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Carcass Characteristics and Consumer Acceptance of Light Weight Hogs

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Summary

The data from 130 hogs indicate that the greatest percentage increase of the lean cuts (ham, loin, picnic and Boston Butt) and bone cuts (neck bone and spare ribs) occurred during the 125-165 pound live weight interval. Conversely, the greatest percentage increase in fat cuts (carcass trim fat, backfat, leaf fat and belly) occurred during the 165-205 pound live weight interval.

Length of ham appeared to be directly associated with the increase in lean cuts, i.e., length of ham increased 2 times more during the 125-165 pound interval than during the 165-205 pound live weight interval. Circumference of ham, depth of body, and width of body and shoulder were more closely associated with gain in live weight than with the yield of lean or fat cuts. Backfat thickness paralleled the increase in weight of fat cuts. The cured cuts from the lighter weight hogs lost a slightly greater percentage of their weight during the smoking process than similar cuts from the heavier hogs.

In conclusion it can be stated that as hogs increase in live weight from 125 to 200 pounds; dressing percent increases slightly, the percentage yield of fat cuts increases greatly and the percentage yield of lean and bone cuts decreases.

Cuts from these 130 hogs were eaten and evaluated by 240 families in two Missouri cities. Each family evaluated cuts from a 205-pound hog and matching cuts from one of the lighter weight hogs. Families evaluated cuts as to general acceptance, leanness, tenderness, and size.

General acceptability was not a function of slaughter weight. While the mean acceptance of the 205 pound group was better than the mean of the other two weight groups, the small differences were not statistically significant. There was considerable variation in the carcass mean ratings within each weight group. The 125 pound carcasses were more homogeneous in acceptance than the heavier carcasses.

Lack of tenderness was not a problem with pork cuts from any of the weight groups.

The percentages of "too fat" ratings were 12, 18, and 19 for the 125, 165, and 205 pound weight groups, respectively. However, the blade roast and picnic received a relatively large number of "too fat" ratings.

The smaller size of several cuts—picnics, chops, steaks, and ham slices—from the lighter weight hogs received some adverse reactions. It is possible that the small size of several of the cuts from light weight hogs would be very attractive to consumers after they became accustomed to them. However, the small size of these cuts might be a minor barrier in the beginning of any merchandising effort.

Conclusions: (1) Slaughter at live weights as light as 125 pounds does not present any palatability problems as judged by this sample of consumers. (2) Cuts from 165-pound carcasses might be more readily accepted than those from 125-pound carcasses because the former differ less in size from conventional cuts. However, acceptance of size as such cannot be determined accurately except by merchandising experiments. (3) The percentage of lean cuts decreases with an increase in slaughter weight. (4) Processing yields are lower from lean cuts. It is postulated that processing techniques can be modified to compensate for this shrinkage.

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Carcass Characteristics and Consumer Acceptance of Light Weight Hogs

S. E. ZOBRIKY, HUGH LEACH, V. JAMES RHODES, AND H. D. NAUMANN

Introduction

Today consumers are purchasing a greater proportion of their diet in the form of lean meat. The rapid growth of the broiler industry, the shift to the right of the demand curve for beef, and the shift to the left of the demand curve for pork are related to consumer attitudes toward fat and lean meat. Consumer acceptance studies of meats have indicated the great extent of the consumer resistance to fat.^{1,2,3,4,*}

Studies concerned with the growth and development of domestic meat animals have vividly illustrated that younger, lighter weight animals have a greater proportionate yield of lean meat. This inverse relation of live weight and lean meat percentage yield is particularly important in swine.^{6,7}

Consumer resistance to fat pork cuts has led to a number of corrective steps in the livestock economies of various important swine producing countries:

- (1) The breeding and performance testing program for meat-type hogs is perhaps the most important step taken in the United States.
- (2) The restricted feeding program, which requires proportionately more labor and a longer feeding period, is used extensively in Denmark, along with a breeding and performance testing program developed earlier than in the United States.
- (3) The slaughter of hogs at light weights *before* excessive fat is deposited is the solution of the fat problem for most fresh pork marketed in Great Britain.

While all three countries utilize breeding and performance testing, the two programs of limited feeding and light weight slaughter go considerably beyond present American programs. This bulletin reports on one phase of research at this Station designed to evaluate the advantages and disadvantages of American use of the light weight slaughter program.

The main purpose of the present study was to attempt to determine the acceptability to American consumers of cuts from light weight hogs of known physical composition. This consumer study is only one of several steps essential to the evaluation in the American economy of slaughter at light weights. A study is also being made of the economy of production and slaughter at light weights.

*Numbers refer to list of references in the back.

Part I

Carcass Characteristics

MATERIALS AND METHODS

One hundred and thirty meat type hogs were purchased from three commercial herds of good, meat type breeding. These hogs were divided into three weight lots. These lots consisted of 30 hogs of approximately 125 pounds, 40 hogs of 165 pounds and 60 hogs of 205 pounds live weight, respectively.

The slaughtering, dressing, and processing procedure followed was that outlined in the Proceedings of the Fifth Annual Reciprocal Meat Conference (1952). Carcass measurements were obtained as described by Zobrisky *et al.* (1958).

The hams, picnics, and bellies were processed within 72 hours after the hogs were slaughtered. The hams were artery pumped to 10 percent of their weight with a 75-degree salimeter pickle, then placed in a 65-degree salimeter cover pickle for five days. After being cured, the hams were soaked in running tap water for 30 minutes, placed in stockinettes and processed in a preheated smokehouse according to the following schedule.

| Smokehouse Temperature | Time |
|---------------------------|--|
| 120° F | two hours, no smoke |
| 140° F | 14 hours, smoke |
| 165° F | 3-4 hours, no smoke until internal temperature of 145° F was obtained |

After being smoked, the hams were held for two hours at 75° F, then chilled and stored at 40° F until distributed, usually within 14 days.

