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TEXAS AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 226 APRIL, 1918

DIVISION OF ANIMAL HUSBANDRY

COOPERATIVE SOFT PORK INVESTIGATIONS

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BULLETIN NO. 226. APRIL, 1918.

COOPERATIVE SOFT PORK INVESTIGATIONS.

PART 1.—A METHOD FOR THE TESTING OF PORK ON THE BASIS OF FIRMNESS.

P. V. Ewing, Roy M. Green, and L. B. Burk.

PART 2.—A TENTATIVE STANDARD FOR THE TESTING OF PORK ON THE BASIS OF FIRMNESS.

P. V. Ewing, L. B. Burk, and Roy M. Green.

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P. V. Ewing, Dr. L. H. Wright, and L. B. Burk.

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PART 1.—A METHOD FOR THE TESTING OF PORK ON THE BASIS OF FIRMNESS

P. V. Ewing, *Roy M. Green, and L. B. Burk

With the increase in the number and importance of soft and oily hogs, it is very desirable that means be devised for the accurate measurement of firmness. This is not only desirable from an investigational standpoint, but, since the market price to be paid for guaranteed hogs is based on the extent they will firm up on chilling, it becomes doubly important that means be provided for accurately measuring the lines of demarcation between the different market grades of meat, on the basis of firmness.

Realizing the importance of this question, the Texas Agricultural Experiment Station has been conducting some investigations and has adopted a method for the testing of pork on the basis of firmness. In principle, this test is similar to the hand test commonly used in the packing house, where the balls of one or more fingers are pressed into the fat meat along the median line and an impression of the degree of firmness is obtained. By the laboratory methods herein described, a figure is obtained expressing the firmness of the sample being tested.

The method consists in the employment of a modification of the Vicat apparatus (utilized in determining the consistency of Portland cement paste), in which use is made of a 300-gram weight on a 1-centimeter right cylindrical plunger. In addition, a multiplier dial, similar to that found on the Dow penetrometer, is used in order to measure accurately the indentation to one-tenth of a millimeter. An illustration of the apparatus used and of the method of making the test is herewith shown.

Indications point to the fact that fresh pork does not undergo rapid changes in consistency at ordinary temperatures. This is no doubt due to the fact that it is made up mostly of lard, which is chemically quite stable under normal conditions, and which does not offer conditions for the rapid growth of bacteria. Nevertheless, owing to the presence of other materials, it will be necessary to preserve all samples for testing at ordinary refrigerator temperature (0°—5° C.)

One of the other substances present in fresh pork fat is moisture, which ranges from 5.5 to 10.5 per cent. in the back fat. When fat is exposed to the air the moisture near the surface dries out rapidly, causing the connective tissue to form a paper-like covering over the sample, which interferes with the test. This must be obviated and can be best controlled by the prevention of evaporation, or by the presentation of a fresh surface for testing.

