STUDIES ON THE IMPORTANCE OF QUALITY IN HAMS

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STUDIES ON THE IMPORTANCE OF QUALITY IN HAMS

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J. T. G.

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INTRODUCTION

The term "quality", as conventionally used in meats' circles, refers to the marbling, firmness, texture, and color of the meat. Variations in these physical characteristics which relate to quality in meats are considered to be due to the age, feeding practices, breeding, and management of meat animals. Maturity is generally associated with dark colored, coarse textured meat with a high connective tissue content, while youthfulness is usually associated with bright colored, fine textured meat. Feeding practices may effect the color of meat, but generally have more influence on the firmness of the fat and lean in the carcass than on other characteristics. Considerable variation in the quality of meats is believed to be due to differences in inheritance in meat animals. Certain lines and breeds of livestock have been observed to produce higher quality carcasses than others.

The consumer is interested in those factors which relate to quality in meat as they affect the flavor, appearance, palatability, tenderness, and cooking characteristics of meat. Consumers have been observed to prefer the well marbled, firm, fine textured, bright colored meats because of the alleged superior juiciness, flavor and tenderness of such meats.

Studies related to meat quality have received little attention, perhaps because of the lack of the necessary methods for evaluating such characteristics as marbling, firmness, texture and color.

In Oklahoma, approximately 950,000 hogs are marketed annually. In the packing plants, pork carcasses as well as the wholesale cuts of the carcass are usually graded according to weight only, with little, if any, consideration given to "quality". However, in the grading of other types of carcasses, full consideration is given to "quality". Under present processing procedures in packing plants, the low quality as well as the high quality hams are processed together and ultimately reach the retail outlet graded according to weight only. The need for information relative to the economic importance of certain quality factors in pork provides the basis for this study.

REVIEW OF LITERATURE

Quality in meats has been described in various ways by researchers over a period of many years. In early literature on meat production, Ewart (1878) referred to "quality of butchers' meat" as determined by the amount of finish and its state of health as food for man. Mitchell et al. (1928) stated that quality in carcass meats is determined chiefly by conformation; the amount, color, firmness, and distribution of the fat; and by the color, texture, and firmness of the lean. This worker questioned whether the color, texture, and firmness of lean meat contribute to its palatability but recognized that tenderness, juiciness, and flavor are important factors which influence palatability.

Mitchell et al (1928) studied factors affecting the connective tissue content of beef muscle. These workers reported that age does not appear to have a great effect upon the connective-tissue content of muscle, nor a consistant effect on the different muscles of the carcass. No relation was found between the ordinary market grading of beef carcasses and the connective tissue content of the lean of the rib-eye or of the round. These workers further stated that the results of this investigation lend no support to the belief that the appearance, texture, and firmness of the meat give reliable information concerning its tenderness.

Ziegler (1948) and Bull (1951) stated that quality in beef refers to the texture, marbling, color, firmness of the lean and fat, and character of the bone.

An investigation was conducted by Naumann *et al*. (1953) to determine the most valuable methods for the quantitative evaluation of factors associated with quality. In this study, carcasses from 38 two-year-old steers were used for the physical, chemical, and organoleptic determinations. Low correlations were found between taste panel scores, the Warner-Bratzler shear scores, and collagen content as tests for tenderness. These workers found juiciness to be more closely related to quantity of press fluid than to the fat content of the press fluid. The color of the lean and fat was measured with the Photovolt Reflectance Meter and the Cary Reflectance Spectrophotometer. Results with the Photovolt Reflectance Meter were compatible with the observed color in beef, whereas the Spectrophotometer was found to be ill-adapted for such work.

Marbling as it affects quality

Beard (1924), as reported by Lowe (1937), studied tough and tender beef and found that intramuscular, and particularly intrafasicular, fat lessens the toughness of meat.

Mackintosh *et al*. (1937) investigated the relation of the degree of finish and quality to the palatability of beef. These workers found marbling to be related to palatability in beef; increased marbling being associated with increased tenderness, juiciness, and flavor. Hankins and Titus (1939) conducted studies with the meat of beef, pork, lamb, and chicken. These workers regarded intramuscular fat as having an influence on several quality factors of meat including color, firmness, marbling, and palatability.

McMeekan (1940 a) stated that marbling in beef is an important quality character; it is less important in lamb and mutton, but so far as is known is of no economical significance in pork.

Hammond (1942) reported that the presence of marbling within the muscle tends to separate the muscle bundles, thereby improving the texture of the meat.

Callow (1947) conducted a series of comparative studies of meat involving beef, pork, and lamb. This worker reported that the fat content of muscular tissue is a very important factor in the quality of meat; good quality being associated with a high fat content in the muscle. Callow found that there was comparatively more fat in the muscle tissue than in the subcutaneous tissue at the beginning of the fattening period. However, as fattening proceeded, there was more fat found in the subcutaneous tissue.

Ziegler (1948) defined marbling as the lacelike network of intercellular or intramuscular fat visible in the cut surface of meat and one of the best assurances of quality. This author further states that marbling is also an important factor affecting firmness and color of lean; the presence of marbling causing a firmer, brighter-colored lean.

