32	.86	0.14
Area of lean in the loin at 10th rib (sq. in.)	A_{10}	3.64	.51	0.085
Area of lean in the loin at the last rib (sq. in.)	A_L	4.03	.58	0.10
Dressing percentage (%)[5]	DP	74.87	1.36	0.23

1 24 hr. shrunk weight.
2 Computed on carcass basis-cold weight.
3 Average of 4 measurements.
4 Average of 6 probes.
5 Dressing percentage = $\frac{\text{cold carc. wt.}}{\text{shrunk live wt.}}$

Table 2. CORRELATION COEFFICIENTS FOR VARIOUS CARCASS MEASUREMENTS, SPECIFIC GRAVITY AND CHEMICAL COMPONENTS.[1]

	SGc	SGrh	A_{10}	A_L	Len	LP	BF
SGc	---	+.862**	+.609**	+.521**	+.317	-.613**	-.594**
SGrh	+.862**	---	+.598**	+.481**	+.344*	-.472**	-.438**
E.E.	-.853**	-.740**					
Wat.	+.834**	+.700**					
Prot.	+.822**	+.758**					
LCL	+.669**	+.519**	+.569**	+.395*	+.154	-.782**	-.674**
LCC	+.654**	+.470**	+.498**	+.348*	+.020	-.831**	-.721**
PCL	+.580**	+.566**	+.461**	+.341*	+.230	-.731**	-.599**
PCC	+.587**	+.497**	+.370*	+.280	+.052	-.794**	-.661**
LC-FT	+.670**	+.519**	+.516**	+.328*	+.102	-.842**	-.730**
FT	-.625**	-.516**	-.473**	-.274	-.174	+.768**	+.666**
BF	-.594**	-.438**	-.176	-.103		+.865**	---
LP	-.613**	-.472**				---	+.865**
Len.	+.317	+.344*	+.327*	+.302	---		
A_{10}	+.609**	+.598**	---	+.824**	+.327*		-.176
A_L	+.521**	+.481**	+.824**	---	+.302		-.103
DP	+.0007	+.119	+.195	+.089			

* Sig. at 5% level.
** Sig. at 1% level.
[1] Refer to Table 1 for key to symbols.

Lean cuts computed on the live basis had a slightly higher correlation coefficient with carcass specific gravity than when computed on the carcass basis. A similar result was obtained when ham specific gravity was related to lean cuts on both bases. This indicated that lean cut-out was more closely predicted by carcass specific gravity without the effect of dressing percentage removed. The correlation coefficient of primal cuts on the live basis with carcass specific gravity was very similar to that of primal cuts on the carcass basis. The lack of a similar trend as shown with lean cuts could not be explained. Ham specific gravity, on the other hand, when correlated with primal cuts showed a higher relation to the live basis figure. Thus, data of the association of ham specific gravity with primal cuts showed that ham specific gravity was a more reliable indication of the live basis figure. From the data obtained, it was concluded that carcass specific gravity was a better measure of lean cut-out than of primal cut-out. However, carcass specific gravity showed higher relations with each of the cut-out measures than ham specific gravity.

The data indicated there was very little relationship between either specific gravity figure and dressing percentage. This meant that specific gravity was a very poor indication of dressing percentage.

When carcass specific gravity was correlated with the percentage of each of the three chemical components of the ham, namely ether extract, water and protein, all correlation coefficients were highly significant. Carcass specific gravity was related slightly more to percentage ether extract (-.853) than to water (+.834) or protein (+.822). The specific gravity of the carcass showed a higher relationship with ether extract than with any other measure of leanness or fatness except ham specific gravity. Carcass specific gravity had higher relationships with any of the chemical components than with any of the cut-out measurements. This indicated that specific gravity was a better estimation of any one of the chemical components of the ham than of any cut-out value. This was also found to be the case with ham specific gravity when related to chemical components and cut-out values.