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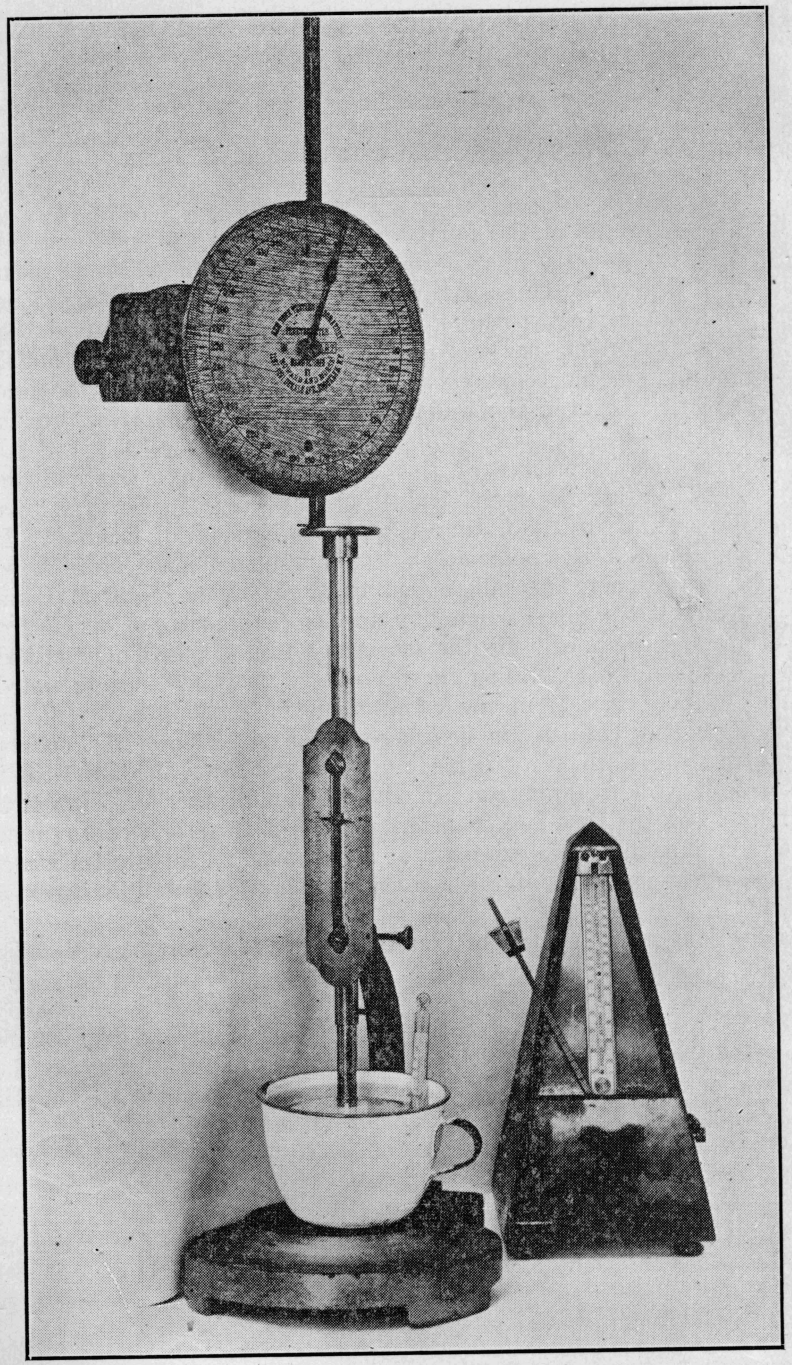

Fig. 1—Apparatus used in making firmness tests on pork.

Another factor to be considered in the testing of meat is the retention of the natural position of the connective tissue. This is very easily disturbed in soft meat and fat handled at higher temperatures, and necessitates the preparation of the sample at as low a temperture as possible.

In order to obtain concordant results it is quite evident that a uniform method of preparation of the sample will have to be adopted. For making the test about one pound from the ham end of the back fat is required. This is placed in a three-ounce cylindrical tin dish, 6 centimeters in diameter with vertical sides approximately 4.5 centimeters in height, so that the pressure is applied perpendicularly to the median line cut. The tests are made on the inner stratum of the back fat and not on the skin stratum, which contains more connective tissue and shows a firmer test. The pieces are placed on edge in the center of the can and packed with sized pieces so as to fill all air spaces as far as possible. To fill completely these spaces, cool but melted lard from the sample is poured in the voids, after which the sample is placed in the refrigerator until ready for testing.

The temperature for testing is zero centigrade. The sample is kept on ice up to the time of testing, when it is placed at a temperature of from one to five degrees below zero for at least two hours, by immersion in a brine solution with crushed ice. It is then kept at zero for an hour prior to testing. During the test the samples are kept in a cup of brine at zero centigrade, the brine just covering the surface of the meat.

Before making the test the needle is thoroughly chilled in the brine solution. The end of the needle is then brought in contact with the surface of the fat and a reading of the instrument taken. The plunger is then released, and allowed to rest upon the surface of the meat for five seconds, when it is again set, and another reading taken. The difference between the two readings is a measure of the degree of firmness. This difference is expressed as points, each point representing an indentation of one-tenth of a millimeter. It is best to measure the duration of time with a metronome, but a watch may be used if preferred.

PART 2.—A TENTATIVE STANDARD FOR TESTING PORK ON THE BASIS OF FIRMNESS.