Firmness

Hankins (1930) reported that the firmness of a pork carcass and its products depend almost entirely on the firmness of the fat. This worker reported that the character and quantity of fat in the pork carcass are influenced by the feed, or more specifically, by the fat or oil in the feed. This worker also noted the discrimination in trade channels against "soft pork".

McMeekan (1940 a) reported that the chemical nature of fat in meats is important particularly with respect to bacon-type carcasses. The degree of saturation of the fat was found to be associated with important qualitative effects in the carcass. Soft fat was associated with poor appearance, excessive freezing, storage, transport, curing and cooking losses. In the unsaturated fat, rancidity was found to develop more quickly than in the firmer more completely saturated fats.

Hiner and Hankins (1941) studied the use of the penetrometer for determining the firmness of fatty tissue of pork carcasses. These workers used 351 back-fat samples from pork carcasses that had been chilled for 72 hours at 33° to 35° F. for their study. A penetrometer of standard type designed to determine firmness or consistency of foods and other materials was employed. Correlation coefficients reported by these workers showed that a close relationship existed between (1) the committee grade for firmness and penetrometer determination and (2) penetrometer determination and refractive index.

Ziegler (1948) states that meats are soft in proportion to their moisture and fat content. According to Ziegler, the cut surface of meat that lacks marbling will appear watery and will be soft to the touch, while well-marbled meat will have a firm dry surface. This worker further states that the firmness of meat increases with the degree of finish unless the fat itself is soft and of "low quality".

Texture

Brady (1937) obtained samples of several different muscles from carcasses of yearling steers and mature cows which had been fed a standard fattening ration for 180 days. A count of the muscle fibers within a muscle bundle was made and the diameter of the fibers determined. The Warner-Bratzler shear was used to determine shear stress and palatability committee scores were obtained on the cooked meat. This worker found that the number of muscle fibers in a bundle could be used as an estimate of texture and that the number of muscle fibers in a bundle could determine the bundle size. From these studies, it was concluded that texture is dependent on the size of the bundle. Furthermore, texture is an indication of tenderness; the "finer" the texture the more tender the meat.

Hirzel (1939) as reported by Meara (1947) conducted studies with mutton and beef. This worker concluded that the evidence on texture and connective tissue, their interrelation and effect on toughness of meat were still inadequate and inconclusive. Hammond (1940) reported that the texture of muscle is important in that coarse texture is associated with tough, stringy meat. Meara (1947) studied the muscles of rabbits and found that the texture of this meat is dependent on the number and size of the muscle fibers which comprise the muscle bundles.

Color

Whipple (1926) and Hammond (1940) reported that the intensity of the color of muscles increases with exercise and age; and, that this is due to the myoglobin content of the muscle.

Millikan (1939) studied the occurrence of muscle hemoglobin in the cat. This worker found that muscle hemoglobin occurred in those muscles requiring vigorous repetitive activity which must be maintained. Muscle hemoglobin was found to increase with age and activity.

Hankins and Ellis (1939) studied the relation of fat to quantity and quality factors of meat carcasses. These workers reported that color of meat was not found to possess any intrinsic value as a quality factor; but, that the color of meat does have psychological and commercial significance.

McMeekan (1940 a) and Hammond (1940, 1942) states that the color of meat is related to flavor; the darker the meat the stronger the flavor. However, McMeekan (1940 a) indicated that color is not an important quality character in pork as it is in veal and beef; though generally a pale color is preferred in the fresh pork trade.

McMeekan (1940 b) studied the effects of feeding pigs four different planes of nutrition. This worker found that pigs on a high plane of nutrition and making the most rapid growth produced lighter colored muscles than slow growing pigs on a low plane of nutrition. The slow growing pigs produced reddish colored muscles so much like beef muscles in color that they could hardly be recognized as pork.

Bull (1942) studied the relationship of exercise to dark colored beef in five heifers and six steers approximately one year of age. The animals were exercised vigorously prior to slaughter. After the carcasses were chilled and graded the color of the Longissimus dorsi between the 12th and 13th rib was measured with a spectrophotometer. Both visual observations and spectrophotometric analysis showed the color of the meat to be desirable in all carcasses. Dark colored beef was not produced experimentally in this study.

Ludvigsen (1954) investigated muscular degeneration in hogs delivered to a Danish bacon factory. This worker reported that the hogs having muscular degeneration had discolored muscles with a greyish or pale color resembling the color of chicken or fish. According to this worker, muscular degeneration is caused by a weakened functioning of the thyroid gland.

Wilson (1955) studied the effect of feeding antibiotics on the incidence of "two-toning" in hams. The reference did not indicate which antibiotics were fed. This worker generalized that feeding antibiotics did not appear to be related to the degree of "two-toning" in the ham muscles. However, results indicated that "two-toning" was related to the breed of hog rather than to the feeding regime. Hams from certain breeds of hogs were affected with "two-toning" more than others.