Carcass specific gravity was more highly correlated with each of the three chemical components of the ham than was the specific gravity of the ham itself. The conclusion was drawn from this that any one of the chemical components was more closely indicated by the specific gravity of the carcass than by ham specific gravity. No explanation for this is apparent.

When specific gravity of the right ham was correlated with its three chemical components, it was more highly related to protein than to ether extract or water, with correlation coefficients of +.758, -.740 and +.700, respectively. Correlations between any one of the components and the specific gravity of the carcass or ham were significant at the one percent level. In addition, ham specific gravity was more highly related to any one of the chemical components than it was to any one of the other measures, with the exception of carcass specific gravity. In either case, specific gravity was not related to dressing percentage.

The area of lean in the loin at both the tenth and last ribs was highly correlated with both specific gravity measures. The correlation obtained between the lean area of the loin at the tenth rib and carcass specific gravity (+.609) was the highest of any factor related to lean area of the loin. That is, carcass specific gravity was a better measure of both loin areas than was backfat thickness, primal cut-out, lean cut-out, length or fat trim. The specific gravity of the ham ranked next as a measure of lean area of the loin. The correlation between the lean area at the tenth rib and lean area at the last rib was positive and highly significant (+.824). However, contrary to the conclusions of Kline and Hazel (16) and Pearson _et al._ (22), the area of lean of the loin measured at the tenth rib showed a higher relationship with each of the other carcass measures than the area at the last rib. As shown in Table 2, the differences in correlation coefficients are consistently in favor of the area of lean at the tenth rib. It was concluded that the lean area in the loin at the tenth rib was a better measure of cut-out than was the area measured at the last rib. In agreement with Kline and Hazel's (16) data, the area at the tenth rib was, on the average, smaller. In contrast to earlier work, (24) no significant relation was found between lean area of the loin and backfat thickness. There was no significant relationship between the area of lean in the loin and dressing percentage.

Correlation coefficients of carcass specific gravity with various cut-out measures compared to those of loin lean area measures with the same cut-out values indicated that carcass specific gravity was a more reliable estimation of cut-out than was either loin area measurement. However, ham specific gravity was not as highly correlated with lean cuts as was lean area at the tenth rib. On the other hand, primal cuts, fat trim and backfat thickness were more highly associated with ham specific gravity than was either lean area of the loin measurement. The correlation (+.327) between the area of lean in the loin at the tenth rib and carcass length was significant at the five percent level, while no significant relation existed between the area at the last rib and length. Neither of the lean area measurements was significantly correlated with dressing percentage.

Carcass length was significantly correlated at the five percent level with the specific gravity of the ham and area of lean in the loin at the tenth rib, with correlation coefficients of +.344 and +.327, respectively. Length was not significantly correlated with any of the cut-out measurements. It was concluded that carcass length <u>per se</u> was not a reliable measure of cut-out. The area of lean in the loin and ham specific gravity were more closely related to length than were the cut-out values. It may be concluded from this that carcass length more closely measures muscle size than it does cut-out percentages. All measures tested, including backfat and live probe, were more highly related to all the cut-out percentages than was carcass length.

Live probe and backfat thickness were highly correlated (+.865), indicating that actual backfat thickness can be quite accurately estimated by the live probe technique previously described. Live probe was more highly associated with both specific gravity measurements and all cut-out percentages than was actual backfat thickness. The differences were not great, but were consistent as shown in Table 2. This indicated that cut-out was more closely estimated by the live probe method than by actual backfat measurements.

Live probe and backfat thickness were significantly correlated with carcass specific gravity with coefficients of -.613 and -.594, respectively.

Contrary to the conclusions of Whiteman et al. (28) and Pearson et al. (22), either live probe or backfat thickness was more highly related to any cut-out value than either specific gravity measure. As shown in Table 2, live probe consistently showed higher relationships with lean cuts, primal cuts, lean cuts minus fat trim and fat trim than carcass specific gravity. However, backfat thickness was not as highly related to the area of lean values as was either specific gravity measurement. This indicated that while cut-out percentages are as closely predictable by backfat thickness as by specific gravity, the size of the loin eye may be more closely estimated by the specific gravity of either the ham or carcass. Although, the differences between correlation coefficients of carcass specific gravity and backfat with cut-out percentages were not great, the relationship of backfat to cut-out was consistently higher.