P. V. EWING, L. B. BURK, AND ROY M. GREEN.

Until quite recently no efforts had been made to measure accurately the firmness of fresh pork and to establish fixed standards of classification upon that basis. While the great variation in firmness of pork after chilling has caused a difference in the price paid for various hogs,

the classification or grading has heretofore been based upon an unfixed arbitrary line which has allowed too much exercise of personal judgment. The method of grading used has depended on feeling the carcass with the fingers. This hand method of grading by sense of touch has never been entirely satisfactory, the principal trouble being that the grading line cannot be definitely fixed and, consequently, two men will seldom grade to the same line.

Most differences of opinion in regard to the grading line have been between the pork producer and the pork packer, for the price of guaranteed hogs has largely depended upon the location of this line. Although it has been agreed by some that it is proper to "dock" soft hogs, the line below which hogs should be docked has not definitely been fixed. For the sake of harmony, efforts have been made to have representatives of the producers and packers agree on a line for grading.

While all Southern markets are troubled to a greater or less extent with soft pork, it is probable that no other of equal importance has been so deeply concerned as the Fort Worth market. As a result, the first substantial progress toward fixing a standard for grading soft hogs was made at this market. After at least one other similar attempt to establish a grading line, a committee representing the Texas Swine Breeders' Association, commission men and representatives of the two principal pork packers (Armour & Co. and Swift & Co.) of that market met in Fort Worth January 28, 1918, and agreed to a line for grading pork on the basis of firmness. The tests to establish this line were made by a representative of the Texas Agricultural Experiment Station, inasmuch as this institution was interested in the investigation from a scientific standpoint. This report covers the results of tests made to establish this line. The methods of measurement are described in Part 1 of this bulletin.

The samples which were tested were selected after 72 hours of chilling in the case of the first five samples and 48 hours in the case of the remainder. They were selected from the coolers of Armour & Co. and Swift & Co. after being graded by their cooler experts, approved by the committee representing the Texas Swine Breeders' Association in the case of the first five samples, and in every case passed on by the Federal inspectors engaged in grading the soft and oily hogs purchased under guarantee to kill firm. The samples were collected on January 28 (5), 29 (9), 30 (16), and 31 (7), 1918, twenty-one samples coming from Swift & Co., and sixteen from Armour & Co. coolers. Efforts were made to select samples as near as possible to the agreed grading line. Although the samples had previously been hand-graded, the laboratory tests showed that some hogs that had been classed as soft were actually hard, and *vice versa*. All testing was done in a laboratory at the stock yards, immediately after the samples were selected. Therefore, there was no chance for deterioration of the pork before testing.

The following table shows: the numbers of samples; the origin ("A"

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from Armour & Co. coolers, and "S" from Swift & Co. coolers); the designation, whether above line (hard) or below line (soft); and the average tests at 0° C. and 20° C.

Table 1.—Firmness tests with modified vicat apparatus to establish grading line between hard and soft pork. (Conducted by P. V. Ewing.)

Number.	Origin.	Destination.	Tests at 0° C.	Tests at 20° C.
1	S	Oily	38	77
2	S	Soft	30	104
3	S	Soft	10	90
4	S	Hard	4	43
5	S	Hard	4	43
6	S	Soft	7	103
7	S	Soft	7	62
8	S	Soft	11	69
9	S	Hard	15	65
10	S	Hard	12	39
11	S	Hard	4	50
12	S	Hard	16	104
13	S	Hard	4	73
14	S	Hard	4	35
15	A	Soft	11	93
16	A	Hard	7	67
17	A	Hard	5	81
18	A	Soft	15	121
19	A	Soft	23	110
20	A	Hard	4	34
21	A	Soft	28	92
22	A	Soft	48	98
23	A	Hard	5	48
24	A	Hard	5	41
25	A	Hard	3	50
26	A	Hard	9	64
27	A	Soft	3*	69
28	A	Hard	3	37
29	A	Soft	20	108
30	A	Soft	30	66
31	S	Hard	50*	90
32	S	Hard	7	24
33	S	Hard	12	46
34	S	Soft	25	51
35	S	Soft	21	38
36	S	Soft	43	101
37	S	Soft	31	62

*Disregarded.

In this table it is noted that the firmness is expressed in numerals, which may be considered as points. The lower the number of points, the firmer the meat; the higher the number of points, the softer the meat. These figures, or points, represent the number of tenths of millimeters a 300-gram weight on a 1-centimeter plunger will sink into a sample of meat in five seconds, when the sample is prepared and tested according to certain specifications.