Scoring

In view of the fact that visual scoring procedures were used in this study, it was felt that a review of the literature relating to visual scoring should be presented.

Lush and Craft (1937) analyzed the scores of four judges who scored 14 pigs for "vigor, health, and thriftiness". These workers found significant differences between scores given different pigs and also the scoring levels of the four judges. The correlation obtained between the scores given the same pig by different judges (+.45) was evidence that the scoring, to some extent at least, did record values on which the four judges agreed. Further computation of the data with respect to the dependability of average scores for the independent scorings by several men revealed that about 76% of the variance in the average scores resulted from values on which all four judges agreed for the character in question.

Lush (1938) studied the repeatability of scores made by the same man. Thirty pigs were scored twice by the same man with a three day interval between the first and second scoring. The scores were analyzed in an effort to find the cause for variation in the scores and to obtain a measure of the dependability of the scoring technique. This worker found that more than half of the variance in single scores came from general differences between the pigs. Nearly half of the remainder of the variance came from differences in characteristics of the same pig; that is, from a pig being good in some characteristics but poor in others. Error of the scorer in using the scoring technique, or changes from one day to another in the apparent merit of the point being scored contributed approximately 15 percent of the variance. This worker also found that changes from day to day in the general scoring level and in the scoring levels for the different points were very small.

Lush and Craft (1938) analyzed the scores of four judges who scored 139 pigs on nine different days. These pigs were scored one time and at a uniform market weight. These workers found that there was close agreement between the different men scoring the same pig; yet the error in the scores could be markedly diminished by averaging the scores given by the four men. It was also observed that there was some drifting of scoring levels as the scorer progressed from one group to another.

EXPERIMENTAL OBJECTIVE

This experiment was designed to study the relative economic importance of certain quality factors in the fresh ham.

EXPERIMENTAL PROCEDURE

The hams used in this study were purchased from a packing company in Oklahoma City. Four groups of 25 hams each, in the 16-18 pound range, were purchased on four different days in the fall of 1954. Although no scoring of hams was done at the plant, the selection of the hams was based on firmness, marbling, color, and texture in order that in each group of 25 hams there would be a wide range of quality represented. There was no information available as to the source, breeding, feeding, management, or sex of the carcasses from which the hams were taken.

The hams were brought to Stillwater immediately after they were trimmed. Upon arrival at the meat laboratory, each ham was identified amd weighed. The hams were then placed on tables in a 34°F cooler with 70% humidity. The hams remained in the cooler 18 hours before they were scored.

a. Scoring Procedure

Three men independently scored each ham for four quality characteristics; namely, marbling, firmness, texture, and color. The score sheet used is described on the following page.

The scoring was done by checking the blank following the term most descriptive of quality in each case.

After the hams had been scored the numbers which corresponded with the descriptive terms checked on the score sheet were recorded and totaled to give each ham a quality score. The hams were then

Score Sheet

Ham No.____

Marbling		Firmness	
1. Devoid of Marbling	______	Very Soft	______
2. Scantily Marbled	______	Soft	______
3. Slightly Marbled	______	Slightly Soft	______
4. Average (Medium)	______	Average (Medium)	______
5. Moderately Marbled	______	Slightly Firm	______
6. Well Marbled	______	Firm	______
7. Abundantly Marbled	______	Very Firm	______

Texture		Color	
1. Very Coarse	______	Uniformly Dull & Ashen Gray	____
2. Coarse	______	Two-Toned & Ashen Gray	____
3. Slightly Coarse	______	Uniformly Very Dark	____
4. Average (Medium)	______	Uniformly Dark	____
5. Slightly Fine	______	Two-Toned Bright & Dark	____
6. Fine	______	Uniformly Slightly Dark	____
7. Very Fine	______	Uniformly Bright Whitish Pink	____

divided into five classes according to the total quality score of the ham. The classes were as follows:

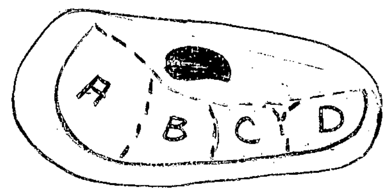
Class		Total Score Range
I	------	24 - 28
II	------	19 - 23
III	------	14 - 18
IV	------	9 - 13
V	------	4 - 8

Representatives of each class were photographed together to show the differences between classes.

b. Penetrometer Determination

The penetrometer was used in this study as a mechanical measure of firmness in the ham. A device was used to hold the hams with the face upright, so that readings could be taken. Two small line levels were used to level the face of the ham.