The picnics were stitch pumped to 10 percent of their weight with a 75 degree salimeter pickle; following this a one-fourth ounce of dry cure* per pound weight was applied. The picnics were placed in curing bins (40° F) for seven to 10 days, after which time a second application of one-fourth ounce dry cure per pound was applied. Seven days after this second application of cure, the picnics were soaked in running tap water; the adhering surface cure was removed and the picnics were placed in stockinettes. Next, the picnics were preheated in the smokehouse for 5 to 7 hours at 130° F then smoked for 12 to 14 hours at 120° F. Hereafter the picnics were handled in the same manner as the hams.

*Commercial ham cure.

Three-quarters of an ounce of bacon dry cure per pound was applied to the bellies. After 10 to 12 days in curing bins at 40° F the bellies were soaked and washed in running tap water. Next, they were dried for 8 to 10 hours at 120° F in a preheated smokehouse. Following the drying period the bellies were smoked for 12 to 14 hours at 110° F. Hereafter, the cured, smoked bellies were handled in the same manner as the hams and picnics.

The carcass cut-out data were studied in respect to actual weight and also percent (carcass basis) of each cut.

The carcass measurement data were studied to determine their increase relative to weight of the hogs and cuts.

The percentages of difference gained or lost, from the uncured to cured weights of the hams, picnics, and bellies of the three weight groups were also studied.

RESULTS AND DISCUSSION

The data in Table 1 show that the live weight of each lot increased approximately 40 pounds over the preceding lot. This difference in live weight was equivalent to approximately a 30-pound increase in carcass. The standard deviations (S.D.) indicate that the variations from the means were progressively greater in the heavier hogs. However, it should be noted that two-thirds of the hogs in each of the three lots differed from the average live weight by less than 1 pound.

The average yield (carcass basis) and weight of the primal cuts from each of the three lots of hogs are presented in Table 2. The interesting features in Table 2 are:

- a. The increase in weight of each of the four lean cuts was greater during the 125 to 165 interval than during the 165 to 205 pound interval.
- b. Conversely, the greatest decrease in the percent of each of the four lean cuts was during the 165 to 205 pound interval. However, the belly actually increased as a percentage of the carcass during this period. These data emphasize that these hogs increased in weight and yield of fat at a greater rate than they increased in weight or yield of lean as they became heavier.

The increase in weight and yield of the fat cuts increased progressively with live weight as shown in Table 3. These data also suggest that the greatest weight increase in fat cuts was during the 165 to 205 pound interval.

The greatest weight increase of the bone cuts presented in Table 4 was during the 125 to 165 pound weight interval. Conversely, the greatest percentage decrease of the bone cuts was during the 165 to 205 pound weight interval.

Tables 1 through 4 emphasize that the fat cuts increase in weight and yield at a greater rate than the lean cuts and also the bone cuts from 165 to 205 pound

TABLE 1--AVERAGE LIVE WEIGHT, CARCASS AND DRESSING PERCENT

| No. | 30 | | 40 | | 60 | |
|---------------------|-------|------|-------|------|-------|------|
| | Avg. | S.D. | Avg. | S.D. | Avg. | S.D. |
| Live Wt. | 122.9 | 0.26 | 165.9 | 0.92 | 206.6 | 0.97 |
| Chilled Carcass Wt. | 92.3 | 0.60 | 124.4 | 0.61 | 153.3 | 1.54 |
| Dressing Percent | 94.9 | 0.18 | 75.0 | 0.16 | 75.1 | 1.10 |

TABLE 2--AVERAGE WEIGHT AND YIELD OF THE PRIMAL CUTS

| No. | 30 | | 40 | | 60 | |
|------------------|------|------|------|------|------|------|
| | % | Lbs. | % | Lbs. | % | Lbs. |
| Ham (untr.) | 22.6 | 20.8 | 22.2 | 27.3 | 21.6 | 33.4 |
| Ham (tr.) | 19.7 | 18.2 | 19.5 | 24.3 | 18.5 | 28.5 |
| Picnic | 8.7 | 8.0 | 8.3 | 10.3 | 7.7 | 11.9 |
| Boston Butt | 6.4 | 5.6 | 6.2 | 7.7 | 5.5 | 8.5 |
| Loin | 14.7 | 13.5 | 15.6 | 19.7 | 14.8 | 22.6 |
| Four Lean Cuts | 49.2 | 45.3 | 50.2 | 62.0 | 46.1 | 71.5 |
| Five Primal Cuts | 62.3 | 57.4 | 63.1 | 78.5 | 60.1 | 92.8 |
| Belly | 13.2 | 12.2 | 13.2 | 16.5 | 13.9 | 21.5 |

TABLE 3--AVERAGE WEIGHT AND YIELD OF FAT CUTS

| No. | 30 | | 40 | | 60 | |
|---------------|-----|------|------|------|------|------|
| | % | Lbs. | % | Lbs. | % | Lbs. |
| Live Wt. | 125 | | 165 | | 205 | |
| Backfat | 7.4 | 6.8 | 7.4 | 9.3 | 9.3 | 14.5 |
| Leaf Fat | 1.8 | 1.6 | 2.6 | 3.2 | 2.8 | 4.4 |
| Total tr. fat | 9.7 | 18.2 | 20.8 | 25.2 | 24.4 | 37.8 |
| Jowl | 3.7 | 3.5 | 3.7 | 4.6 | 3.7 | 5.7 |

TABLE 4--AVERAGE WEIGHT AND YIELD OF THE BONE CUTS

| No. | 30 | | 40 | | 60 | |
|-------------------------|-----|------|-----|------|-----|------|
| | % | Lbs. | % | Lbs. | % | Lbs. |
| Live Wt. | 125 | | 165 | | 205 | |
| Neck Bone | 1.9 | 3.5 | 1.7 | 4.7 | 2.9 | 5.4 |
| Spare Ribs | 3.8 | 1.8 | 3.8 | 2.2 | 3.5 | 2.5 |
| Feet, Tail, and Kidneys | 4.3 | 4.0 | 3.9 | 4.8 | 3.5 | 5.4 |

TABLE 5--AVERAGE BACKFAT THICKNESS

| Live Wt. | 125 | 165 | 205 |
|-------------------------|------|------|------|
| No. | 30 | 40 | 60 |
| 1. First Thoracic, m.m. | 36.7 | 41.2 | 51.3 |
| 2. Last Thoracic, m.m. | 23.3 | 27.2 | 34.9 |
| 3. Last Lumbar, m.m. | 29.7 | 32.2 | 41.3 |
| Average of 1, 2 & 3 | 30.1 | 33.8 | 43.3 |

live weight. Conversely, the weight increment in muscle and bone was considerably smaller between 165 and 205 pounds than it was between 125 and 165 pounds.