The multilinear correlation coefficient obtained between chemical composition and carcass specific gravity was the highest value obtained (.884) (Table 3). This indicated that 78 percent of the variation in carcass specific gravity was accounted for by corresponding changes in the percentages of the three chemical components of the ham. A multiple correlation coefficient of .867 indicated that 75 percent of the variation in ham specific gravity was accounted for by changes in the percentages of the ether extract, water and protein in the ham. Thus, the chemical composition of the ham was closely predicted by specific gravity. Carcass specific gravity was as closely related to chemical composition of the ham as was ham specific gravity. It was concluded that specific gravity was a better measure of chemical composition than it was of any other measure of leanness or fatness. There was little difference between carcass or ham specific gravity as an estimation of total chemical composition (Table 3). However, when each chemical component was related individually with both specific gravity values (Table 2) carcass specific gravity was more reliable than ham specific gravity.

Twenty-five percent of the variation in the ham specific gravity could not be accounted for by variations in chemical composition. This could have been due to any one or a combination of several factors. They may have included: (1) variation in bone and skin specific gravity; (2) variations in temperature and degree of desiccation of the ham; (3) weighing and sampling errors.

Multilinear correlation coefficients as shown in Table 3 indicated a high relationship between live probe and carcass length combined and all the cut-out values. In fact, carcass length combined with live probe showed a higher relation with each of the cut-out values than any single measure tested. However, the advantage of the combined estimate over live probe alone was slight and impractical.

Approximately 69 percent of the variation in lean cuts on the carcass basis was accounted for by live probe and length combined as an index. Live probe and length were more highly associated with the carcass cut-out percentages than were backfat and length as shown by the multilinear correlation coefficients in Table 3. Combining live probe with length gave only slightly higher relationships with each cut-out than did live probe alone. The combined measure of live probe and length showed a higher relationship with lean cuts minus fat trim than with any other

Table 3. MULTILINEAR CORRELATION COEFFICIENTS FOR CERTAIN MEASUREMENTS OF LEANNESS.[1]

	L P & Len.	B F & Len.	E E Wat. & Prot.
SGc			0.884**
SGrh			0.867**
LCL	0.792**	0.704**	
LCC	0.832**	0.723**	
PCL	0.759**	0.625**	
PCC	0.797**	0.661**	
LC-FT	0.844**	0.730**	
FT	0.783**	0.676**	

* Sig. at 1% level

** Sig. at 5% level

[1] Refer to Table 1 for key to symbols.

cut-out measure. Approximately 71 percent of the variation in the lean cuts minus fat trim value could be predicted by corresponding variations in live probe and length. Lean cut-out, when computed on the carcass basis, was more highly related to the combined measure of live probe and length than when computed on the live basis. This indicated that live probe and length as a single measure of carcass leanness was more reliable when the effect of dressing percentage was removed. This also held true in the case of primal cut-out.

As a combined estimate of carcass cut-out, backfat thickness and carcass length was not as highly related to each cut-out percentage as was live probe and length. However, multiple correlation coefficients for backfat and length with various cut-out values (Table 3) were higher than the coefficients obtained when any single measure was correlated to the same measures of cut-out. As was the case with live probe and length, the combined measure of backfat and length was more highly related to lean cuts minus fat trim than with any other cut-out value. Also, this combined measure was more closely associated with lean and primal cuts when computed on the carcass basis. Both combined linear measures were highly correlated with fat trim. As shown in Table 2, the relationship between carcass length and cut-out was small, and the advantage of the combined estimates of leanness over live probe or backfat alone was off-set by the extra labor involved in obtaining data and in computing multi-linear correlations for the combined estimate. Therefore, it was concluded that the use of length combined with backfat or live probe adds little information of practical value over the use of a single measurement.