In establishing the grading line, it is quite apparent that merely an average of these figures would not be adequate, since a number of the soft samples were evidently far from the line. Also, it is quite apparent that all these determinations should not be used, for it is certain that some error was made in the selection of sample 27, which was called "soft" and which proved quite hard, and of sample 31, which was called "hard" and proved quite soft. The results obtained from testing these two samples have been disregarded in the establishment of the line. The other average firmness figures were then plotted as seen in fig. 2, with the designation of the samples indicated. From

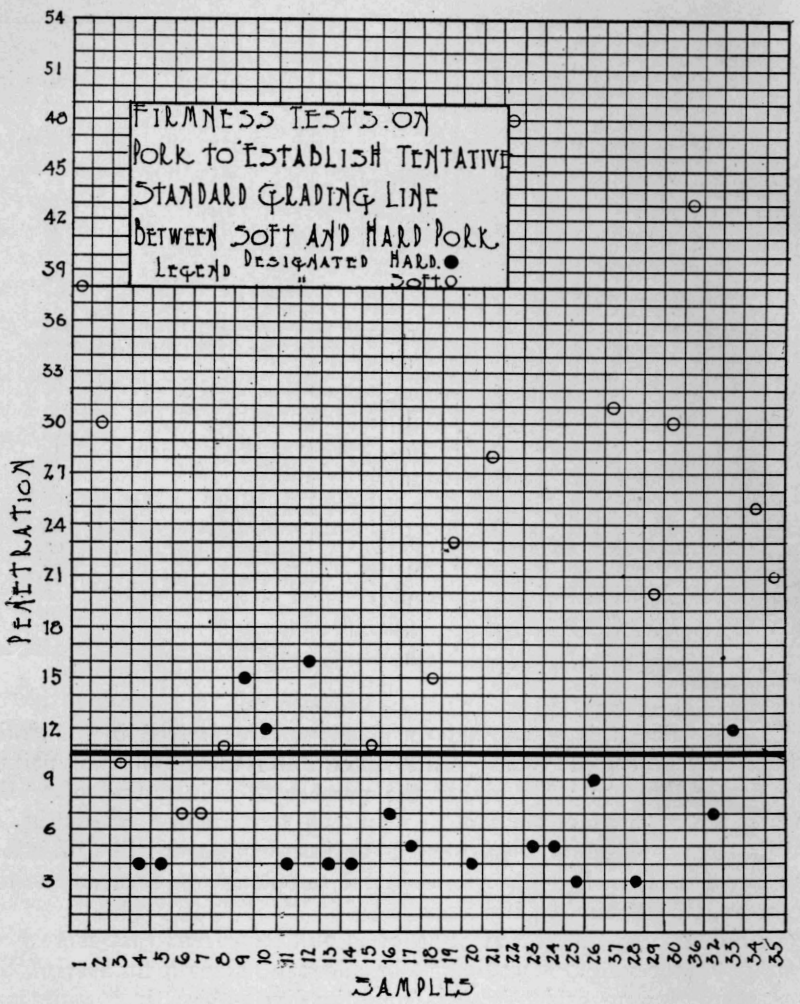

Fig. 2—Tentative standard grading line between hard and soft pork.

the results obtained it is seen that some of the samples selected as soft were actually hard and some hard samples were actually soft, although in every case they were only slightly over the line.

The line was established as that line which would give approximately the same number of errors of soft and hard samples. After several trials (see fig. 2) it was found that the exact location of this line should be between 10 and 11. When located at a point between 10 and 11 the errors stand four hard and three soft, which is about as close as can be expected with the number of samples used. This means that a sample testing up to 11 would be called hard, according to the agreed-on basis, while that testing 11 or over would go as soft. This tentative standard is obtained with relatively few samples. Also, we should know more of how the samples called hard will cure out and smoke out. It is quite probable that with the accumulation of additional information it may be advisable to shift this line one way or the other and it should, therefore, be accepted as a tentative standard only.

It will be noted that the tests made at 20° C. were not used in establishing a grading line. The reasons for disregarding the tests at this temperature being first, the fact that grading is usually done at 0° C. or 32° F., approximate cooler temperature; and, second, that a careful study of the results secured from the testing at 20° C. showed this temperature to be unreliable for testing, since the samples showed no apparent relationship to designation.