The penetrometer was equipped with a ball .375 inches in diameter. The firmness of the ham was estimated by measuring the depth of penetration of the ball into the face of the ham to the nearest tenth of a millimeter. The total weight of the ball, the test rod that held it, and the added weight was 66 grams. With the aid of a mirror attached to the penetrometer it was possible to adjust the ball to the face of the ham. The weight of 66 grams was then allowed to force the ball against the face of the ham for ten seconds. Four readings were taken on four separate areas on the face of each ham as shown in the following illustration:



The readings for the areas A, B, C, and D were averaged to give a penetrometer score for firmness.

c. Samples for Chemical Analysis

Samples for chemical analysis were taken from the center of the cushion of each ham. A knife, sharpened on both edges of the blade, was used to remove the samples. This method allowed removal of the sample from the cushion without excessive mashing or mutilation of the sample. All samples were taken from as near the same location as possible on each ham, using the end of the aitch bone as the reference point. These samples weighed approximately eight grams each and were wrapped immediately in cellophane and aluminum foil and placed in numbered, air tight bottles for freezing at -10° F.

Approximately four months after the samples were taken, 25 of the 100 samples were analyzed for moisture, fat, ash, and protein. These 25 samples were selected on the basis of the marbling and firmness score of the ham in order that a wide range of quality would be represented as measured by these two quality characteristics.

d. Curing and Smoking

All hams were treated as nearly alike as possible during the process of curing and smoking. Each ham was pumped to 10 percent of its weight with a curing solution. A pressure pump which exerted 40 pounds of pressure was used to pump the curing solution into the hams by way of the arterial system. The formula for the curing solution and dry cure was as follows:

	Water (gal.)	Fine Salt (lbs)	Sugar (lbs)	Quick-Action Pickle* (lbs)
Curing Solution	10	15.5	2.9	2.5
Dry Cure mix		5.1	2.5	2.4

After pumping, the hams were rubbed with the dry cure at the rate of four pounds of mix per 100 pounds of ham. The hams were then placed on shelves in a 37°F curing cooler for an eight-day curing period.

At the end of the curing period, the hams were soaked for three hours in water (75°F) for the removal of excess curing ingredients. The hams were then allowed to drain for 12 hours, after which they were weighed and placed in stockinettes suitable for hanging in the smokehouse. The hams were hung in a gas-fired smokehouse heated to 160°F and smoked with hickory wood smoke for 24 hours. After the hams were smoked they were weighed, hung in a 34°F cooler for 48 hours, and were then weighed again to obtain 48-hour cooler shrinkage.

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*Quick-action pickle is a quick-cure formula composed of nitrite, nitrate, and salt components patented by the B. Heller & Company, Chicago, Illinois.

Two cured hams were taken at random from each of the five classes for photographing. Visual observations and individual pictures were made of each ham for comparison of the range of quality in the finished product.

e. Statistical Analysis

The statistical analysis of the data in this study consisted of computing simple correlations as described by Snedecor (1953). The computation of the scoring data was done on an intra-week basis to remove differences in scoring between weeks. However, total correlations were computed whenever any comparisons were made with the data from chemical analysis since only 25 samples selected from 100 were chemically analyzed.

RESULTS AND DISCUSSION

The hams used in this study were classified on the basis of their total quality scores as follows:

Class	Number of Hams	Score Range
I	20	24 - 28
II	27	19 - 23
III	19	14 - 18
IV	26	9 - 13
V	8	4 - 8

The fresh hams shown in Plate I are representatives from each of five quality classes used in this study. The ham shown in the lower left portion of the plate is a representative of Class I hams. This was a well marbled, firm, fine textured, bright colored ham that maintained its weight during curing and smoking. The ham shown in the upper right portion of the plate is a representative ham of Class V hams. This ham which was soft, watery, coarse textured, two-toned in color, and devoid of marbling is in sharp contrast to the Class I ham. The Class V ham shrunk 9.0% in weight during curing and smoking. The shrinkage during processing, quality scores, and penetrometer scores for the hams shown in Plate I are presented in Table I.

The weights and shrinkage data for all the hams used in this study are presented in appendix Table IV. The per cent shrinkage for each of the five quality classes is shown in Graph I. These data indicate that the low quality Class V hams had almost twice the shrinkage during pro-

Plate 1.

Top Row: Class IV and Class V.