SUMMARY AND CONCLUSIONS

Carcass specific gravity was highly related to ham specific gravity and can be accurately estimated by the latter. Either specific gravity measure was a more reliable index of ether extract, water and protein, when taken singly or as total chemical composition, than it was as a measure of cut-out, loin lean area or linear carcass measurements. Also, specific gravity more closely predicted the size of the lean area of the loin than did live probe, backfat thickness or length. Specific gravity more closely predicted the live cut-out value than carcass cut-out value. However, specific gravity was not significantly related to dressing percentage.

The area of lean in the loin measured at either the tenth or last rib was not as closely associated with cut-out as was specific gravity. Although, the area at the tenth rib was closely associated with the area at the last rib, the tenth rib cross section of lean more closely predicted cut-out than the last rib area. Backfat thickness was not significantly related to lean area of the loin.

Carcass length showed a higher relation to ham specific gravity than to any other measure. Length *per se* was not a reliable measure of carcass cut-out. Although carcass length more closely predicted the area of lean in the loin than did backfat thickness, the relationship was not high. Perhaps the relationship was explained by the tendency for larger hogs to have larger muscle areas.

The live probe estimate of backfat thickness seemed to be a valid one due to the highly significant relationship between the two. However, live probe more closely predicted specific gravity or carcass cut-out than did backfat thickness. Both live probe and backfat had closer associations with the cut-out values than did specific gravity. However, it may be postulated that specific gravity was a more reliable measure of such desirable traits as large loin eyes and small inter-muscular fat deposits than was live probe or backfat thickness.

A higher correlation coefficient indicated that the multiple relationship of live probe and carcass length was a more reliable measure of carcass cut-out than any other measure tested, but no practical information was obtained over live probe alone. This meant that the widely used estimate of pork carcass value, live probe and length, was a valid estimation of cut-out. However, specific gravity may be a more reliable estimation of the consumer desirability of the individual cuts after they are trimmed. Proof of this theory was indicated by the high relationship between the specific gravity measures and combined chemical composition of the ham.

BIBLIOGRAPHY

1. Aunan, W. J. and L. M. Winters. 1949. Study of the variations of muscle, fat and bone of swine carcasses. Jour. An. Sci. 8:182.

2. Aunan, W. J. and L. M. Winters. 1952. A method for measuring the proportion of fat and lean tissues in swine carcasses. Jour. An. Sci. 11:319.

3. Behnke, A. R., B. C. Feen and W. C. Wilham. 1942. The specific gravity of healthy men. Jour. Am. Med. Assoc. 118:495.

4. Benne, Erwin J. 1956. Personal interview. Dept. Agr. Chem., Mich. State Univ.

5. Boyd, Edith. 1933. The specific gravity of the human body. Human Biol. 5:646.

6. Bratzler, L. J. and E. P. Margerum, Jr. 1953. Relationship between live hog scores and carcass measurements. Jour. An. Sci. 12:856.

7. Brown, C. J., J. C. Hillier and J. A. Whatley. 1951. Specific gravity as a measure of the fat content of the pork carcass. Jour. An. Sci. 10:97.

8. Cole, J. W. 1951. Slaughtering, chilling and cutting methods for pork carcass evaluation. Proc. Fourth Ann. Recip. Meat Conf. 4:111.

9. Fredeen, H. T., G. H. Bowman and J. G. Stothart. 1955. Appraisal of certain methods for evaluation of ham quality. Can. Jour. Ag. Sci. 35:91.

10. Fredeen, H. T., G. H. Bowman and J. G. Stothart. 1955. Relationships between certain measurements of ham and carcass quality. Can. Jour. Ag. Sci. 35:95.

11. Goulden, Cyril H. 1952. Methods of Statistical Analysis. Second Ed. John Wiley and Sons, Inc., New York.

12. Hankins, O. G. and N. R. Ellis. 1934. Physical characteristics of hog carcasses as measures of fatness. Jour. Agr. Res. 48:257.