As a tentative standard, subject to revision, we may therefore consider that any pork testing under 11 at 0° C. can be considered as "hard," while that testing 11 or above is "soft."

It is of significance that the application of this standard to a lot of fifty-five experimentally fed hogs, which had previously been hand-graded, showed a variation from the hand-grading in only one instance.

PART 3.—ANTEMORTEM GRADING OF PORK ON BASIS OF FIRMNESS.

P. V. EWING AND L. B. BURK.

Since the soft and oily hog proposition has assumed its present importance, there has been a great demand for a practical antemortem method of distinguishing oily hogs from those that will chill firm. From the work that has been done at the Texas Agricultural Experiment Station we know it is possible to determine fairly accurately how the hog will kill out by the extraction of a small amount of adipose tissue from the back, from the lard of which the melting point can

be ascertained. While this has importance from an experimental standpoint, it is not practical or of any value in the marketing of hogs.

From time to time men familiar with the value that would come from a workable method of determining hard and soft hogs have come forward with claims of ability along this line which they have not been able to substantiate. Some persons have claimed to be able to make the distinction by the appearance of the hog on foot, but all have failed to demonstrate their ability. Others have endeavored to associate with softness certain carcass characteristics, such as what is familiarly known as "brown ribs" in the packing house. Others have pro-

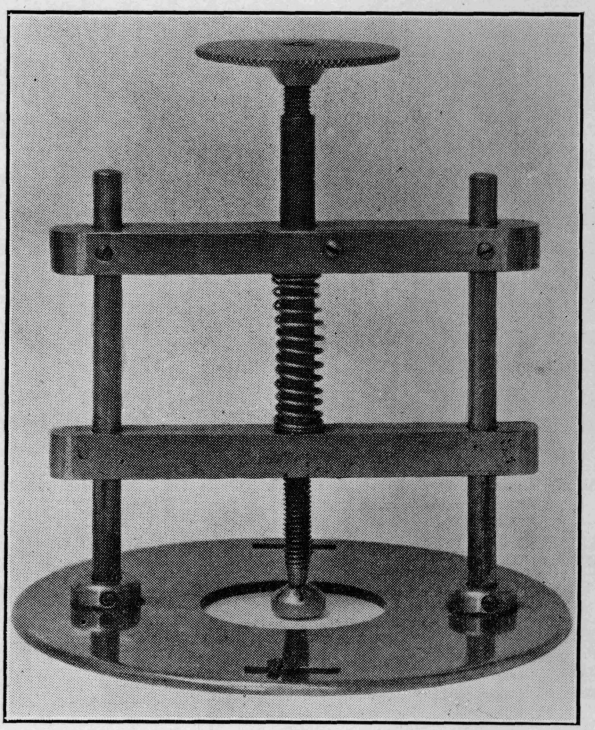

Fig. 3—Apparatus for measuring firmness of bodies of live hogs.

posed a similar coloration of other cartilaginous bony structures, but this test, given trial, has failed to demonstrate any association of these characters with softness.

Realizing the value of a method for the antemortem determination of the kind of a carcass the hog would kill, the Texas Agricultural Experiment Station concerned itself with the problem. After a careful review of the situation it was evident that there was no apparent difference between soft and hard hogs on foot. If there was any difference visible to the eye, it would have been noted long ago on the hog markets where soft hogs play such an important rôle. While it

was realized that a fat extraction operation and melting point determination was not practical, it was considered worthy of a trial, to ascertain whether any correlation existed between the firmness of the body of the live hog and the kind of pork it would kill out. Accordingly, a machine for the purpose was constructed, as shown in the illustration. This machine had a plunger on a spring with a 1.5 centimeter rounded, loose end, centering in a two-inch opening of the base plate. The pressure exerted on application of the machine was variable and in reverse ratio to the penetration. The machine was set at a maximum penetration of 3 centimeters at zero pressure and with 3 kilograms pressure at zero penetration.

During November and December of 1917 this machine was applied experimentally to sixty-four hogs whose condition as to probable firmness on killing and cooling had been determined by fat extractions. The tests were made on a clipped six-inch circular area centering three inches off median line and three inches back of last rib on the right side. The tests ranged all the way from 2 to 9 millimeters in penetration, with from 2.8 kilograms down to 2.1 kilograms pressure.