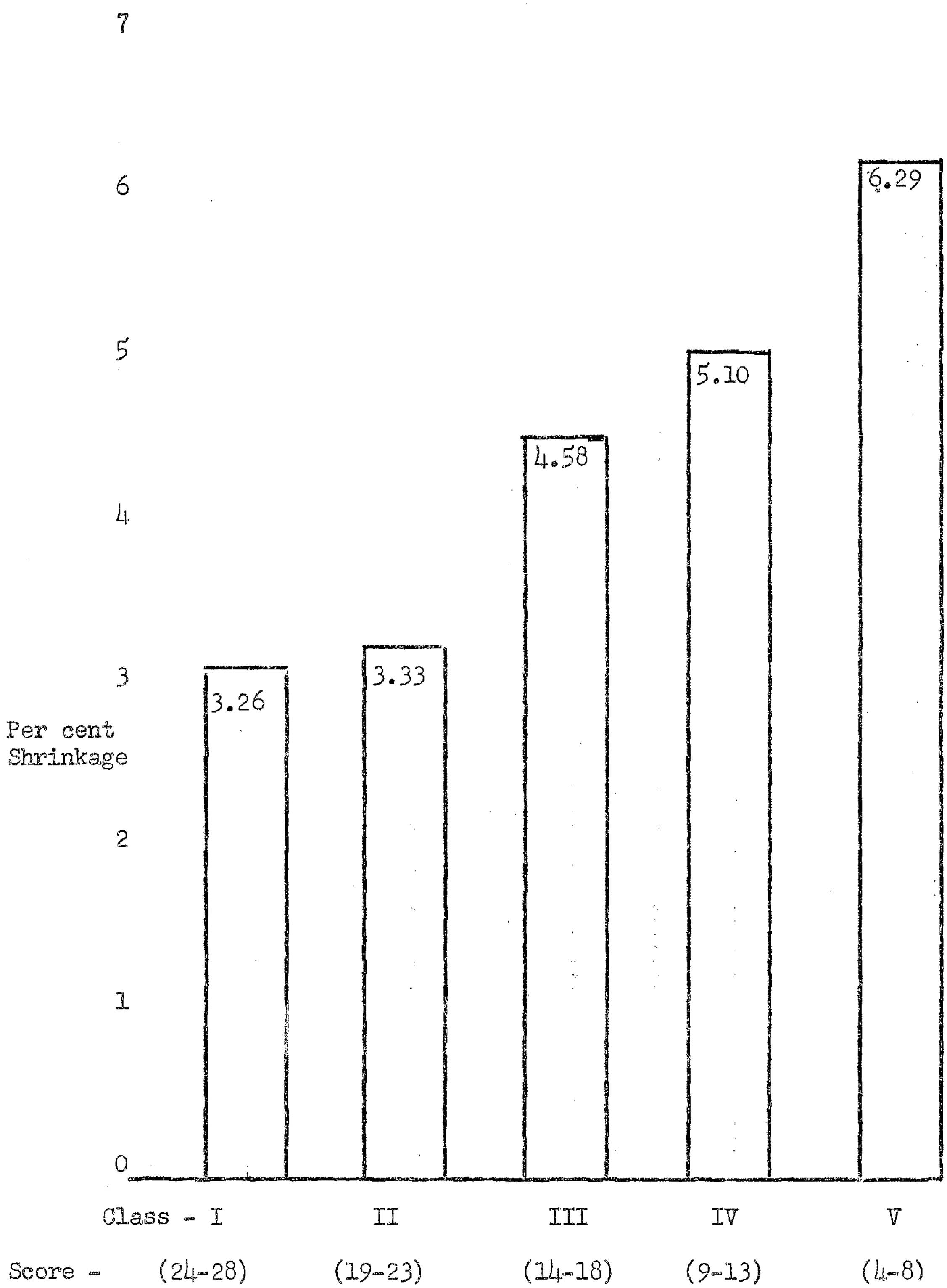
Bottom Row: Class I, Class II, and Class III.

TABLE I

Quality Estimates for Fresh Hams Shown in Plate I

Class	Shrinkage	Marbling	Firmness	Texture	Color	Total	Penetrometer[1]
	per cent						
I	0.0	6.0	6.5	6.0	6.0	24.5	30
II	2.9	5.5	5.0	6.0	4.0	20.5	30
III	1.9	3.0	3.5	6.0	3.5	16.0	48
IV	3.6	2.0	2.0	3.0	5.5	12.5	67
V	9.0	1.0	1.5	2.0	2.0	6.5	74

[1]Penetration of the penetrometer ball measured in tenths of a millimeter.



Graph I. Per Cent Shrinkage for Hams by Classes cessing as the higher quality Class I hams. Class III and IV hams also had more shrinkage than those in Class I. However, Class I and II hams had practically the same shrinkage during processing since Class II hams had only .07% more shrinkage than those in Class I. The per cent of total shrinkage for each of the quality classes for different periods during processing is shown in Table II. The data presented in Table II indicate that there is a similar trend for the percentage of total shrinkage which occurred in each of the classes during any one period of processing.

Table II

Per Cent of Total Shrinkage by Classes

Class	Before Curing[1]	During Curing & Smoking[2]	After Smoking[3]
	per cent	per cent	per cent
I	27	46	27
II	36	36	28
III	30	46	24
IV	24	48	29
V	29	49	24
Average for all Classes	29	45	26

[1]Thirty hour period

[2]Nine day period

[3]Forty-eight hour period

The results of statistical analyses are shown in Table III. These negative correlations indicate that any one of the four quality characteristics scored, or a combination of the four, are related to the shrinkage of the ham during processing. The correlation of -.421 between marbling score or -.409 between firmness score, and total shrinkage indicates that these two quality characteristics are the most valuable of those studied for determining curing "quality" of the fresh ham.

TABLE III

Correlations for Quality Estimates

	Total[1] Shrinkage	Penetrometer[1] Reading	Fat[2] Content	Moisture[2] Content
Marbling Score	-.421**		.443*	
Firmness Score	-.409**	-.817**		.080
Texture Score	-.349**			
Color Score	-.338**			
Total Score	-.418**			
Penetrometer Reading	-.410**			
Total Shrinkage				-.097

**Significant at the 1% level

*Significant at the 5% level

[1]Intra-week correlation based on 96 d.f.