13. Hankins, O. G. and R. L. Hiner. 1937. A progress report on the meat yields of Danish Landrace hogs in comparison with certain American breeds. Proc. Am. Soc. An. Prod. 1937:255.

14. Hazel, L. N. and E. A. Kline. 1952. Mechanical measurements of fatness and carcass value for live hogs. Jour. An. Sci. 11:313.

15. Hetzer, H. O., O. G. Hankins, J. X. King and J. H. Zeller. 1950. Relationship between certain body measurements and carcass characteristics in swine. Jour. An. Sci. 9:37.

16. Kline, E. A. and L. M. Hazel. 1955. Loin area at tenth and last rib as related to leanness of pork carcasses. Jour. An. Sci. 14:659.

17. Kraybill, H. F., O. G. Hankins and H. O. Bitter. 1951. Body composition of cattle. I. Estimation of body fat from measurement in vivo of body water by use of antipyrine. Jour. Applied Physiol. 3:681.

18. Loeffel, W. J., W. W. Derrick and M. Peters. 1943. Weight of pigs as it affects gains and carcass qualities. Neb. Expt. Sta. Bul. 351. Dec. 1943.

19. McMeekan, C. P. 1941. Part IV. The use of sample joints and of carcass measurements as indices of the composition of the bacon pig. Jour. Agr. Sci. 31:1.

20. Margerum, E. P., Jr. 1949. The relationship between live hog scores and actual carcass measurements. M. S. Thesis. Mich. State Col.

21. Messinger, W. J. and J. M. Steele. 1949. Relationship of body specific gravity to body fat and water content. Proc. Exp. Biol. and Med. 70:316.

22. Pearson, A. M., L. J. Bratzler, R. J. Deans, J. F. Price, J. A. Hoefer, E. P. Reineke and R. W. Luecke. 1956. The use of specific gravity of certain untrimmed pork cuts as a measure of carcass value. Jour. An. Sci. 15:86.

23. Rathbun, E. M. and N. Pace. 1945. Determination of total body fat by means of body specific gravity. Jour. Biol. Chem. 158:667.

24. Stothart, J. G. 1938. A study of factors influencing swine carcass measurements. Sci. Agr. 19:162.

25. Warner, K. F., N. R. Ellis and P. E. Howe. 1934. Cutting yields of hogs as an index of fatness. Jour. Agr. Res. 48:241.

26. Whiteman, J. V., J. C. Hillier and J. A. Whatley. 1951. Carcass studies on hogs of different breeding. Jour. An. Sci. 10:638.

27. Whiteman, J. V. and J. A. Whatley. 1953. Evaluation of some swine carcass measurements. Jour. An. Sci. 12:591.

28. Whiteman, J. V., J. A. Whatley and J. C. Hillier. 1953. A further investigation of specific gravity as a measure of pork carcass value. Jour. An. Sci. 12:859.