The increase in thickness of backfat paralleled the increase in weight and yield of fat cuts. The fat over the first thoracic vertebrae increased more than that over the last thoracic or last lumbar during the 125 to 165 and also the 165 to 205-pound live weight intervals. The backfat thickness was inversely proportional to the yield of lean cuts.

The carcass measurements in Table 6 appear to be directly associated to the increase in live weight since the differences between the 125 and 165-pound

TABLE 6--AVERAGE CARCASS MEASUREMENTS

| Live Wt. | 125 | 165 | 205 |
|--------------------------|-------|-------|-------|
| No. | 30 | 40 | 60 |
| Ham, Length, m.m. | 320.6 | 347.5 | 361.7 |
| Ham, Circumference, m.m. | 427.4 | 472.8 | 513.2 |
| Body Depth, m.m. | 297.4 | 327.2 | 348.1 |
| Body Width, m.m. | 216.3 | 245.5 | 273.1 |
| Shoulder Width, m.m. | 236.4 | 260.9 | 286.4 |

hogs approximate the differences between the 165 and 205 pound hogs. The only exception in this respect is ham length, which appears to be directly associated with the increase in lean cuts presented in Table 2.

The data in Table 7 show the consistency of the percentage (cut basis) of pickle pumped into the hams and picnics. Statistically these averages do not

TABLE 7--AVERAGE PERCENTAGE OF PICKLE PUMPED INTO THE HAMS AND PICNICS

| Live Wt. | 125 | 165 | 205 |
|----------|-------|-------|-------|
| No. | 60 | 80 | 120 |
| Hams | 12.7% | 12.8% | 11.6% |
| Picnics | 13.9 | 9.7 | 10.1 |

differ significantly. However, it should be noted that the greatest variation in percentage of pickle introduced was in the smaller cuts, i.e., picnics.

The percentages of gain or loss in weight of the hams, picnics, and bellies indicated in Table 8 are attributed to causes other than the amount of pickle introduced by pumping. This is suggested since there were no significant differ-

TABLE 8--AVERAGE PERCENTAGE DIFFERENCE FROM UNCURED WEIGHT TO CURED CHILLED WEIGHT

| Live Wt. | 125 | 165 | 205 | Signifi- cance |
|----------|------|------|------|-------------------|
| No. | 60 | 80 | 120 | |
| Hams | 3.5% | 3.3% | 3.7% | N.S. |
| Picnics | -5.0 | -1.4 | -0.5 | 0.05 |
| Bellies | -1.6 | -1.4 | -1.1 | 0.05 |

ences in percentage of pickle introduced. As illustrated in Table 8, the hams from each weight group gained approximately 3.5 percent in weight during the curing, smoking, and chilling period. The picnics shrank considerably in weight during the curing, smoking, and chilling period. The picnics from the small hogs decreased in weight more than those from the large hogs. The difference in cured, chilled weight among three lots was significant at the 5 percent level.

Differences in average percentage weight loss of the bellies among the three lots were also significant. The light weight bellies shrank more than the heavier ones during the curing, smoking, and chilling period.

Apparently, the final cured, chilled weight of the picnics and bellies was indirectly associated with the mass, i.e., weight of the cut or weight per unit of surface area. It is also logical to assume that these cuts from the smaller hogs contained a greater percentage of lean and, therefore, more moisture and a lesser percentage of fat than similar cuts from the larger hogs. All of these factors would be conducive to shrinkage during the smoking and chilling period.

Tables 9 and 10 present the average percentage differences in weight gained or lost for the hams, picnics, and bellies during the smoking and chilling interval. Most of the shrink in the picnics and bellies occurred during the smoking period as indicated in Table 9. The picnics from each weight group shrank ap-

TABLE 9--AVERAGE PERCENTAGE DIFFERENCE FROM CURED WEIGHT TO SMOKED WEIGHT

| Live Wt. | 125 | 165 | 205 | |
|----------|------|------|------|------|
| No. | 60 | 80 | 120 | |
| Hams | 0.6% | 0.5% | 0.6% | N.S. |
| Picnics | -0.9 | -0.9 | -0.9 | N.S. |
| Bellies | -1.2 | -1.2 | -0.9 | .05 |

TABLE 10--AVERAGE PERCENTAGE DIFFERENCE FROM SMOKED WEIGHT TO CHILLED WEIGHT

| Live Wt. | 125 | 165 | 205 | |
|----------|------|------|------|------|
| No. | 60 | 80 | 120 | |
| Hams | 0.1% | 1.4% | 0.1% | N.S. |
| Picnics | -0.3 | -0.3 | -0.2 | N.S. |
| Bellies | -0.2 | -0.1 | -0.2 | N.S. |

proximately three times as much during the smoking period as during the chilling period which followed the smoking period. The bellies from each weight group shrank approximately five times as much during the smoking period as during the chilling period. These data strongly suggest that the greatest loss in weight occurs during the time the cuts are in the smoke house and subject to drying and smoking temperatures.

Part II

Consumer Acceptance

PROCEDURE

Design of Experiment: Cuts were composited so that each household purchased the equivalent of a quarter carcass from each of two weight groups. The 205-pound weight group was paired with either the 125-pound weight group or the 165-pound weight group. Thus, each household received a quarter of a carcass from one of the lighter groups.

