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Measurement of Back Fat Thickness on Pork Carcasses

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At the beginning of this century it was realized in Denmark that the meat producing value of a pig must be judged by actual measurements of the dressed carcass. This carcass judging originated with the setting up of the first pig progeny testing station (1907), when it was assumed that the true value of the parent animal could only be estimated by the slaughter and examination of its progeny, and that external conformation was relatively unimportant compared with the main issue - the production of a prime side of bacon. The following carcass measurements were made:

1) Length (from neck cut to the round end of femur)

2) Thickness of streak of lean (the average of the three measurements opposite the centre of the ribs, opposite the last rib and in the flank)

3) Thickness of back fat (the average of one measurement at the thickest point over the shoulder (a), one at the thinnest point in the centre of the back (b), and three over the lumbar - sacral area (c, d, e)). In most countries this method of back fat measurements is now used and the average back fat thickness is computed as:

$$m = \frac{a + b + \frac{c + d + e}{3}}{3}$$

These problems of progeny testing and carcass evaluation of pigs have been dealt with by many research workers, among whom can be mentioned Davidson (1948), Clausen (1958), and Harrington (1958).

During recent years it has been found that the thickness of the fat in the mid-line of the animal does not always adequately indicate the amount of fat over the eye muscle and along the side of the pig. This fact is illustrated in figure 1, which shows a cut across the level of the last rib. The back

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fat thickness in the mid-line is seen to be x and the thickness 7-8 cm from the mid-line is indicated by y. The y thickness is nearly always a few mm greater than x, but in some carcasses, from one of which the cut shown is taken, this tendency is so excessive, that it declassifies the whole carcass. The trouble is that this unsatisfactory composition is not found by normal grading of the carcass. For this reason rather extensive efforts have been spent on developing instruments and methods for measuring fat thickness in such places as shown in the figure by y which is not accessible without cutting up the carcass.

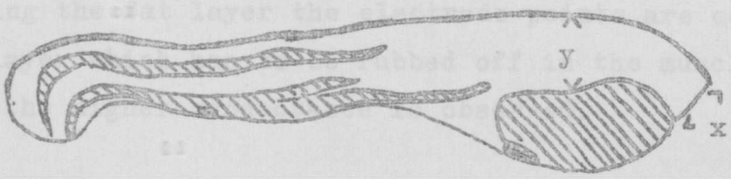

Fig. 1

A number of different measuring methods for fat thickness which have been considered in our experiments should be mentioned.

1) An electrical measuring device based on the difference in electric conductivity of muscular tissue and fat.

2) An ultra-sonic method based on the ability of the interface between fat and muscular tissue to reflect ultra-sonic waves.

3) A chemical method based on the fact that muscle tissue has a well-defined measureable pH-value not found in fat.

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4) A mechanical method which utilizes the difference in mechanical resistance of the fat tissue and the muscle membrane or muscle fibres.

5) An optical method by which an endoscope-like probe is inserted, making it possible to see the layer of separation between fat and muscular tissue.

Electrical Method. In the experiments using the electrical method, different probes with built-in electrodes have been tried. By connecting the electrodes to a suitable measuring instrument, the conductivity of the tissue surrounding the probe could be measured. The probe could then be pushed slowly through the tissue and the conductance increase when the electrode points pass from the fat to the muscle tissue could be observed. The fat thickness can then be read on a scale ingraved at the probe.

This would seem to be an easy and reliable method, but in practice we have found it difficult to get a clear cut shift when the electrodes pass from fat to lean. A more or less continuous change of the conductance is observed while pushing the probe through from fat to lean. The reason for this might be that in passing the fat layer the electrode points are covered with a thin insulating fat layer which has to be rubbed off in the muscle tissue before a full shift to the higher conductance is observed.

Ultra-sonic Method. Dumont (1957) described how this method may be applied to the measurement of back fat thickness of pigs. It was found that ultra-sonic sound waves at a pre-determined frequency of between 1 and 5 million cycles per second (Mc/s) are transmitted through the tissue of a living pig or the slaughtered animal and that the boundary between the fat and the lean tissues will reflect the waves. The technique of measuring is the following: An ultra-sonic chrystal transmitter and receiver probe is placed on the rind surface of the carcass. The time taken for the transmitted wave to travel from surface to fat-lean boundary and back to surface and receiver chrystal depends upon the velocity of sound in the fat and the thickness of the fat. On a cathode ray tube in the circuit it is possible to measure the time taken for the signal to reach the lean boundary and this value is proportional to the depth of fat provided that the velocity of sound in the fat is the same in all the measured

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objects. This may not always be the case as variations in temperature, chemical composition, and water content of the fat tissue must be taken into consideration (Claus, 1957). In our experiments with this method we had other difficulties. We found it difficult to get the sound waves to penetrate the rind. This is probably caused by the singeing treatment given the carcasses in the Danish bacon factories. The method has proved to be more successful for measurements on live pigs, which are not dealt with here.

Chemical Method. The pH value of the muscle tissue in a pig carcass one hour after the animal is slaughtered is in the range of 5.3 - 6.8. This means that a probe impregnated with the proper indicator solution would show a color change when placed in contact with the muscle tissue. One way of using this principle is as follows. The indicator Brom Cresol Green has a pH range 3.8 - 5.4; it is orange below that range and green at pH-values above that range. A solution of the indicator is prepared and the acidity adjusted until the color is orange (pH below 3.8). Wooden sticks, 2 mm in diameter and about 12 cm in length, are moistened with the solution and allowed to dry. The sticks are placed in the carcass where measurements are to be made. By leaving them there for ½ - 3 minutes according to the temperature of the carcass, that part of the stick in contact with muscle tissue turns green. A mark is made on the stick at the point where it passes the rind. When the stick is removed, the fat and meat thickness can be measured on it. To avoid contamination of the stick with fat while it enters the carcass from the rind side, and to facilitate pushing it through, it can be placed in a cannula-like probe which is removed immediately, leaving the stick in position. The method might be too slow and cumbersome for routine grading of carcasses, but it has the advantage of being able to measure interior meat thickness, for example the thickness of loin eye.

Mechanical Method. When pushing a probe through the back fat of a carcass, resistance is felt when the probe reaches the meat membrane and muscle tissue. The resistance is distinctly felt when the probe is shaped like a flat steel pin about 10 mm wide and 2 mm thick and of a suitable length. The edge should not be sharpened but pointed to a thickness of about 1 - ½ mm. To facilitate the penetrating of the probe through the rind, one of the edge corners is

sharpened so that a small cut can be made in the rind. When pushing the probe through the fat, the edge of it should be at a right angle to the muscle fibres to give the maximum resistance when hitting them. A scale in mm or marks is engraved on the pin for the maximum thickness of fat allowed for the different grades at the place measured. This method is quick and simple but obviously there is a danger of false measurements caused by the subjectivity in feeling the resistance. A membrane in the fat layer may exceed some resistance or the probe may be pushed through the muscle surface. However, in the hand of a skilled operator, this method may work with a rather high degree of accuracy. The deviation between the numerical values found by the probe measurement and those found by direct measurement on the sides cut up are within 2 mm.

Optical Method. By means of a probe having an optical system it is possible to see the fat-lean borderline. An embodiment of an instrument for this purpose has a tubular probe which can be pushed into the tissue at the point where the fat thickness should be measured. The probe has a cutting front and behind this a small window. Through this window, light is flashed on the tissue from a small lamp inside the probe, and a system of mirrors transmits the view through the window to the outside of the carcass for inspection. The fat thickness can then be measured in the following way. While the probe is pushed into the carcass, the tissue passing in front of the window can be inspected from the outside. When the borderline between fat and muscle tissue is seen, the probe is placed so that a measuring line on the window coincides with the layer of separation; the fat thickness, which is the distance between the line of measuring and the surface of the carcass, can then be measured. The thickness can be read either at a scale engraved on the surface of the probe or better by a sliding feeler, the front of which is made to contact the surface of carcass near where the probe is inserted; the feeler has an indicator pointing on a scale where the thickness can be read. Back fat thickness can be measured with great safety and accuracy by this optical method. The error of the length measured may be within ½ - 1 mm. Patents are being applied for in several countries for this measuring method and instrument, developed at the Danish Meat Research Institute.

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With the aid of the above mentioned mechanical methods and to a lesser extent the optical method considerable experiments on fat thickness in pork carcasses have been made at the Danish Meat Research Institute. One of the findings in these experiments is that the difference between the thickness y in fig. 1, measured by the probes, and the thickness x, measured directly on the cut, can serve as an indication of the meat content of the whole carcass.

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