A P P E N D I X

Appendix Table 1 - Summary of Data

				1	2	3	4	5
Code No.	Hog Number	Sex[1]	Slaughter Weights	Sp. Gr.[2] Carcass	Sp. Gr.[2] Ham	% Ether Extract	% Water	% Crude Protein
1	D-37-9	2	214.0	26	38	38.16	47.84	13.94
2	D-36-3	1	184.5	17	31	46.32	41.36	12.50
3	C-25-7	1	182.5	20	35	41.35	45.16	13.63
4	D-37-8	2	249.0	22	37	39.66	46.68	13.56
5	D-36-13	2	197.5	25	38	40.30	46.18	13.30
6	C-25-8	1	188.0	27	46	36.48	48.06	15.28
7	C-26-1	1	228.5	30	46	37.89	47.78	14.26
8	C-26-2	1	224.0	26	44	36.94	48.55	14.47
9	C-26-6	1	218.5	20	35	41.84	44.88	13.06
10	D-37-2	1	235.0	16	32	41.10	45.81	12.69
11	D-37-3	1	227.0	19	32	44.24	43.36	12.04
12	D-37-4	1	220.0	19	32	43.16	44.42	12.22
13	Y-C 16-8	2	185.0	28	45	35.33	49.84	14.88
14	D-28-5	1	187.0	22	39	38.00	47.93	14.18
15	D-28-12	2	177.0	22	31	39.17	47.51	13.63
16	D-28-13	2	184.0	32	40	34.43	50.89	14.60
17	D-30-11	2	180.5	27	36	34.89	50.43	14.28
18	D-31-9	2	177.0	26	34	34.15	51.15	14.35
19	D-31-7	2	186.0	25	43	39.02	46.87	14.06
20	Y-C 15-1	1	178.0	34	50	31.87	52.17	15.90
21	C-23-5	1	178.0	22	42	38.17	47.59	14.18
22	C-23-10	2	188.0	31	47	31.82	52.49	15.40
23	D-30-2	1	183.0	27	42	36.32	49.49	13.90
24	D-31-4	1	188.5	34	48	30.66	53.82	15.00
25	H-4-8	1	194.5	20	41	40.64	46.06	13.00
26	H-2-4	1	196.5	37	51	34.08	50.72	14.94
27	H-3-2	2	212.5	32	50	35.94	49.30	14.28
28	H-3-5	2	204.0	34	50	35.13	50.08	14.60
29	H-2-3	1	193.0	34	52	34.58	50.52	14.32
30	H-10-1	2	201.5	35	49	33.68	51.42	14.50
31	H-4-4	1	211.5	26	44	36.61	48.92	13.84
32	H-1-4	1	203.0	24	44	38.26	47.90	13.72
33	H-3-6	2	188.5	25	47	36.29	49.31	13.97
34	H-2-2	2	204.5	32	46	37.26	48.43	14.25
35	H-10-5	2	199.0	38	56	32.08	52.06	15.31
36	H-3-3	2	203.0	28	45	39.71	46.19	13.81
			7172.0	962	1518	1345.53	1741.77	505.85
	Mean		199.22	26.7	42.2	37.38	48.38	14.05
	S.D.		18.32	5.86	6.75	3.61	2.74	.88

[1] Sex: 1 = barrow; 2 = gilt

[2] Coded values for specific gravity at 1.0

Appendix Table 2 - Summary of Data*

	6	7	8	9	10	11
Code No.	Lean Cuts Live	Lean Cuts Carcass	Primal Cuts Live	Primal Cuts Carcass	Lean Cuts Minus Fat Trim	Fat Trim
1	36.50	48.96	47.20	63.32	24.51	24.45
2	32.30	43.50	43.63	58.76	14.30	29.20
3	32.60	45.08	43.94	60.76	15.54	29.54
4	34.94	47.28	46.02	62.28	21.19	26.09
5	32.81	45.16	48.35	66.55	17.29	27.87
6	32.13	44.91	42.87	59.92	18.81	26.10
7	32.91	43.09	42.93	56.22	15.01	28.08
8	32.37	42.15	43.35	56.45	12.50	29.65
9	31.40	40.59	42.47	54.91	10.41	30.18
10	32.60	43.70	43.91	58.87	17.46	26.24
11	32.20	42.50	43.30	57.15	15.76	26.74
12	32.27	44.04	41.95	57.25	9.92	34.12
13	36.54	48.29	46.27	61.14	23.15	25.14
14	35.99	48.42	45.88	61.73	23.96	24.46
15	33.95	45.53	45.14	60.53	18.26	27.27
16	38.70	51.22	49.13	65.04	29.35	21.87
17	35.68	48.06	45.93	61.87	21.94	26.12
18	36.05	48.52	46.33	62.36	27.99	20.53
19	34.95	46.43	46.34	61.57	20.72	25.71
20	37.98	51.41	48.31	65.40	30.12	21.29
21	34.94	46.94	46.69	62.72	22.79	24.15
22	39.26	52.16	48.94	65.02	28.84	23.32
23	35.63	48.30	45.96	62.30	23.86	24.44
24	38.36	51.28	48.28	64.54	28.58	22.70
25	33.68	43.38	45.96	59.20	14.90	28.48
26	37.20	49.73	48.19	64.42	27.08	22.65
27	35.76	47.20	48.19	63.60	22.98	24.22
28	35.98	47.35	47.74	62.84	22.83	24.52
29	34.97	46.23	47.05	62.19	22.26	23.97
30	35.53	48.22	46.95	63.70	25.26	22.96
31	35.74	46.96	48.46	63.66	22.12	24.84
32	34.58	45.14	49.09	61.48	18.77	26.37
33	36.34	48.24	49.60	65.84	25.70	22.54
34	35.50	46.69	47.68	62.70	20.97	25.72
35	36.43	49.83	47.44	64.88	25.78	24.05
36	33.60	44.72	46.35	61.70	18.49	26.23
	1258.37	1681.21	1663.82	2222.87	759.40	921.81
Mean	34.95	46.70	46.22	61.75	21.09	25.60
S.D.	2.05	2.83	2.08	2.90	5.35	2.81