The meat was divided into two groups. A list of cuts in each group were:

Group I

Ham (Shank Portion)
Blade-End Roasts
Pork Steaks
Ham Slices
Pork Chops
Spare Ribs
Jowl
Bacon
Sausage

Group II

Ham (Butt Portion)
Loin End Roasts
Pork Steaks
Picnics
Pork Chops
Spare Ribs
Jowl
Bacon
Sausage

Each household had a choice as to which group they would receive. The groups ranged in weight from 38 to 48 pounds each, with approximately twenty to thirty packages in each group.

Panel: Samples of 90 families in Mexico, Mo., and 150 in Jefferson City, Mo.,** were drawn by area probability methods. Every other household in the sample blocks was invited to participate, if eligible. Eligibility requirements were aimed at (1) eliminating the meat "expert" (family members with special experience in cutting or selling meats were excluded), (2) reducing the number of poor risks as continuing members of a panel (no housewife of more than 60 years of age or with less than eight years of formal education was included), (3) eliminating those not regularly pork consumers (families had to have two adults who regularly consumed pork), and (4) reducing the rural aspects of the panel (members had to have lived in city a minimum of two years).

The pork was sold at reduced cost and delivered to the respondent's home or frozen food locker in April or May, 1958. Rating cards of the type shown in the Appendix were packaged with the various cuts.

**Small industrial cities of approximately 13,000 and 30,000 population, respectively.

Rating cards were returned by 239 cooperators. Eight of these cooperators returned only about one-third of their rating cards, but most returned 90 percent or more. The analysis that follows includes data from all 120 carcasses and the rating cards of 239 households.

ACCEPTANCE RESULTS

Four aspects of consumer acceptance were measured. These four measurements—general acceptance, leanness, tenderness, and size—provide a fairly general view of consumer attitudes.

Leanness: There was a smaller number of ratings of "too fat" for the 125-pound carcasses, compared to the other weights (Table 1). The large variation among cuts as to the percentage "too fat" emphasizes the fact that "too fat" is a crucial

TABLE 1--LEANNESS RATINGS BY WEIGHT GROUPS

| | (Actual Count) | | | (Percent) | | |
|----------|----------------|------------|----------|-----------|------------|----------|
| | Too Fat | Just Right | Too Lean | Too Fat | Just Right | Too Lean |
| 125 lbs. | 93 | 641 | 19 | 12 | 85 | 3 |
| 165 lbs. | 257 | 1140 | 22 | 18 | 80 | 2 |
| 205 lbs. | 420 | 1763 | 27 | 19 | 80 | 1 |

problem for some cuts but not for others (Table 2). Trimming of external fat eliminated fat as an important problem for ham slices and loin roasts of all weights of carcasses. The expected result of lower weight being associated with fewer ratings of "too fat" was found for ham shank portions, bacon, and chops.

The failure of 165-pound carcasses to receive fewer "too fat" ratings than 205 pound carcasses in the case of pork steaks, picnics, and Boston butts is surprising. The 125-pound carcasses did receive fewer "too fat" ratings than the 205 pound carcasses on all three cuts. While the highest percentage of "too fat" was associated with blade roast from 205-pound carcasses it is clear that regardless of size of carcass the cut is too fat for many consumers. There were far too few ratings of "too lean" to cause concern about consumers judging 125-pound carcasses too lean.

Tenderness: Lack of tenderness is a relatively minor problem with pork. Tenderness ratings were obtained on the slice cuts only—bacon, chops, steaks and ham slices. Percentages of "tender" ratings varied only slightly by cut or weight group. (Tables 3 and 4)

TABLE 2--LEANNESS RATINGS BY CUT BETWEEN WEIGHT GROUPS

| Retail Cut | Live Weight Hogs (lbs.) | Total No. | Percent of Total | | |
|---------------------|-------------------------------|--------------|------------------|---------------|-------------|
| | | | Too Fat | Just Right | Too Lean |
| Chops | 125 | 206 | 9 | 87 | 4 |
| | 165 | 285 | 14 | 85 | 1 |
| | 205 | 514 | 16 | 82 | 2 |
| Blade Roast | 125 | 35 | 43 | 57 | 0 |
| | 165 | 70 | 36 | 64 | 0 |
| | 205 | 107 | 49 | 50 | 1 |
| Loin Roast | 125 | 38 | 11 | 89 | 0 |
| | 165 | 72 | 7 | 90 | 3 |
| | 205 | 106 | 7 | 93 | 0 |
| Steak | 125 | 142 | 17 | 82 | 1 |
| | 165 | 299 | 27 | 71 | 2 |
| | 205 | 465 | 21 | 78 | 1 |
| Picnic | 125 | 33 | 24 | 76 | 0 |
| | 165 | 70 | 33 | 47 | 0 |
| | 205 | 98 | 30 | 70 | 0 |
| Bacon | 125 | 137 | 10 | 83 | 7 |
| | 165 | 283 | 17 | 80 | 3 |
| | 205 | 413 | 24 | 75 | 1 |
| Ham Slice | 125 | 93 | 4 | 95 | 1 |
| | 165 | 199 | 2 | 96 | 2 |
| | 205 | 301 | 4 | 94 | 1 |
| Ham (Shank Portion) | 125 | 33 | 6 | 94 | 0 |
| | 165 | 75 | 15 | 84 | 1 |
| | 205 | 102 | 23 | 77 | 0 |
| Ham (Butt Portion) | 125 | 36 | 11 | 89 | 0 |
| | 165 | 66 | 29 | 70 | 1 |
| | 205 | 104 | 16 | 83 | 1 |

TABLE 3--TENDERNESS RATINGS BY WEIGHT GROUP

| | (Actual Count) | | (Percent) | |
|----------|----------------|-------|-----------|-------|
| | Tender | Tough | Tender | Tough |
| 125 lbs. | 525 | 47 | 92 | 8 |
| 165 lbs. | 938 | 123 | 88 | 12 |
| 205 lbs. | 1754 | 204 | 90 | 10 |

TABLE 4--PERCENTAGE OF CUTS RATED TENDER BY WEIGHT GROUPS

| | Chops | Steaks | Ham Slices | Bacon |
|----------------------|-------|--------|------------|-------|
| 125 lbs. | 93 | 92 | 93 | 89 |
| 165 lbs. | 90 | 85 | 90 | 90 |
| 205 lbs. | 92 | 88 | 87 | 90 |
| Total, all groups | 92 | 88 | 90 | 90 |
| Total No. Cuts Rated | 1030 | 905 | 648 | 815 |

General Acceptance: The mean acceptance of the 205-pound group was very slightly better than the means of the other groups. However, this difference was not significant statistically because of the rather large variation in acceptance means of carcasses within each weight group (Table 5).