After a thorough trial these firmness tests on the live hog were discontinued, for not only could no correlation between the firmness of the body of the hog and the way he killed out be detected, but the variation on individual and separate hogs was so great as to preclude possibilities of valuable results being obtained.

There were several reasons for the failure of this method to give positive results. Both the firmness tests and the operations performed in making fat extractions showed a marked variation in the character of the hide of different hogs, even when the hogs had been bred, fed and managed alike. Some had harsh, leathery hides, while the skins of others were soft. Of course, the penetration was less and the pressure greater with the leathery hides. The hogs with looser hides showed a greater penetration and a correspondingly less pressure. The degree of condition was another variable factor which worked both ways. The hogs with the better condition showed softer, except in those cases where the skin was stretched tightly, when a correspondingly greater pressure and a less penetration were recorded.

The position in which the hog stands is an important factor. He may stand with his back arched and hard or with it drooped and soft. The muscular tension affects the reading. Also, a great variation was noticed in the readings with only slight changes in location of the exact spot of testing, which was due to the proximity of the skeletal structure.

In short, from the work that has been done, it seems that there is no detectible correlation between the firmness of the live hog and the firmness of the carcass he will produce.

While on the surface it appears as though there may be a possibility of correlation between the firmness of bodies of hogs and the way in which they kill out, there seems to be no good reason why such should be the case. Difference in firmness does not show up on slaughtered

hogs until after chilling. Also, fat that the hog carries on his back has a low melting point and is in reality in a liquid condition, although each droplet is contained within the fat cell wall which gives shape to the tissue. Since for all usual purposes one melted lard is just as liquid as another, regardless of melting points, there is no good reason why the back or any part of the body of a hog that will kill firm should be any harder than one that will kill soft.

In another experiment conducted to ascertain from the antemortem characteristics how the hog will chill on slaughter, temperatures were used as a basis. It had been known for many years that the temperatures of hogs varied greatly, with normal temperatures ranging from 101° to 105° F. No cause has been assigned for this variation. Since the possibility of a relationship between the temperature of the hog and the way he chills out exists, an experiment was run to see if this relationship obtained. While the tests made were extensive, the following is characteristic of the results that have been secured. In this test, sixteen hogs were used. The probable way they would chill out was not only known from the feeding, but fat samples had been extracted from half of the hogs and they were killed shortly after the temperatures were taken. The average temperatures derived were as follows:

Table 2.—Ante mortem temperature tests.

Lot 2. Corn (6) and C. S. M. (1) 80 days. (All hard)		Lot 3. Peanuts alone 80 days. (All soft)	
Number.	Temperature.	Number.	Temperature.
20	103.2	67	104.7
71	101.8	52	102.5
43	101.5	61	101.6
69	103.5	58	101.9
16	102.7	19	102.5
2	102.1	54	102.5
45	103.8	44	102.2
39	102.2	1	102.8
Average	102.6	Average	102.6

From these results it is quite evident that no relationship exists between the antemortem temperature of the hog and how it firms on chilling. Thus, all things considered from the knowledge we have at present, it appears as though a practical antemortem method of determination of soft hogs is out of the question.

PART 4.—METHOD OF EXTRACTING FAT SAMPLES FROM LIVE HOGS.

P. V. EWING, *DR. L. H. WRIGHT, AND L. B. BURK.

In the course of an investigation on soft pork being conducted by the Texas Agricultural Experiment Station, a method of periodically extracting small samples of fat from the live hogs was developed. These fat extractions were made in order to follow through the feeding periods the changes in quality of pork being produced by the feeding. Correlation studies between the softening point of fat and the firmness of pork made it possible, with one known, to interpolate the other within a small degree of accuracy.

This method of procedure enables one to determine at any time during the feeding period the probable quality of pork that would be produced on slaughter. This permits statements as to what length of feeding is necessary in order to produce a certain degree of hardness or softness of pork. In work of this sort, it has been customary to take hogs from several lots and make slaughter tests at stated periods through the experiment. While this has advantages, it does not take into fullest account the factor of individuality. After a hog is slaughtered his experimental value from a feeding standpoint becomes a thing of the past.

The selection of a method for making fat extractions was not a case of selecting methods and instruments, for none were at that time in use. It was a question of selecting the most likely and applicable method. The method to be chosen depended somewhat on the size of sample adipose tissue required. It was found that by taking a series of fifteen variously sized samples from a slaughtered hog ranging from .05 of a gram to 5 grams, that the .05 gram sample was amply large and that, while a smaller sample could be used, better results could be had from the use of a slightly larger sample. This meant that a very small sample would be adequate and that a method yielding the small sample would be sufficient, if satisfactory otherwise.

The two general plans considered for employment were:

A. The making of a lunar-shaped incision and drawing back the skin and removing the sample, and either suturing the flap back in place or allowing it to heal free.

B. Using a trocar, and extracting the fat through the canula. See fig. 4-1.)

Since the first of these methods is more severe than the other it was deemed best to try the second method first, because it was necessary to have a method that would not interfere with the results of the feed-

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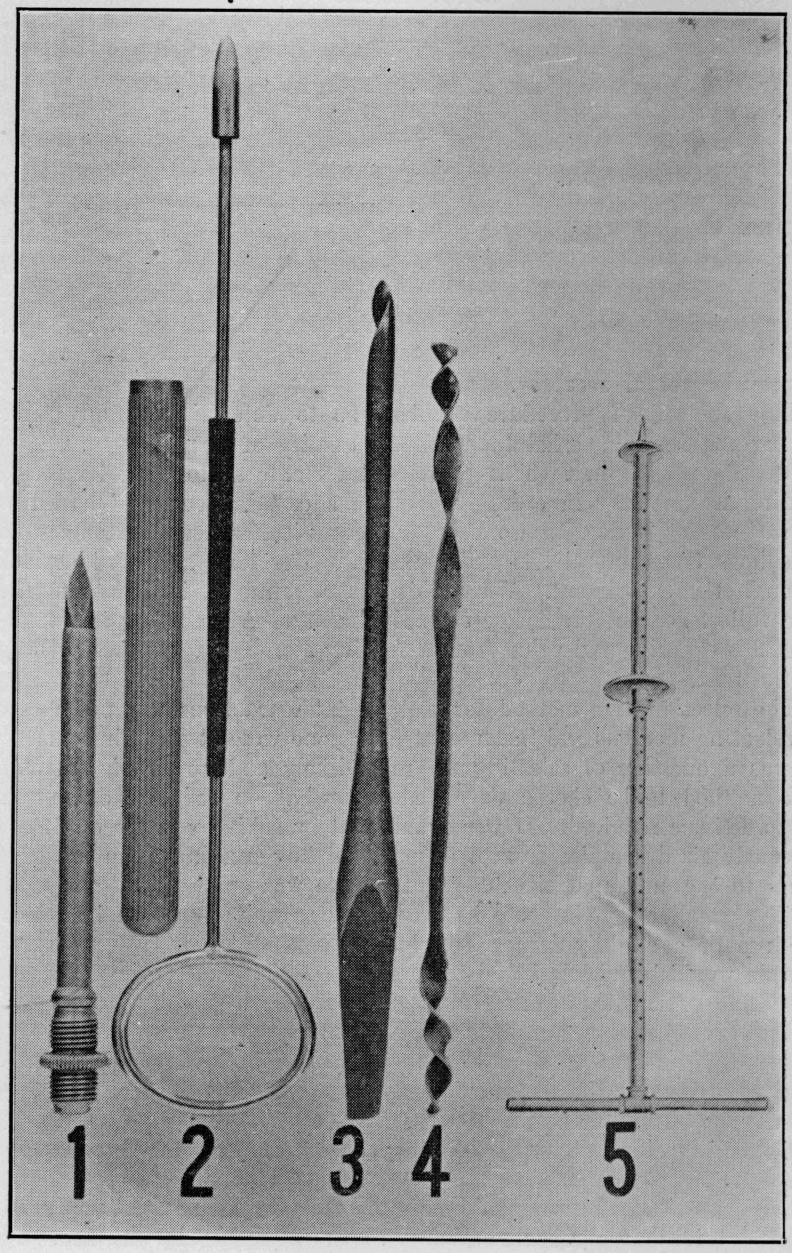

Fig. 4—Instruments for extracting fat samples from live hogs.

ing tests. In making use of the trocar method, the question then became one of extracting the sample through the canula after insertion. There were two possible methods of doing this, as follows:

A. To disturb the tissue structure sufficiently so that it could be aspirated.

B. To extract the fat with a specially made stilet which might take one of the several following forms:

1. Bell-shaped, after fashion of a teat tumor extractor. (Fig. 4-2.)
2. Augur-shaped with spiral elevator. (Fig. 4-3.)
3. Split disk on end of rod after manner of some augur post hole diggers. (Fig. 4-5.)

A No. 15 trocar was agreed upon as probably the most satisfactory. Method "A" of extracting the fat through the canula by agitation, fol-

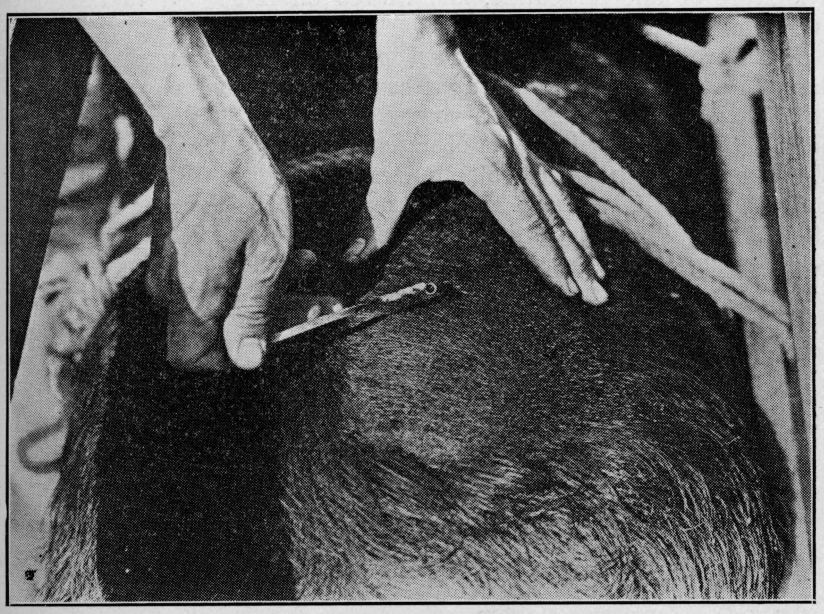

Fig. 5—The operation of removing fat from hog's back.

lowed by aspiration, was painful to the hog and no fat was secured by the method. Under "B" method, No. 1 was tried out, with very poor and unsatisfactory results. Practically no fat could be extracted by this method. Method No. 2 was then tried with a single-groove wood bit, made more or less blunt. The fat was actually bored out, but the single groove and shape of the bit shown as seen from the cut (fig.4-3) did not permit of most efficient results, since not only were several borings necessary, which required time, but the chances of infection were multiplied. The style of borer was then changed to that in fig. 4-4, which consisted of a twisted clock spring fitting inside

the canula, sharpened on the end like a bit. This method of extraction proved entirely satisfactory.

The operation itself is very simple. The hog to be operated on is tied down in a specially constructed crate. The operating area, located on the loin, is six inches in diameter and centered three inches to the right of center line and three inches back of last rib. This area is first clipped and then washed with brush, soap, and hot water. Iodine is then applied to the area and the sterilized trocar is inserted and the sample removed in as aseptic a manner as practical. The operation is shown in the photograph.

After the sample is taken, the canula is withdrawn and in some instances the temperature of area is taken one-half inch below the surface of the skin. The wound is then poured full of a five per cent. iodine in alcohol solution and sealed over with collodion, after which a mixture of tar, turpentine, and linseed oil is applied to keep flies away and aid in healing.

While over one hundred of these operations have been performed to date, no cases of serious infections have occurred and pigs slaughtered after having been operated on showed only a slight discoloration and no infection as a result of the operation. Most of these operations are bloodless and the extracted fats are clear and white. The blood vessels encountered are in the skin or near the skin. The pain from the operation is not severe and but few hogs ever squeal. All will get up and go to eating at once after the operation, as though nothing had happened. For our purpose this method is adequate and satisfactory.