* Refer to Appendix Table 1 for Hog Number and Sex

Appendix Table 3 - Summary of Data *

	12	13	14	15	16	17
Code No.	Backfat Thickness	Live Probe	Length Carcass	Area 10th Rib	Area Last Rib	Dressing Per Cent
1	1.89	1.78	28.19	4.13	4.57	74.53
2	2.02	1.87	26.57	2.35	3.00	74.25
3	1.72	1.75	27.28	2.66	3.09	72.33
4	1.94	1.93	29.29	3.94	4.84	73.90
5	1.94	1.90	28.03	3.30	3.59	72.66
6	1.78	1.78	26.69	3.42	3.57	71.54
7	1.91	2.00	29.72	4.02	4.25	76.37
8	2.02	2.22	29.17	3.73	4.52	76.78
9	2.05	2.37	28.23	3.67	3.98	77.34
10	2.06	2.05	29.37	3.39	3.91	74.60
11	2.10	1.98	28.62	3.28	3.96	75.77
12	2.10	2.03	27.09	3.25	4.24	73.27
13	1.71	1.58	28.54	4.05	3.91	75.68
14	1.66	1.57	28.23	2.90	3.08	74.33
15	1.63	1.58	28.15	2.58	2.87	74.58
16	1.34	1.37	28.94	3.47	3.81	75.54
17	1.61	1.63	27.64	3.86	4.54	74.24
18	1.73	1.53	27.36	3.81	3.89	74.29
19	1.92	1.73	27.76	4.01	3.63	75.27
20	1.62	1.48	28.74	4.03	4.14	73.88
21	1.73	1.77	26.46	3.44	3.94	74.44
22	1.76	1.65	27.48	5.12	5.26	75.27
23	1.57	1.60	28.66	3.58	3.33	73.77
24	1.62	1.48	27.67	3.73	3.96	74.80
25	1.97	1.87	28.86	3.21	3.02	77.63
26	1.76	1.55	28.82	3.85	4.58	74.81
27	1.68	1.52	29.64	3.88	4.50	75.76
28	1.93	1.72	28.66	4.03	4.36	75.98
29	1.68	1.70	28.15	3.47	4.04	75.65
30	1.56	1.53	29.17	4.18	4.56	73.70
31	1.58	1.66	29.06	3.77	4.69	76.12
32	2.09	1.88	28.78	3.64	3.82	76.60
33	1.56	1.42	28.62	3.90	4.24	75.33
34	1.68	1.63	28.94	3.68	4.33	76.04
35	1.48	1.40	29.09	4.17	4.94	73.12
36	1.78	1.63	27.95	3.67	4.13	75.12
	64.18	62.14	1019.62	131.17	145.09	2695.29
Mean	1.78	1.73	28.32	3.64	4.03	74.87
S.D.	.195	.23	.86	.51	.58	1.36

* Refer to Appendix Table 1 for Hog Number and Sex.