THE INFLUENCE OF THE KIND AND QUANTITY OF FAT IN THE DIET ON PORK CARCASS QUALITY

J. C. MILLER
OKLAHOMA A. & M. COLLEGE

This subject is one which has received attention at various intervals over a considerable period of time. Early work dealt with the softening effect of peanuts, later the influence of soybeans and soybean oil on the firmness of pork fat were studied and more recently the effects of animal fats. As indicative of the thinking of the times, much of the earlier work dealt mainly with the firmness of the fat produced, whereas, later studies have considered the amount of fat deposited in the carcass as well.

It would appear that the total level of fat in swine rations has been on the decline over the past several years. This is due to the more complete extraction of oil from high protein meals of plant origin as well as from animal by-products used as swine feed. In addition there is evidence indicating that most modern high yielding hybrid corns are lower in both fat and protein than corn was formerly. Milo, which is being grown and used for swine feed in increasing amounts, contains about twenty-five per cent less fat than corn. However, in very recent months fats and oils have accumulated in such quantities and prices have been thus depressed to the point that large quantities of animal fats are now available, at prices permitting their use as animal feed.

Dr. H. R. Kraybill, Director of Research of the American Meat Institute Foundation has recently estimated that surplus animal fats are available for use in feed, to the tune of about 800 million pounds annually. The indications are that these fats can best be used in dog (Siedler and Schweigert, 1952) in broiler (Schweigert, et al., 1952) and in swine feeds. Meat packers, renderers, feed mixers and feeders have recently shown considerable interest in this subject. Thus, the problem of the influence of the kind and quality of fat in swine rations on the quality of the carcasses produced is again a current one. Particularly, since there is a tendency for the fat to become firmer as hogs become older and fatter and our present trend is toward younger hogs with less finish.

Anderson and Mendel (1928) pointed out that fats occurring in the tissues and fluids of a species may actually vary in chemical composition as well as quantity. To what extent fats produced through synthetic procedures from carbohydrate and protein are uniform in character was studied by these workers. When food fat made up 60 per cent of the calories of the diet, the feeding of soybean oil with an iodine number of 132.3 produced body fat in rats with an iodine number of 122.5; corn oil with an iodine number of 124.3 produced fat with an iodine number of 114.2 and peanut oil with an iodine number of 102.4 produced fat with an iodine number of 98.4. When starch provided 60 per cent of the calories the iodine numbers of the body fat ranged from 58 to 63.

After soft body fat had been developed, it was found that it could be hardened by feeding a ration rich in carbohydrate and relatively low in fat. The change from one type of depot fat to another could be brought about most rapidly by depleting the fat reserves prior to the change in diet.
In studying the influence of certain feeds on the characteristics of the fat produced, Ellis and Isbell (1926) found that the iodine number and refractive index values were excellent measures of firmness in pork fat. These workers found iodine for fat in common feeds as follows: Brewer's Rice 100, Corn 126, Soybeans 128, Peanuts 93.7, and Cottonseed Oil 107.4. The refractive index of these fats at 40°C were Brewer's Rice 1.4645, Corn 1.4673, Soybeans 1.4648, Peanuts 1.4625 and Cottonseed 1.4620.

The economic importance of the character of pork fat was pointed out in early work by Hankins and Ellis (1926). These workers point out the principal cause of soft pork was the amount and character of the fats present in the feeds used, with the principal causes of soft pork at that time being the feeding of peanuts. It was pointed out that the firmness of a hog carcass depends to a great extent on the firmness of fat and that soft fats contain a higher amount of unsaturated fatty acids than firm fats. Thus, iodine number, a measure of unsaturation was also a measure of softness.

Hankins and Ellis (1928) later pointed out that the soft pork problem, formerly considered to apply only to the peanut feeding areas, took on greater importance with the increased production of soybeans in the late 1920's. At this time producers, packers and consumers were all concerned with the problem of soft pork from soybean and peanut fed hogs. These workers state, "The soft pork problem is fundamentally a fat problem. When the fat of feeds is stored by the hog there is no essential change in its characteristic with respect to character and firmness. ---There is enough fat in some feeds to account for all of that stored. In such cases the body fat closely resembles the feed fat. With feeds low in fat and high in carbohydrates there is little similarity between the fat consumed by the hog and that found in his body.

When a hog grows and fattens, normally, the rate of fat deposition gradually increases. Thus, while a low-fat feed may contain practically enough fat to fulfill the fat storage requirements of the younger pig, it probably will not contain enough for the older hog, fattening at a more rapid rate. The other nutrients, particularly the carbohydrates, must enter into fat formation to an increasing extent under these conditions. This results in the hog becoming firmer as it acquires weight and finish."