[2]Total correlation based on 24 d.f.

A highly significant correlation of -.817 was obtained between firmness score and penetrometer reading. This relationship is in agreement with Hiner and Hankins (1941) who obtained a correlation of

-.905 between committee scores for firmness and penetrometer readings on fats from pork carcasses. These correlations indicate that both estimates of firmness (visual score and penetrometer) are quite in agreement on this quality factor.

A significant positive correlation of .443 was found between marbling score of the hams and fat content of the lean samples. However, little correlation was observed between moisture content of the lean samples and firmness score or shrinkage of the hams during processing. This low relationship is perhaps due to errors in the sampling technique used to obtain the lean samples. The samples used for chemical analysis comprised but a very small portion of the lean of the entire ham.

Chemical analyses for moisture, fat, ash, and protein content of the ham samples were completed on 25 samples. Chemical analyses for the 25 lean samples are presented in appendix Table V.

Five of the ten cured hams were taken at random from the five quality classes for photographs. These are shown in Plates 2 through 6. Observations made on each ham upon cutting are presented in the following discussion. The Class I ham was a moderately marbled, slightly two-toned, firm ham. The Class II ham was moderately marbled, uniformly slightly dark in color and firm. The Class III ham was also moderately marbled, slightly two-toned bright and dark, and firm. The Class IV ham was scantily marbled, two-toned gray and slightly dark, and soft; free moisture was observed in this ham upon cutting. The Class V ham was very scantily marbled, firm, and had what appeared to be a three-toned color; no apparent free moisture was observed in this ham. The

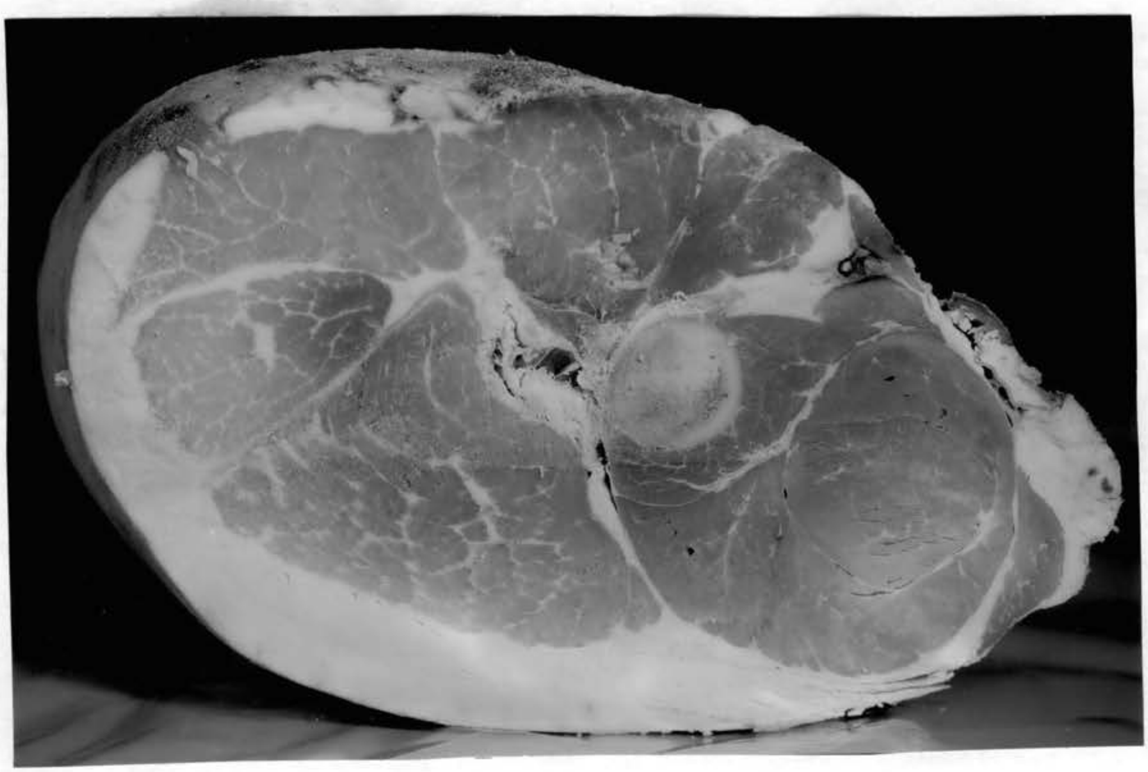


Plate 2. Class I

Plate 3. Class II

Plate 4. Class III

Plate 5. Class IV

Plate 6. Class V

cured hams shown in these plates illustrate only a part of the differences in quality found in the cured and smoked hams from the five quality classes.