TABLE 5--RANGES OF CARCASS ACCEPTABILITY MEAN SCORES BY WEIGHT GROUPS USING NINE-POINT HEDONIC SCALE

| | 125 lbs. | 165 lbs. | 205 lbs. |
|----------------------|-----------|-----------|-----------|
| Best Quartile | 2.03-2.25 | 1.66-2.10 | 1.43-2.10 |
| Middle Two Quartiles | 2.35-2.59 | 2.11-2.63 | 2.11-2.48 |
| Poorest Quartile | 2.68-2.96 | 2.63-3.66 | 2.50-3.63 |
| Mean of Group | 2.45 | 2.36 | 2.17 |
| Range of Group | .93 | 2.00 | 2.20 |

Acceptance of 125-pound carcasses was much more homogeneous than that of heavier carcasses. Since the poorest carcass of the 125-pound group had the quite acceptable rating of 2.96, there is no reason to expect general palatability problems from the light weight hogs.

The acceptability means for cuts are generally consistent with the small differences by weight group in carcass means. The 205-pound group was rated best for chops, picnics, shanks, and butts; the 165-pound group for steaks, blade, and loin roasts; and the 125-pound group for bacon and ham slices (Table 6). However, all differences were quite minor except for blade roasts with a range of 0.52.

Acceptance of Size of Cut: As shown by the carcass data, size of cut does not decline as rapidly as size of carcass. However, the possibility of an adverse reaction to smaller size of cuts was recognized, and cooperators were asked to evaluate cut as to size.

Slice cuts from 205-pound carcasses were rarely judged too large and only a few of the roast cuts fell in that category. Therefore, it is not surprising that a

TABLE 6--CUT ACCEPTABILITY MEAN SCORES BY WEIGHT GROUPS

| | Chops | Blade Roasts | Loin Roasts | Steaks | Picnics | Bacon | Ham Slices | Shanks | Butt |
|--------------------|-------|-----------------|----------------|--------|---------|-------|---------------|--------|------|
| 125 lbs. | 2.07 | 2.78 | 1.95 | 2.35 | 2.28 | 3.02 | 2.03 | 1.97 | 2.32 |
| 165 lbs. | 2.03 | 2.23 | 1.86 | 2.23 | 2.18 | 3.04 | 2.19 | 2.04 | 2.24 |
| 205 lbs. | 2.00 | 2.45 | 2.22 | 2.35 | 1.98 | 3.17 | 2.15 | 1.89 | 2.06 |
| Mean of Groups | 2.03 | 2.47 | 2.05 | 2.31 | 2.10 | 3.10 | 2.15 | 1.95 | 2.13 |
| Range of Groups | .07 | .52 | .36 | .12 | .30 | .15 | .16 | .15 | .28 |

large number of the slice cuts from the two lighter weights were characterized as too small. Size insufficiency was most pronounced for chops with 52 percent of the 125-pound group called too small (Table 7). The proportion of ham shank

TABLE 7--SIZE RATINGS OF SLICE CUTS BY WEIGHT GROUPS

| | | Too Large | Just Right | Too Small | Number of Cuts |
|-----------|----------|-----------|------------|-----------|----------------|
| Chops | 125 lbs. | 0% | 48% | 52% | 222 |
| | 165 lbs. | 0 | 62 | 38 | 305 |
| | 205 lbs. | 0 | 73 | 27 | 550 |
| Steaks | 125 lbs. | 1 | 64 | 35 | 149 |
| | 165 lbs. | 2 | 68 | 30 | 321 |
| | 205 lbs. | 5 | 72 | 23 | 500 |
| Ham Slice | 125 lbs. | 1 | 55 | 44 | 98 |
| | 165 lbs. | 1 | 69 | 30 | 217 |
| | 205 lbs. | 2 | 72 | 26 | 370 |

portions said to be the right size increased from 74 to 81 percent as carcass weight decreased (Table 8). However, the proportion of picnics of optimum size declined from 74 percent to 50 percent as carcass weight decreased. Size ratings for all roasts—loin, blade, shank portion, picnics, and butt—declined from 72 to 63 percent right size as carcass weight declined.

It is difficult to know how much importance to give to size reactions since the initial reactions might change after the new, smaller sizes become commonplace in the retail displays. However, their small size does appear to be somewhat of an initial barrier for all cuts except ham shank portions. To overcome this barrier might possibly require a short acclimation period or effective merchandising or, in a few cases, cut redesign.

Consumer Comments: Consumer comments are sometimes useful in pointing out factors affecting acceptance which were not anticipated by the researcher. The relative frequency of comments by weight group is also of interest in this study. However, most comments were made by less than one-third of the respondents, so they may not be representative of the total sample.

The frequency of comments was strikingly similar by weight groups, which is in agreement with the similarity by weight groups of the other acceptance data. Minor dissimilarities were a slightly smaller percentage of "too fat" and a somewhat larger percentage of "too small" comments for cuts from the 125-pound group (Table 9).

Comments on bacon indicated that an "old taste" was of primary concern with 34 percent of the total number of comments referring to this "old taste." The reference to "old taste" was evenly distributed between weight groups with each group receiving about one-third of the total comments.