Ellis and Zeller (1930) found that a lack of fat in the ration did not influence the degree of finish on the carcass, for animals on low-fat diets synthesized and stored fat at a normal rate. As the pigs became older the body fat was more saturated and harder.

Shrewsbury and Vestal (1941) fed six lots of pigs on rations ranging from 0.5 to 20 per cent fat. At regular intervals during the course of the experiment animals were slaughtered and fat samples taken and analyzed. Fat samples from animals receiving the 0.5 and 5 per cent fat rations were found to increase in firmness as the experiment progressed, while samples from those on the 10, 15, and 20 per cent rations became softer. In a replication of the previous work, (Shrewsbury and Vestal, 1942), soybean oil was used to raise the fat content of the rations. Differences in rate of gain were not large. The feed required to produce a pound of gain was 3.45, 3.17, 2.91, 2.78, and 2.70 pounds, respectively, for rations containing 0.5, 5, 10, 15, and 20 per cent fat. As the percentage of fat in the ration increased the firmness of fat decreased. The 0.5 per cent fat ration produced uniformly firm carcasses while the 20 per cent fat ration resulted in soft oily carcasses. More than 5
per cent soybean oil in the ration was undesirable from the standpoint of carcass quality. In the work reported in 1943, by these investigators, the depth and length of carcasses was not affected by the fat content of the ration, but the total depth of backfat increased with increasing levels of fat in the ration.

Later Shrewsbury and Vestal (1945) fed rations containing 0.5, to 2.0, 3.5 and 5.0 per cent fat with the additional fat coming from soybean oil. The additional fat did not influence the rate of gain but did reduce the feed required per unit of gain materially. Even these relatively low amounts of soybean oil produced notable softening effects on the fat. The average refractive index of the backfat indicate that 5 per cent soybean oil added to the ration produced softer body fat than the same amount of oil contained naturally in the feed.

Robison at the Ohio Station (1943, 1946) studied the effect of rate of fat deposition on the firmness of fat in swine. Rations containing 2.6, 5.6 and 8.7 per cent fat were fed. Corn oil was used to alter the fat content of the rations. Each ration was fed to two groups of pigs with one being self-fed and the other one restricted in feed intake. In the full-fed group differences in rate of gain among lots were small, but differences in feed efficiency were quite large. In the limited fed group differences in rate of gain as well as economy were significant. The full-fed pigs were as fat at 200 pounds as the limited fed pigs at 250 pounds. At the same degree of finish regardless of weight or length of feeding period there was little difference in the firmness of fat of the full-fed and limited groups. However, in both groups the refractive index became higher as the pigs became heavier and fatter. Increasing the percentage of oil in the ration caused the production of softer fat on the carcass. The rate of fat deposition, degree of fatness at slaughter and weight influenced the firmness of the fat but not to as great an extent as the oil content of the ration.

Hostetler, et al., (1939) in conducting investigations to determine how peanuts could best be used as hog feed and yet not produce soft pork came to the following conclusions: (1) The degree of firmness of a carcass is estimated more accurately by either iodine number or melting point than by refractive index. (2) Adding cottonseed meal to corn rations raised the melting point of the fat produced. (3) A softening period (peanut ration) followed by a hardening ration produced harder carcasses than a single feeding period in which the same total amount of oil and starch was consumed. (4) Brewer's rice produces firmer carcasses than corn in hardening ration because rice is very low in fat, containing only 0.6 per cent fat. (5) In order to feed an appreciable amount of peanuts and still produce firm pork, the peanuts must be fed to relatively small pigs. Usually the animals had eaten the maximum allowable amount of oil by the time they had reached 80 to 95 pounds. At that time it was necessary to change them to a hardening ration. (6) Thirteen to eighteen per cent cottonseed meal was the most effective in the hardening ration. (7) Adding cottonseed meal to the peanut ration was not effective in hardening the carcass. (8) To produce firm carcasses the gain in weight in the hardening period had to about 3.5 times that made in the softening period.

Data collected by Scott (1930) indicated that the percentage of fat in fatty tissue increases with increasing depth of backfat and the percentage of moisture and nitrogen decreases by a corresponding amount. Over the range in backfat thickness from 1.9 to 4.7 centimeters, in 180 day old
hogs, the refractive index decreased from 1.4606 to 1.4597, the per cent of fat in the tissue increased from 91.3 to 94.2 and the per cent moisture decreased from 6.37 to 1.79 in back fat. These data show clearly that the certain characteristics of pork fat are closely related to the total fat in the carcass.