SUMMARY

A study was initiated in the fall of 1954 to determine the relative importance of certain quality factors in fresh hams. One hundred hams were scored by three men for four quality characteristics - namely, marbling, firmness, texture, and color. The hams were classified into five quality classes on the basis of quality scores. The penetrometer was used as a mechanical measure of firmness in the fresh ham. Samples were taken from the hams for chemical analysis and the analyses on 25 of the lean samples are presented. Shrinkage data were obtained and are presented for each ham processed during this study.

The total shrinkage during processing for low quality hams was found to be twice as high as the shrinkage for high quality hams. Statistical analysis of the data indicates that the quality of the ham as determined by visual score is related to the shrinkage during processing. Significant negative correlations were obtained between each of the four quality characteristics scored and a combination of the quality characteristics and shrinkage of the ham during processing. These correlations indicate that either marbling or firmness of the ham are as reliable as indicators of shrinkage during processing as a combination of marbling, firmness, texture, and color.

A highly significant negative correlation was obtained between two different estimates of firmness (visual score and penetrometer

determination) indicating that these estimates are in close agreement on this quality factor.

Fat content of the lean samples was found to be related to the observed marbling in the ham. Moisture content of the lean samples showed practically no relationship between observed firmness or shrinkage of the hams when analyzed statistically. This lack of relationship may have been due to the sampling technique employed since only a small portion of the lean of the ham was used for chemical analysis.

Quality in hams is an economically important characteristic in the meat industry. From the data obtained in this study, it appears that further work on the problem of quality in pork is indicated, with particular reference to some causes of low "quality" in pork.

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A P P E N D I X

Table IV

Ham Weights and Total Shrinkage by Classes

Class I

Ham No.	Ham Weights (lbs.) Initial	Before Cure	Smoked	Final	Lbs. Shrinkage	Quality Score
1	17.0	16.8	15.8	15.6	1.4	24.3
2	16.5	16.3	15.4	15.3	1.2	25.2
26	17.0	16.9	17.0	16.8	0.2	24.6
30	16.3	16.2	15.8	15.6	0.7	24.0
31	17.5	17.4	16.9	16.7	0.8	25.3
32	16.4	16.3	15.8	15.6	0.8	25.3
35	16.0	15.9	16.2	16.0	0.0	25.7
51	16.2	16.0	15.9	15.8	0.4	23.5
54	16.1	16.0	16.3	16.2	-0.1	23.5
64	16.5	16.3	15.7	15.5	1.0	24.5
67	16.9	16.7	16.4	16.3	0.6	25.0
68	16.7	16.6	16.4	16.2	0.5	25.5
70	18.1	18.1	17.9	17.8	0.3	23.5
71	16.3	16.2	15.8	15.6	0.7	24.5
73	17.2	17.0	16.9	16.8	0.4	24.5
60	16.6	16.4	16.2	16.1	0.5	26.0
77	16.5	16.3	16.0	15.9	0.6	23.5
78	16.3	16.1	15.9	15.8	0.5	23.5
79	16.8	16.7	17.0	17.0	-0.2	24.5
81	17.4	17.2	17.1	16.8	0.6	24.5

Class II

Ham No.	Initial	Before Cure	Smoked	Final	Lbs. Shrinkage	Quality Score
3	17.0	16.7	15.9	15.7	1.3	22.9
4	18.3	18.0	17.5	17.4	0.9	23.2
5	16.3	16.0	15.8	15.6	0.7	23.2
6	18.0	17.7	17.4	17.2	0.8	20.5
7	16.8	16.5	16.4	16.3	0.5	22.6
8	17.5	17.3	16.9	16.8	0.7	21.5
9	16.5	16.2	15.4	15.3	1.2	20.8
12	16.5	16.0	15.7	15.4	1.1	20.8
27	17.1	16.9	16.5	16.3	0.8	20.3
28	15.8	15.6	15.6	15.4	0.4	21.3
29	16.7	16.5	16.3	16.1	0.6	20.3
33	17.6	17.5	17.4	17.2	0.4	19.4
34	16.2	16.1	16.3	16.1	0.1	22.3
36	17.0	16.9	17.2	16.8	0.2	21.6
37	17.5	17.3	16.3	16.1	1.4	20.6
38	17.5	17.3	17.1	16.9	0.6	20.7
55	15.8	15.6	15.6	15.5	0.3	19.5
57	16.7	16.6	16.4	16.3	0.4	20.0

Table IV (Cont'd)