TABLE 8--SIZE RATINGS OF PICNIC AND HAM (SHANK PORTIONS) BY WEIGHT GROUPS

| | | Too Large | A Little Large | Right Size | A Little Small | Too Small | Number of Cuts |
|-------------------------|----------|-----------|----------------|------------|----------------|-----------|----------------|
| Picnic | 125 lbs. | 0% | 3% | 50% | 39% | 8% | 36% |
| | 165 lbs. | 0 | 7 | 66 | 20 | 7 | 71 |
| | 205 lbs. | 1 | 8 | 74 | 17 | 0 | 100 |
| Ham (Shank Portions) | 125 lbs. | 0 | 6 | 81 | 13 | 0 | 32 |
| | 165 lbs. | 5 | 5 | 77 | 9 | 4 | 76 |
| | 205 lbs. | 6 | 11 | 74 | 6 | 3 | 104 |

TABLE 9--COMMENTS BY WEIGHT GROUP^{a/}

| Comments | Carcass Weight Groups | | |
|---------------------------------------|-----------------------|----------|----------|
| | 125 lbs. | 165 lbs. | 205 lbs. |
| Good flavor or delicious | 17% | 19% | 18% |
| Poor flavor or flavorless | 1 | 3 | 2 |
| Too fat | 6 | 7 | 9 |
| Too lean | 1 | 1 | 1 |
| Tough, stringy or grainy | 6 | 10 | 7 |
| Tender | 12 | 15 | 13 |
| Old taste or too salty or uneven cure | 2 | 1 | 1 |
| Too small cut | 13 | 4 | 3 |
| Unsatisfactory package size | 8 | 4 | 5 |
| General approval | 26 | 29 | 34 |
| General disapproval | 8 | 7 | 7 |
| Total | 100% | 100% | 100% |
| No. of comments | 240 | 444 | 665 |

^{a/} Bacon comments not included.

Ten percent of the comments for the 165-pound and 205-pound groups referred to the bacon as being "too fat," while only 3 percent of the comments on the 125-pound group had the criticism of "too fat." The particular bacon flavor problem was undoubtedly related to the length of time the bacon was in frozen storage (in consumer's locker or freezer). It would be interesting to know how many flavor problems also develop in the home refrigerator during the normal consumption period for a package of bacon.

RELATED DATA

Household variation: There is evidence of variation between ratings by different households. The following null hypothesis was tested:

There is no significant difference in the mean acceptability ratings given by households.

An analysis of variance test showed a significant difference between ratings of households at the 1 percent level.

The range of household acceptability means was 3.3. The household with the high mean of 4.5 rated 18 cuts, while the household with the low mean of 1.2 rated 20 cuts. The average number of cuts rated by households was 21. Five percent of the households had a mean rating of 3.5 or over. Seven percent of the households had a mean rating of 1.5 or under. Thus, 88 percent of the households had a mean rating between 1.5 and 3.5, or a range of 2.

Stability of rating within each household was indicated when both carcasses were rated the same. In nine of the 239 households both carcasses had the same mean rating and in 37 percent of the households the means of both carcasses differed by 0.25 scale ratings or less. Thirteen percent of the households rated cuts such that the means of both carcasses differed by one scale rating or more. In only one household were the means of the two carcasses different by as much as two scale ratings. Thus, each household tended to rate both of the carcasses toward the same rating. The tendency of households to rate both carcasses alike indicated a stability within the households.

There are at least three factors causing variation in household ratings in addition to random factors. The first two factors are aspects of consumer preference while the third appears to be an extraneous factor associated with the use of rating scales. These three factors can be labeled:

- (1) Relative consumer preference between two units of a given pork cut from different weight groups,
- (2) relative consumer acceptance of a given pork cut or of pork in general, and
- (3) relative liberality with which any product is praised or condemned on a rating scale.

The first factor is generally the one of primary interest in relation to household variation in a preference study. Phrased as a question, the problem is, "do the various households have quite different attitudes as to which pork (by weight group) is better?" This answer is found in the statements above that 37 percent of the households gave mean ratings differing 0.25 or less between the two carcasses while only 13 percent differed by 1.0 or more.

Variation in household ratings among pork cuts or between pork and beef indicates the existence of the second factor. This degree of enthusiasm reflects itself in some households rating certain pork cuts (from *both* weight groups) higher than do other households.

It is impossible to separate accurately the impact upon ratings of the second and third factors. Observation over several preference panels indicates, however, that some households refuse to give the best rating, for example, to any product while other households seldom give a rating much below the best under similar circumstance. Evidence of the existence of this factor can be observed in social groupings of household. Table 10 indicates that the higher income group gave a poorer average rating of pork from all weight groups. While the rating difference by income groups is small, it has been found in other surveys and for other products.†

TABLE 10--ACCEPTANCE RATINGS BY CARCASS WEIGHT GROUP AND HOUSEHOLD INCOME GROUPS

| | Income* | | |
|------------|---------|--------|------|
| | Low | Medium | High |
| 125 lbs. | 2.30 | 2.45 | 2.59 |
| 165 lbs. | 2.42 | 2.27 | 2.48 |
| 205 lbs. | 2.26 | 2.31 | 2.40 |
| All Groups | 2.32 | 2.31 | 2.45 |

* Low - \$2,400 to \$4,799

Med. - \$4,800 to \$7,199

High - \$7,200 and Over

The significant difference between ratings of households found in this study is mainly a result of factors 2 and 3.

The slightly inverse relationship of mean acceptability and carcass weight for the high income group indicates that this group was slightly more critical of the lightweight pork than were other income groups.

Laboratory Taste Panel: The six-member laboratory taste panel rated ham slices according to saltiness, tenderness, and general preference ratings. Each carcass received 36 ratings. There were 12 ratings per carcass for each of the categories, saltiness, tenderness, and general preference ratings. A five-point

†See Figure 10, Missouri Research Bulletin 651.

scale was used for saltiness rating, an eight-point scale for tenderness, and a nine-point scale for general preference ratings.

An analysis of variance test was computed on the data for each of the groupings to discover any significant variation between weight groups. In each case there was no significant indication of variation between weight groups. The laboratory evidence is further support of the hypothesis that there was little difference in the acceptability of pork from hogs of different weights.