Hughes of the California station (1937) conducted work on the effect of alfalfa pasture on the hardness of pork fat. He found no difference in hardness of fat between lots self-fed on alfalfa pasture as compared to those self-fed in dry lots. In this work it was observed that the Duroc consistently produced a firmer fat than Poland Chinas. The average refractive index for fat from Durocs was 1.4582, and for Polands 1.4590.

In recent work at North Carolina (Blumer, 1953) four lots of six pigs each were started at weaning on rations containing various levels of fat. Three pigs from each lot were killed at 140 pounds and the remaining three at 225 pounds. Lot 1 received the corn-soybean meal basal ration, Lot 2 the basal ration plus 10 per cent peanut oil, Lot 3 the basal ration plus 10 per cent beef fat and Lot 4 the basal plus 5 per cent beef fat and 5 per cent peanut oil.

Measurements on average backfat thickness indicate that the carcasses from all lots receiving additional fat were fatter than those from the hogs fed the basal ration. Fat constants from samples of backfat were not available, thus the influence of the fats added to the ration on the character of the fat produced could not be assessed. However subjective scores on the firmness of the fat indicated the basal ration produced the firmest fat and the ration with ten per cent peanut oil added produced the softest fat.

In our own work (Hillier, 1953) four trials have been conducted in which various quantities of rendered pork or beef fat was added to a corn soybean meal type ration. In the first trial the basal ration contained 1.40 per cent fat. Lard was added to the other rations to give a total of 3.5, 7.7 and 11.5 per cent fat in the other rations. Average daily gains of 1.73, 1.79, 1.85 and 1.90 pounds were obtained from these rations in the order of increasing fat levels on pigs over the period from 35 to 225 pounds. The feed required per pound of gain was 3.7, 3.5, 3.4 and 3.1 for the 1.40, 3.5, 7.7 and 11.5 per cent fat rations respectively. The carcasses from these groups of hogs ranged from 1.9 to 2.1 inches in average backfat thickness, from 43.5 to 46.1 in per cent of fat cuts and from 53.3 to 56.4 in per cent fat by chemical analysis, with the fatter carcasses coming from the hogs fed on the higher level of fat. The average specific gravity values were 1.031 for the group on the low level of fat to 1.021 for those on the highest fat level. These differences were all statistically significant.

In trials 2 and 3 rations containing 1.46 and 11.39 per cent fat were used. In these trials average daily gains of 1.73 were secured on the low fat rations and 1.83 on the high fat rations. Those on the low fat rations consumed 3.5 pounds of feed per pound of gain while those on the high fat rations consumed an average of only 2.8 pounds for each pound of gain. The pigs fed the high fat rations produced carcasses that had 0.2 inches more backfat but did not appear to be much fatter than the carcasses from pigs on the low fat rations when one considers the percentage of fat cuts or specific gravity values.
In trial 4 fat levels of 1.31 and 13.79 were used. In this trial pigs on the low level of fat gained at the rate of 1.76 pounds daily on 4.5 pounds of feed per pound of gain while those on the higher level of fat gained at the rate of 2.13 pounds per day on 3.1 pounds of feed per pound of gain. In this trial the higher fat rations produced significantly fatter carcasses as indicated by every measurement used (backfat thickness vs. 1.9 per cent fat cuts 41.6 vs. 45.2 and specific gravity 1.039 vs. 1.031).

Fat constants were run on samples taken from carcasses produced on trials 2 and 3. In trial 2, where lard was used as the added fat, the iodine number of the backfat samples increased from 51.7 to 62.8 with the increasing level of fat in the ration. At the same time the melting point decreased from 40.6 to 32.5 and the thiocyanogen number increased from 46.3 to 54.8 with the increasing levels of fat in the ration.

In trial 2 in which beef tallow was used as the added fat the iodine number increased from 53.6 for backfat produced on the low level of fat (no beef fat added) to 61.3 when about twelve per cent beef tallow was added, the melting point decreased from 40.0 to 36.3 and the thiocyanogen number increased from 40.9 to 44.8.

Considering the four trials, the addition of each per cent fat to the ration increased the average daily gains by 0.07 pounds and reduced the feed required per pound of gain by about .6 pounds. There was no evidence to indicate that the relationship between the level of fat in the ration and rate or economy of gain was not linear. Each additional per cent of fat in the ration caused the carcasses to measure .02 inches thicker in backfat and to have 0.18 per cent more weight in the fat cuts.

REFERENCES CITED


---

MR. KLINE: We are going to take up the carbohydrate picture next, and W. L. Brown, of North Carolina is going to present the paper.