Ham Weights and Total Shrinkage by Classes

Ham No.	Ham Weights (lbs.) Initial	Before Cure	Smoked	Final	Lbs. Shrinkage	Quality Score
			Class II			
61	18.1	17.9	18.1	18.0	0.1	21.5
65	16.5	16.4	16.3	16.2	0.3	21.0
72	17.2	17.0	16.8	16.7	0.5	21.5
74	17.8	17.7	17.9	17.8	0.0	22.5
76	17.9	17.6	17.4	17.3	0.6	23.0
80	17.5	17.3	17.5	17.3	0.2	23.0
82	17.7	17.6	17.6	17.5	0.2	21.5
83	17.2	17.1	16.9	16.7	0.5	20.5
85	16.3	16.2	15.9	15.7	0.6	18.5
			Class III			
10	16.5	16.3	15.4	15.2	1.3	18.6
11	16.5	16.1	15.6	15.3	1.2	18.9
13	18.0	17.7	17.6	17.4	0.6	15.6
14	16.3	15.9	15.4	15.2	1.1	16.8
15	16.8	16.6	16.2	16.0	0.8	16.6
16	18.3	17.4	16.7	16.5	1.8	15.6
39	17.9	17.7	17.5	17.3	0.6	15.0
43	16.0	15.9	15.6	15.4	0.6	14.7
52	16.7	16.4	16.1	16.0	0.7	15.5
53	16.5	16.3	15.8	15.7	0.8	15.0
56	16.7	16.5	16.3	16.1	0.6	16.5
62	16.2	16.0	15.5	15.3	0.9	16.0
63	17.0	16.8	16.3	16.1	0.9	15.5
75	17.3	17.1	16.9	16.8	0.5	16.5
84	16.2	16.1	15.8	15.6	0.6	18.0
86	16.7	16.6	16.4	16.2	0.5	15.5
89	17.8	17.7	17.6	17.5	0.3	16.0
90	16.1	16.0	15.6	15.4	0.7	13.5
91	18.0	18.0	18.0	17.8	0.2	13.5
			Class IV			
17	17.0	16.6	16.7	16.4	0.6	11.5
18	16.5	16.3	15.6	15.3	1.2	10.8
19	16.3	15.9	15.6	15.4	0.9	11.2
20	17.8	17.5	16.6	16.4	1.4	12.6
21	17.0	16.8	15.9	15.6	1.4	10.9
22	17.0	16.6	15.5	15.3	1.7	10.5
24	16.3	15.9	15.0	14.8	1.5	12.2

Table IV (Cont'd)

Ham Weights and Total Shrinkage by Classes

Class IV

Ham No.	Ham Weights (lbs.) Initial	Before Cure	Smoked	Final	Lbs. Shrinkage	Quality Score
41	17.6	17.4	17.7	17.6	0.0	12.3
42	16.3	16.1	15.3	15.2	1.1	9.7
44	17.0	16.8	16.6	16.4	0.6	11.3
45	16.5	16.4	15.2	15.0	1.5	9.3
46	16.5	16.4	16.2	16.0	0.5	10.3
47	16.6	16.5	16.0	15.7	0.9	12.0
48	16.1	15.9	16.0	15.8	0.3	9.4
49	16.7	16.4	15.8	15.6	1.1	8.7
59	17.0	16.9	16.6	16.4	0.6	11.5
69	16.9	16.6	15.9	15.7	1.2	13.0
87	17.4	17.3	17.2	17.0	0.4	12.5
88	17.2	17.1	17.0	16.7	0.5	12.5
92	16.7	16.7	16.5	16.1	0.5	12.0
93	17.2	17.1	16.7	16.4	0.8	11.0
94	17.6	17.5	17.3	17.0	0.6	9.0
95	17.1	17.0	17.0	16.7	0.4	10.5
96	17.5	17.4	17.2	16.9	0.6	12.5
99	18.1	17.8	17.1	16.7	1.4	12.0
100	15.3	15.2	15.0	14.6	0.7	9.0
		Class V				
23	15.0	14.6	13.7	13.4	1.6	8.0
25	16.8	16.5	15.8	15.5	1.3	8.0
40	17.6	17.4	17.2	17.0	0.6	8.4
50	16.4	16.2	15.6	15.4	1.0	8.0
58	18.0	17.8	17.5	17.3	0.7	8.4
66	17.4	17.2	16.6	16.4	1.0	8.0
98	17.9	17.3	16.7	16.3	1.6	6.5
97	17.6	17.4	17.1	16.8	0.8	7.5

Table V

Analysis of Ham Samples

Sample No.	Moisture	Fat	Ash	Protein*
	Per cent	Per cent	Per cent	Per cent
4	72.94	4.01	1.47	21.58
8	68.36	2.86	1.35	27.43
10	73.19	3.24	1.46	22.11
14	74.18	4.09	1.46	20.27
17	75.04	1.59	1.24	22.13
22	72.73	3.18	1.42	22.67
24	75.17	2.15	1.45	21.23
28	77.47	2.98	1.28	18.27
33	74.13	3.67	1.42	20.78
34	74.76	3.56	1.46	20.22
38	72.66	2.25	1.36	23.73
40	70.71	1.86	1.30	26.13
41	75.06	2.10	1.26	21.58
42	75.02	1.81	1.39	21.78
46	75.12	1.85	1.39	21.64
51	75.23	1.81	1.25	21.71
52	73.06	2.25	1.65	23.04
56	68.07	2.08	1.13	28.72
59	74.60	2.13	1.28	21.99
65	75.29	2.36	1.25	21.10
71	75.17	2.03	1.20	21.60
72	74.81	2.94	1.28	20.97
77	70.97	6.00	1.62	21.41
88	74.40	2.40	1.36	21.84
99	75.04	2.15	1.36	21.45

* By difference

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