Analysis of Shear Values for Chops. Shear values were taken on three one-half inch cores from each of two chops taken from each carcass. The chops were broiled to an internal temperature of 180° F, then placed in an oven held at 220° F for five minutes. The cores were taken from the cooked chops; pounds of force required to shear the core were measured by the Warner-Bratzler mechanical shear. Within the limitation of this test the lower value shear indicates more tender meat. The shear mean for the 125-pound group was 6.43, for the 165-pound group it was 5.98, and for the 205-pound group it was 5.54. An analysis of variance indicated a possible significant variation between the shear means of weight groups. The shear mean from each carcass was paired with the respective carcass acceptability mean for chops. A coefficient of correlation of chop shear means with chop acceptability means was computed for each weight group. None of the correlation coefficients differed significantly from zero.

Effect of Cooking Method Upon Acceptability: Effect of cooking method was analyzed by dividing all methods into moist heat and dry heat categories (Table 11). The moist heat category included braising, stewing, pressure-cooking, bar-

TABLE 11--EFFECT OF COOKING METHOD ON ACCEPTABILITY RATINGS

| | Means | |
|-------|-------|------------|
| | Chops | Ham Slices |
| Moist | 2.02 | 2.20 |
| Dry | 2.02 | 2.11 |

becueing with sauce, frying with lid and meat that was cooked in foil wrap. The dry heat category included broiling, roasting, and pan frying without lid. Acceptability means were computed for each category for chops and ham slices. Cooking method had no effect on the acceptability means of chops and had very little effect on the acceptability means of ham slices.

Any sort of inference about impact of cooking method upon consumer acceptance is hampered by the fact that some households mainly use one method and some mainly use another—presumably because of preferences—and any acceptance difference or lack of difference cannot be disassociated from the differences among people.

Meals at Which Cuts Were Eaten: A large percentage of chops and ham slices were eaten at the dinner meal (Table 12). The cuts eaten most for lunch were ham shank portions and picnics.

TABLE 12--MEALS AT WHICH CUTS WERE EATEN

| | Total Number | Percent of Total | | |
|------------|-----------------|------------------|-------|--------|
| | | Break- fast | Lunch | Dinner |
| Chops | 1001 | 1 | 19 | 80 |
| Picnics | 192 | 9 | 41 | 50 |
| Ham Slices | 645 | 7 | 25 | 68 |
| Shanks | 189 | 6 | 48 | 46 |

About 69 percent of all bacon was eaten at breakfast. Consumers reported that all of the bacon in about 57 percent of the packages was eaten at breakfast while none of that in 15 percent was eaten at breakfast. a

The two higher income groups ate a higher percentage of bacon at breakfast than did the lowest income group (Table 13).

The preponderance of comments about not curling, not shrinking, and cooking evenly suggests the prime importance to housewives of those cooking properties in bacon. The majority of comments were favorable. Comments did not vary more than slightly among weight groups except for evenness of cooking and shrinkage; the lightest weight bacon came out better on both counts (Table 14).

TABLE 13--PROPORTION OF BACON CONSUMED AT BREAKFAST BY INCOME GROUPS

| Income Groups | Percentage of a Bacon Package Eaten at Breakfast | | | | | | | Total No. Pkgs. Eaten |
|---------------|--|-------|-------|------|-------|-------|------|-----------------------|
| | 0 | 10-20 | 30-40 | 50 | 60-70 | 80-90 | 100 | |
| Low | 16.1 | 9.1 | 3.5 | 16.7 | 2.8 | 1.0 | 50.8 | 317 |
| Middle | 15.7 | 7.1 | 1.9 | 10.5 | 2.8 | 1.5 | 60.5 | 466 |
| High | 21.1 | 8.6 | 1.9 | 14.5 | 3.5 | 1.6 | 57.8 | 256 |

TABLE 14--COMMENTS ON COOKING PROPERTIES OF BACON BY CARCASS WEIGHT GROUP

| Weight Group | Comments | | | | | | | | | | |
|--------------|--------------|----------------|----------------|--------|----------------|---------------|-------------|--------|--------------|---------------|--------------------|
| | Fried evenly | Fried unevenly | Browned evenly | Shrank | Did not shrink | Cooked slowly | Cooked fast | Curled | Did not Curl | Did not Crisp | |
| 125 lbs. | 18.2 | 4.2 | 4.9 | 4.2 | 26.6 | 3.5 | 2.1 | 4.9 | 30.7 | 0.7 | 100% ^{a/} |
| 165 lbs. | 13.6 | 3.1 | 2.3 | 11.3 | 26.5 | 4.7 | 3.9 | 2.7 | 30.0 | 1.9 | 100% |
| 205 lbs. | 13.9 | 4.4 | 4.7 | 9.4 | 24.1 | 5.7 | 2.9 | 5.3 | 27.8 | 1.8 | 100% |

^{a/} Percentages based on total comments of 143, 257 and 618, respectively in the 125, 165 and 205-pound weight groups.

Methodological Test: A pound of extra fat bacon (from non-test hogs) was provided each household along with the regular bacon. A failure of the panel to discriminate against the fatter bacon would have been regarded as raising serious doubts about the usefulness of panel results. (It seems unnecessary to defend the assumption that most consumers do prefer regular to extremely fat bacon.)

The mean of extra fat bacon was 0.6 of a point inferior to the regular bacon. It appears likely that this difference would have been larger if palatability differences had not been confounded by some deterioration of palatability during freezer storage. About 41 percent of the extra fat bacon was rated as "too fat" by consumers, compared with 24 percent of the bacon from the 205-pound group.

Pilot Study: Design of this study was based upon the findings of a small panel conducted by Hatesohl the previous year.†† Ten carcasses in each of four carcass weight groups—125, 150, 175, and 200 pounds—were paired and distributed so that each of 40 Columbia households received pork cuts from one-half of a lightweight carcass and one-half of a heavier one.

No significant difference was found in carcass acceptability of the four weight groups. Neither was there a significant difference between ratings of the weight groups when compared cut by cut. Carcasses of the 175-pound group received slightly better scores than carcasses of the other weight groups.

A small but significant difference was found in the leanness ratings of the four weight groups. The 125-pound group received more "too lean" ratings than the other weight groups, but it also received about as many "too fat" ratings as the other groups. The 150 and 200-pound groups received almost identical leanness ratings. Cuts showing the most "too lean" ratings were ribs and bacon, while steaks, blade roasts, and picnics had the most "too fat" ratings.

A significant difference was found in size ratings of the different weight groups. More than 50 percent of the cuts from the 125-pound group were rated as "too small" or "a little small." The heavier groups received fewer small ratings but received more ratings of "too large" or "a little large." The 150-pound group received the largest percentage of "right size" ratings on roasts, while the 200-pound group received the most such ratings on sliced cuts. More sliced cuts than roasts were rated "too small," but the ratings of sliced cuts were undoubtedly confounded by the small size of the packages.

Hatesohl's data clearly indicated that there was considerable variation as to leanness between carcasses within each of the weight groups. However, the carcasses were all from fairly well-muscled hogs with much less variation than would be found in the general population.

Hatesohl's results are generally consistent with those of the present study. However, the smaller carcasses were rated relatively better as to leanness in the present study.

††Delmar E. Hatesohl, "Consumer Evaluation of Pork from Light-Hogs," Master's thesis, University of Missouri, 1959.

REFERENCES

1. V. James Rhodes, Elmer R. Kiehl and D. E. Brady, *Visual Preferences for Grades of Retail Beef Cuts*, Mo. Res. Bul. 538, 1955.
2. George W. Campbell, *Consumer Acceptance of Beef*, Arizona Report No. 145, 1956.
3. Robert E. Branson, *The Consumer Market for Beef*, Texas Ag. Exp. Sta. Bul. 856, 1957.
4. H. D. Naumann, Edwin A. Jaenke, V. James Rhodes, Elmer R. Kiehl, and D. E. Brady, *A Large Merchandising Experiment with Selected Pork Cuts*, Mo. Res. Bul. 711, 1959.
5. H. D. Wallace, G. E. McCabe, A. Z. Palmer, M. Koger, J. W. Carpenter and G. E. Combs, *Influence of Slaughter weight on Economy of Production and Carcass Value of Swine*, (abstract Journal of Animal Science 18: 1484: 1959).
6. R. M. Washburn and C. H. Jones, "Studies of the Value of Different Grades of Milk in Infant Feeding," Vermont Agr. Exp. Sta., Bul. No. 195, 1916.
7. W. J. Loeffel, W. W. Derrick, and M. Peters, "Weight of Pigs as it affects Gains and Carcass Qualities," Neb. Agr. Exp. Sta., Res. Bul. No. 351, 1943.
8. O. G. Hankins and N. R. Ellis, "Composition and Nutritive Value of Pork as Related to Weight of Animal and Cuts," *U.S.D.A. Circular No. 731*, 1945.
9. S. E. Zobrisky, H. D. Naumann, J. F. Lasley, D. E. Brady, and A. M. Mullins, "Physical Composition of Swine During Growth and Fattening," Mo. Agr. Exp. Sta. Res. Bul. No. 672, 1958.
10. Delmer E. Hatesohl, "Consumer Evaluation of Pork from Light-weight Hogs," Master's thesis, University of Missouri, 1959.
11. V. James Rhodes, Elmer R. Kiehl, D. E. Brady, and H. D. Naumann, *Predicting Consumer Acceptance of Beef Loin Steaks*, Mo. Res. Bul. No. 651, 1958.

Appendix

SAMPLE OF RATING CARD FOR SLICED CUTS

Date eaten _____

Please circle or fill in answers that apply:

Meal: Breakfast, Lunch, Dinner

How Cooked: _____

Liquid added: Yes No Lid: Yes No

FOR OUR FAMILY

This size cut is:

_____ Too Large

_____ Just Right

_____ Too Small

This cut is:

_____ Too Thick

_____ Just Right

_____ Too Thin

_____ Tender

_____ Tough

_____ Too Fat

_____ Just Right

_____ Too Lean

Disregarding size, how well did your family like this cut?

_____ Like Extremely

_____ Like Very Much

_____ Like Moderately

_____ Like Slightly

_____ Neither Like Nor Dislike

_____ Dislike Slightly

_____ Dislike Moderately

_____ Dislike Very Much

_____ Dislike Extremely

Comments:

SAMPLE OF RATING CARD FOR ROAST CUTS

Date eaten _____

Please circle or fill in answers that apply:

Meal: Breakfast, Lunch, Dinner

How cooked: _____

Liquid added: Yes No Lid: Yes No

FOR OUR FAMILY

This size cut is:

_____ Too Large
 _____ A Little Large
 _____ Right Size
 _____ A Little Small
 _____ Too Small

This cut is:

_____ Too Fat
 _____ Just Right
 _____ Too Lean

Disregarding size, how well did your family like this cut?

_____ Like Extremely
 _____ Like Very Much
 _____ Like Moderately
 _____ Like Slightly
 _____ Neither Like Nor Dislike
 _____ Dislike Slightly
 _____ Dislike Moderately
 _____ Dislike Very Much
 _____ Dislike Extremely

Comments:

SAMPLE OF RATING CARD FOR BACON

Date eaten _____

Please circle or fill in answers that apply after you have eaten all of this package.

What % of this bacon did you use other than at Breakfast?

How did this bacon cook? Please give details

This bacon is:

| | | | |
|-------|--------|-------|------------|
| _____ | Tender | _____ | Too Fat |
| _____ | Tough | _____ | Just Right |
| | | _____ | Too Lean |

How well did your family like this bacon?

| | |
|-------|--------------------------|
| _____ | Like Extremely |
| _____ | Like Very Much |
| _____ | Like Moderately |
| _____ | Like Slightly |
| _____ | Neither Like Nor Dislike |
| _____ | Dislike Slightly |
| _____ | Dislike Moderately |
| _____ | Dislike Very Much |
| _____ | Dislike Extremely |

Comments: