ABSTRACT

EFFECT OF DIET ON THE FATTY ACID

COMPOSITION OF PORK FAT

By

Duane Elmer Koch

A total of 21 hogs averaging 97 lbs. live weight were placed in three lots. Lot A contained six hogs, which were fed a control ration (corn - SBOM). Lot B contained six hogs, that were fed a 10% safflower oil ration (barley - SBOM). Lot C contained nine hogs and they were fed the same ration as Lot B for 5 weeks, after which they were placed on a 10% tallow ration (barley - SBOM). Three hogs from each of Lots A and B were slaughtered after 5 weeks and three from each were slaughtered after 11 weeks. Three hogs from Lot C were slaughtered at 2, 4, and 6 weeks subsequent to being fed tallow. Each slaughter group contained at least one barrow and one gilt.

Fat samples were collected from the leaf fat, intramuscular fat from the Longissimus dorsi muscle at the 10th rib, and the inner and outer layers of backfat from over the first rib, last rib, and last lumbar vertebra. Methyl esters of the fatty acids from the samples were prepared and analyzed by gas-liquid chromatography. Dietary lipids were analyzed by the same method. Taste panel evaluations and Warner-Bratzler shear tests were also conducted on loin samples from each hog.

Backfat and leaf fat from the safflower oil-fed hogs contained a lower % of total saturated fatty acids than that from controls. The levels of palmitic and oleic acids decreased, while the level of linoleic acid increased. The inner backfat layer of the controls was always more saturated than the outer layer. However, in some instances, the outer layer of backfat from the safflower oil-fed hogs was more saturated than the inner layer. Linoleic acid behaved in a reverse manner to the total saturated fatty acids. The fatty acid changes of the leaf fat were intermediate between the changes of the inner and outer backfat layers.

Changing hogs from a safflower oil ration to a tallow ration increased the degree of saturation of their depot fats. The levels of palmitic and oleic acids increased, while the level of linoleic acid decreased.

In all instances, the % of total saturated fatty acids of the intramuscular fat remained constant. While changes occurred in the linoleic and oleic acid composition of the intramuscular fat, the changes in composition were much less than those occurring in the leaf fat or backfat.

The major changes in the fatty acid composition occurred within 4 - 5 weeks. There was essentially no difference in the fatty acid composition of the fat from the initial or final safflower oil groups.

Most of the fatty acid changes due to the tallow ration had occurred by the end of the 4th week.

The depot fat of barrows contained a higher level of total saturated fatty acids than that of the gilts. The fat from barrows contained more palmitic and stearic acids and less linoleic acid than the fat from gilts. There was no difference between barrows and gilts in the fatty acid composition of the intramuscular fat.

There was no significant difference in consumer preference or Warner-Bratzler shear values of the loin samples from any of the slaughter groups. This suggests that none of the diets had any adverse effect upon palatability.

EFFECTS OF DIET ON THE FATTY ACID COMPOSITION OF PORK FAT

by

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INTRODUCTION

Soft pork was once a serious problem in the United States. The character of the depot fat was found to be the major factor affecting the firmness of the chilled carcass. It was also discovered that feed had a pronounced effect on the composition of the depot fat.

More recently, the highly saturated fatty acid content of animal fats in the human diet has been shown to increase serum cholesterol levels. High serum cholesterol levels have been implicated as a possible cause of atherosclerosis. Incorporation of polyunsaturated fats, and especially linoleic acid, into the diet has been shown to reduce serum cholesterol levels.

Since fat often comprises over 40% of the pork carcass and can be altered by dietary means, it is a potential source of unsaturated fat for human consumption. Thus, the present investigation was undertaken to study the effects of feeding a highly unsaturated diet upon the fatty acid composition of the fat produced. An additional facet of this study involved following the changes in the composition of the fat after the hogs were removed from the softening ration and placed on a more saturated diet. Because it was suspected that various fat locations might be affected in a different manner, the fatty acid composition of lipid samples from the leaf fat, the intra-

muscular fat from the Longissimus dorsi muscle, and both the inner and outer layers of backfat from over the first rib, last rib, and last lumbar vertebra were studied.

LITERATURE REVIEW

Early Significance and Causes of Soft Pork

Burk (1922) listed the differences between oily, soft, and firm pork. In the fresh chilled condition, he noted that oily carcasses remained very soft, and the fat had a slightly yellowish tinge. Even after cooling, the carcasses and wholesale cuts were similar to those of a warm carcass. He stated that firm carcasses were solid and firm and the fat was pure white. In soft carcasses, the fat was white, although it was neither firm nor oily. He further indicated that the average melting point for leaf fat was 34.7°C. for oily fat, 40.3°C. for soft fat, and 43.4°C. for firm fat. He also stated that hogs producing soft or oily carcasses could not be distinguished before slaughter from those yielding firm carcasses.

Hankins and Ellis (1926) reported that products from soft and oily hogs were difficult to handle and oily in appearance. They indicated that fluid fat sometimes dripped from smoked products, and that soft bacon was difficult to slice. They also noted that lard from soft and oily hogs lacked body and was sometimes liquid at ordinary refrigerator temperatures. They further stated that these undesirable characteristics resulted in market discounts to producers of soft and oily hogs.

Burk (1922) and Hankins and Ellis (1926) listed feed as the primary

cause of soft pork. Hankins and Ellis (1926), in summarizing the work of early European investigators from Denmark, reported that barley, rye, root crops, and palm nut meal produced firm pork, sunflowers produced soft pork, while corn and wheat bran produced carcasses of intermediate firmness. When added to rations, linseed oil was noted to have a softening effect, whereas, coconut oil had a hardening effect. Hankins and Ellis (1926) further indicated that some German workers had reported that barley, potatoes, palm kernel meal, coconut meal, milk, and meat meal in various combinations produced hard pork. Corn produced a slightly softer fat, whereas, peanut, sesame, and linseed meals or oils resulted in still softer fat. Rations low in fat were noted to produce firm pork. These authors also stated that the German researchers reported that suckling pigs were soft in comparison to mature pigs fattened on grain or potatoes.

Hankins and Ellis (1926) in summarizing English research, indicated that these workers laid great stress on the effects of rations rich in oil in producing soft bacon. They reported that Canadian investigators had found that most of the soft bacon in Canada came from immature or underfed pigs. Usually these pigs had been fed on poorly balanced rations, such as corn alone or beans alone. They further noted that the softness could be eliminated if rapid, satisfactory gains were obtained by the use of mixed feeds, including corn, barley,

peas, and skimmilk. They reported that the Canadian researchers considered the amount of "olein" to be the controlling factor in determining softness, i.e., the quantity of unsaturated fatty acids was closely correlated with the softness of the fat.

American investigators demonstrated that feeding peanuts as the major part of the ration for any significant time resulted in soft, oily pork (Bennett, 1898, 1900; Duggar, 1898, 1903; Burns, 1910; Gray, 1916; Burk, 1916, 1918a, 1919; Scott, 1918, 1922; Youngblood, 1920; Hankins and Ellis, 1926). Hostetler et al. (1939) have shown that as little as 10 lbs. of peanut oil in the diet may produce soft pork.

A number of workers attempted to harden peanut-fed hogs with corn or corn supplemented with either cottonseed meal, milo chops, meat meal, velvet beans, or shorts (Duggar, 1903; Gray, 1916; Burk, 1918a, 1919; Templeton, 1920; Scott, 1921, 1922; Hankins and Ellis, 1926). These workers reported that if the subsequent hardening period was long enough (five weeks or more), a definite improvement in carcass firmness occurred. However, carcass firmness was still inferior to that from corn-fed hogs. Hostetler et al. (1939) reported that in order for peanut-fed hogs to grade firm, the weight gain from the hardening ration should be 3.5 times that from the peanut ration. They found that removal of part of the

soft fat by starvation before hardening had a beneficial effect in producing firm carcasses.

When peanut meal was fed in amounts up to one half of the ration, Burk (1916, 1918b), Scott (1918), and Hankins and Ellis (1926) produced acceptably firm pork. However, they observed that carcasses did not become firm upon chilling if peanut meal was the sole source of feed.

A number of workers reported that if soybeans were fed to the extent of 20% or more of the ration for seven to eight weeks prior to slaughter, soft pork resulted (Gray, 1916; Hankins and Ellis, 1926; Bull et al., 1931; Robison, 1931; Vestal and Shrewsbury, 1932, 1935; Helser et al., 1939; Hostetler and Halverson, 1940). Robison (1931) and Vestal and Shrewsbury (1932) found that cooking or roasting of soybeans did not alleviate the problem. To successfully harden soybean-fed pigs, Hostetler and Halverson (1940) stated that the ratio of weight gains from the hardening ration (corn and tankage with 13% cottonseed meal) to that from the soybean ration should be 3.4:1. They further noted that the ratio of total starch ingested from both rations to that of total oil (exclusive of cottonseed oil) was 8.9:1. Robison (1931) and Vestal and Shrewsbury (1935) indicated that soybean oil meal will produce firm pork if not used as the sole source of feed.

Rice bran, when fed alone, and to some extent, rice polish can also produce soft pork (Burns, 1910; Dvorachek and Sandhouse, 1918; Burk, 1918a, 1918b; Hughes, 1922; Warren and Williams, 1923; Hankins and Ellis, 1926). Gray (1916) and Hankins and Ellis (1926) indicated that oak mast produced relatively soft pork. Lush et al. (1936) raised the iodine value of lard an average of 6.1 by feeding a total of 2.5 to 3 lbs. of cod-liver oil over a period of 120 days. Sinclair (1936) reduced the iodine number of pork fat by decreasing the proportion of oats in the ration. Ellis and Isbell (1926a) stated that both corn and soybean oil resulted in greater softening of the fat than peanut or rice oil.

Duggar (1898, 1903) stated that fat produced from sorghum or a mixture of cowpeas and corn was scarcely different from fat produced from corn alone. Burns (1910) noted no difference in carcass firmness on feeding corn alone or corn supplemented with molasses. Burk (1918b) produced firm pork by feeding milo chops and cottonseed meal (6:1). Scott (1918) noted that velvet beans produced hard pork. Hankins and Ellis (1926) reported that hogs fed brewer's rice and tankage produced firmer carcasses than hogs fed corn. Robison (1931) indicated that rations low in fat produce firm pork. Shorland et al. (1944) stated that pigs fed skimmilk or buttermilk generally yielded carcasses with firm fat.

Henriques and Hansen (1901) found that the temperature of the body fat becomes successively higher from external to internal locations. They noted that this was directly related with the fat solidifying point, and indirectly related with iodine value. These workers also placed one pig at each of the following environmental temperatures for two months: (1) 30 - 35°C.; (2) 0°C.; and (3) 0°C. but covered with a sheepskin coat. Iodine values of the outermost layer of backfat were 69.4, 72.3, and 67.0, respectively. They concluded that the temperature at the site of fat deposition plays a role in determining hardness. Sinclair (1936) found that the average iodine number of fat samples from 150 pigs fed during the summer was 58.2, while the average of 72 samples taken during the winter was 63.2.

Scott (1930) and Robison (1931) indicated that type may exert an influence on carcass firmness. Robison (1931) stated that intermediate or chuffy type hogs would be expected to be firmer than rangy hogs having the same fat thickness. Lush et al. (1936), upon analyzing lard from 157 hogs belonging to 54 litters, reported that gilts had an iodine value of 1.7 units higher than that of litter mate barrows.

Hankins and Ellis (1925) and Ellis (1926) noted that younger pigs have softer fat than older or heavier pigs. Scott (1930) found that

young pigs had soft fat, which gradually hardened during the growing and fattening process. Several workers reported that hogs with a greater fat depth usually produced firmer carcasses, providing no softening feed was fed (Scott, 1930; Hankins, 1930; Robison, 1931, 1946). The amount of weight gain on a softening or hardening ration will influence fat firmness (Hankins and Ellis, 1926; Hankins et al., (1928; Hostetler et al., 1939; Hostetler and Halverson, 1940). A number of workers (Hankins and Ellis, 1926; Hankins et al., 1928; Robison, 1931, 1946; Sinclair, 1936) reported that as the rate of fat deposition increased, the fat became firmer.

Duggar (1898) found that leaf fat was firmer than backfat. Burk and Ewing (1919) demonstrated that the melting point of backfat was 6 - 8°C. lower than that of leaf fat. Henriques and Hansen (1901) indicated that the layer of backfat sampled must also be considered.

Scott (1921) and Sinclair (1936) stated that there is a great difference in the firmness of fat between individual hogs treated alike. Lush et al. (1936) reported that the variance in fat firmness between litters sired by the same boar was actually a little larger than the variance between the progeny of different boars in the same year.

Fatty Acid Composition

White et al., (1964) stated that body lipids serve as a source of potential chemical energy. Since most of the body fat is located subcutaneously, they further indicated that it protects the more thermosensitive tissues against excessive heat loss to the environment and insulates the body against mechanical trauma. They reported that lipid exists in the depots of living animals mostly as triglycerides, which are in a liquid state. These authors also noted that the more nearly saturated a sample of lipid, the larger the energy yield upon oxidation. Thus, they concluded that mammals deposit that type of lipid richest in chemical potential energy, but still liquid at the ambient temperatures.

Using isotopic tracers, Schoenheimer (1942) concluded that body fats are in a state of rapid flux. He indicated that upon absorption of fats, the fatty acids of the diet merge with those from the depot, forming a mixture indistinguishable as to origin. He further noted that all of the complex reactions involved in the turnover of fatty acids are so balanced that the amount and structure of the fat mixture in the depots remains relatively constant.

Jeanrenaud (1961) and Vaughan (1961) indicated that adipose tissue is an extremely active system primarily concerned with the synthesis, oxidation, storage, and release of fats, representing a

major site of metabolic interrelationships between carbohydrates and lipids. White et al. (1964) stated that adipose tissue exhibits two major metabolic features: (1) the assimilation of carbohydrates and lipids, and their intermediates for fat synthesis and storage, and (2) the mobilization of lipids as free fatty acids.

Wakil (1964) and White et al. (1964) indicated that animal tissues contain three different metabolic pathways involved in the synthesis and interconversion of the various fatty acids: (1) de novo synthesis of saturated acids; (2) elongation; and (3) desaturation. They stated that palmitic acid is synthesized de novo from acetyl CoA, malonyl CoA, and $NADPH_2$. They further noted that palmitic acid can be elongated by the addition of one or more units of acetyl CoA to form longer chained saturated acids. They reported that palmitic and stearic acid can be desaturated to palmitoleic and oleic acids by microsomes in the presence of O_2 and $NADPH_2$. They also stated that animal tissues have lost the ability to synthesize linoleic acid.

The most recent and complete characterizations of pork fat include those by Magidman et al. (1963) using silicic acid and gas chromatography and Sink et al. (1964) using gas chromatography. These workers reported that the composition of normal pork fat includes approximately 1.0 - 1.7% myristic acid, 23 - 27% palmitic acid, 10 - 14% stearic acid,

2.0 - 4.5% palmitoleic acid, 44 - 47% oleic acid, 9 - 12% linoleic acid, 0.5 - 1.0% linolenic acid, and 0.1 - 0.2% arachidonic acid. Also included in detectable amounts were the following fatty acids: 10:0, 11:0, 12:0, 13:0, 14:1, 15:0, 17:0, 17:1, 19:0, 19:1, 20:0, 20:1, 20:2, 20:3, 20:5, 22:0, 22:2, 22:4, and 22:5.

Effect of Maturity.-- Ellis and Hankins (1925) reported that the fat of growing hogs becomes progressively harder on a ration containing a moderately low amount of softening fat, such as is found in corn. They further noted that this change was accompanied by an increased rate of fat deposition. These workers found that as the amount of total saturated acids increased, the proportion of linoleic acid decreased, while the per cent of oleic acid remained relatively constant.

Ellis and Zeller (1930) noted that a gradual increase in saturation occurred up to a weight of 100 lbs., above which extremely hard body fat was produced. These workers reported that from a maximum content in the suckling pig, linoleic acid steadily decreased up to a weight of 170 lbs. They concluded that the decrease in linoleic acid was responsible for the increased saturation.

McMeekan (1940) found that the iodine number of hog fat increased from birth up to eight weeks. A steady decrease in iodine value was observed from eight weeks to twenty weeks, after which it remained

relatively constant. It was indicated by de la Mare and Shorland (1944) that the assimilation of linoleic acid from sow's milk by suckling pigs provided a reasonable explanation for the increase in iodine number from birth until weaning.

Sink et al. (1964) reported the selective deposition of saturated fatty acids with increasing live weight. These workers found an increase in both palmitic and stearic acids. They also noted that linoleic acid definitely decreased. It was further shown that palmitoleic acid also decreased, while oleic acid remained fairly constant or increased slightly.

Effect of Fat Location.--Sink et al. (1964) reported that the saturated fatty acids are preferentially deposited in perirenal rather than in subcutaneous fat, and in the inner backfat rather than the outer backfat layer. The results of Brown (1931), Bhattacharya and Hilditch (1931), Banks and Hilditch (1932), Hilditch et al. (1939), McMeekan (1940), and Ostrander and Dugan (1962) are in agreement. Sink et al. (1964) stated that the leaf fat contained approximately 4% more saturated fatty acids than the inner backfat, and about 7% more than the outer backfat. They noted that an increase in the amount of saturated fatty acids was accounted for by increases in both palmitic and stearic acids. Shorland and de la Mare (1945a) had previously reported similar results.

Sink et al. (1964) further reported that the amounts of palmitoleic, oleic, and linoleic acids decreased as the degree of saturation increased. Shorland and de la Mare (1945b) stated that as saturation decreased, oleic acid increased, while stearic acid decreased. Dahl (1958) verified these results. Banks and Hilditch (1932) indicated that this relationship caused a decrease in the ratio of linoleic acid to oleic acid. These workers stated that this was so, even though the linoleic acid content increased slightly with decreasing saturation. However, Shorland and de la Mare (1945b) noted that the small differences in linoleic acid content had but little effect upon the degree of saturation.

Dean and Hilditch (1933) divided the backfat of a sow into five layers, three inner layers and two outer layers. They found that the fatty acid content of the three inner layers was almost identical, but the outermost of these layers contained slightly less palmitic and more stearic acid. These workers also found that the innermost layer of the outer backfat was intermediate between the inner layers and the outermost layer, but more closely approximated the latter.

Garton et al. (1952) fed a diet of 50% crude whale oil. From the normal fatty acid composition of pig fat and whale oil, they calculated that about 60% of the leaf fat and inner backfat was true pig fat, while 40% was derived from whale oil. They also calculated

that only 35% of the outer backfat was true pig fat, with the remaining 65% being derived from whale oil. However, Bhattacharya and Hilditch (1931) had previously concluded that diet has less effect on the outer layer of backfat than on the inner layer or the leaf fat. They found that when the diet contained arachis oil (peanut oil), the degree of saturation of leaf fat and inner backfat was almost reduced to that of the outer backfat.

Callow (1935) stated that the faster the rate of fat deposition, the more saturated the fat. He indicated this was true because more fat would be synthesized from non-lipid sources. Shorland and de la Mare (1945b) stated that this theory broke down when referred to an individual hog. They noted that as pigs grow the outer layer of backfat is deposited first and then the inner layer. However, they found that over the whole period of growth, the inner layer was always more saturated than the outer.

Sink et al. (1964) noted no significant difference in saturation between backfat samples removed from over the shoulder, loin, or rump. However, Shorland et al. (1944) had previously found that backfat from the front end of the carcass was more saturated than that at the rear.

Greer et al. (1965) found no difference in the per cent of total saturated fatty acids between the outer layer of backfat and the intra-

muscular fat from the Longissimus dorsi muscle. They also reported no differences for each of the individual saturated fatty acids. These workers and Ostrander and Dugan (1962) reported that intramuscular fat contained more oleic acid and less linoleic acid than did the subcutaneous fat. Greer et al. (1965) further noted that intramuscular fat usually contained a higher level of palmitoleic acid. McMeekan (1940) had earlier found that up to eight weeks of age, muscle fats had higher iodine values than subcutaneous fat. After this age, he noted that the iodine value of muscle fat appeared to approximate the values of backfat and belly fat.

Effect of Diet.--Ellis and Isbell (1926a) reported that the variation in percentages of oleic, linoleic, and total saturated fatty acids of lard from peanut and soybean-fed hogs was very similar to that of peanut and soybean oil, respectively. Ellis and Isbell (1926b) found that peanut oil and soybean oil contained around 23% and 52% linoleic acid, respectively, whereas, the resulting "peanut lard" and "soybean lard" contained about 19% and 33% linoleic acid. They also reported that the feeding of soybeans caused the deposition of small quantities of linolenic acid, while feeding peanuts led to the deposition of arachidic acid. These workers stated that the fat formed from a ration of brewer's rice and tankage, which contained

less than 1% fat, contained over 97% of the glycerides of oleic, palmitic, and stearic acids. Ellis and Isbell (1926a) reported that linoleic acid decreased from 30.6% in oily fat from soybean-fed hogs to 1.9% in hard fat from hogs fed brewer's rice.

Ellis et al. (1931) fed hogs a basal ration plus 0, 4, 8 or 12% cottonseed oil. As the level of cottonseed oil increased, they found a marked increase of linoleic and stearic acids at the expense of oleic and palmitic acids. Although the maximum content of total saturated acids occurred at the 4% level, they noted that stearic acid steadily increased up to the 12% level. These workers reported that the hardest carcasses were found at the 4% level, while larger quantities of cottonseed oil resulted in greater softness.

Brown (1931) reported that 2.7% of highly unsaturated fatty acids was found in lard from pigs fed a 14% menhaden oil diet. He noted that these fatty acids had about the same molecular weight, but a lower iodine value than the mixture of acids isolated from the original menhaden oil.

Bhattacharya and Hilditch (1931) indicated that pig fat tends to approximate a constant molar content of total 18 carbon acids, in spite of variation in the total proportion of saturated to unsaturated acids. They stated that the stearic acid content will vary indirectly

with the oleic acid content. These workers further noted that the constancy of total 18 carbon acids disappears when hogs are fed a diet containing over 5 - 8% fat.

Banks and Hilditch (1932) reported that linoleic acid was readily assimilated in the fat of a sow fed 7% fish meal. Since unsaturated 20 and 22 carbon acids were found in fish oil, they were also detected in the depot fat. These workers indicated that the softness of the fat was due to an increase of the unsaturated fatty acids, with an unusually large amount of linoleic acid. Bhattacharya and Hilditch (1931) had found similar results by feeding arachis oil.

By comparing the component fatty acids of the diet with those of the body fats, Hilditch et al. (1939) concluded that a substantial amount of palmitic, stearic, and oleic acids were synthesized by the animal body. They noted that these acids were synthesized in an average proportion of 1 mole of palmitic acid to 1.9 moles of stearic and oleic acids. They also stated that palmitoleic and myristic acids may be synthesized, but linoleic acid and the unsaturated 20 and 22 carbon acids are derived only from ingested fat.

Shorland and de la Mare (1945a) found a constant palmitic acid content of 26 - 30 moles % from the depot fat of hogs fed skimmilk or buttermilk. They also reported 2 - 3 moles % less stearic acid and

2 - 3 moles % more palmitoleic acid from these diets than that from normal diets. A maize meal supplement was found to decrease the myristic acid content and to increase the unsaturated 20 and 22 carbon acids. They indicated that a copra supplement increased the lauric, myristic, and palmitoleic acid contents, but decreased the amount of oleic and stearic acids. These workers concluded that a decrease in oleic acid may compensate for increased lauric and myristic acids. They also stated that it was possible that unsaturated acids displaced palmitic acid, but that the saturated acids of lower molecular weight than myristic promoted the synthesis of palmitic acid.

Garton et al. (1952) found palmitoleic acid and the unsaturated 20 and 22 carbon acids in greater amounts than normal from the depot fat of a hog fed on 50% crude whale oil for 198 days. Garton and Duncan (1954) reported that adding cod-liver oil to the diet resulted in depot fats that were dark brown in color and semi-solid at room temperature. The fats were found to have a green flourescence in daylight and an odor of cod-liver oil. These workers noted that some of the fatty acids of cod-liver oil were incorporated into the depot fats.

Blumer et al. (1957) divided twenty 45 lb. pigs into five groups: 10% soybean oil throughout, 10% soybean oil followed by 10% coconut

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oil beginning at 175, 150, and 125 lbs. live weight, and 10% coconut oil throughout. All hogs were slaughtered at 205 lbs. They found that the total saturated fatty acid contents of the backfat were 33.12, 38.68, 42.81, 45,21, and 51.60%, respectively. Linoleic, linolenic, and arachidonic acids showed a progressive decrease as the length of time on coconut oil increased. Since the amount of oleic acid remained rather constant, they concluded that oleic acid had little effect on fat firmness. Since the oleic acid content of soybean oil and coconut oil was 32% and 18%, respectively, they further concluded that ingested oleic acid has little effect on the oleic acid content of depot fat.

Elson (1964) fed a hog on a 20% corn oil diet for 17 days. He found that the backfat contained less palmitic, stearic, and oleic acids than normal. He further reported that the polyunsaturated acids, linoleic and linolenic, showed a marked increase accounting for 34% of the total fatty acids.

Greer et al. (1965) reported that the outer layer of backfat from corn-fed hogs contained more linoleic acid than that from barley-fed hogs. However, they found no difference in the fatty acid content of the intramuscular fat from the Longissimus dorsi muscle on either a corn or barley ration.

Dahl and Persson (1965) found that the content of linoleic acid in backfat and leaf fat ran parallel to the amount of oil in the feed. Because of the accumulation of dietary fat, they noted that even small quantities of oil will exert an influence on the properties of depot fat. However, they stated that the maintenance of a practically constant iodine value in cases of a variable, but low or moderate supply of oil in the diet, might be achieved in the body by regulation of the amount of synthesized oleic acids going to the fat depots. These workers also found evidence for a preferential deposition of polyunsaturated fatty acids, indicating that this could give rise to a depot fat with a higher iodine value than the dietary fat.

Hilditch et al. (1939) reported the deposition of fat from pigs fed on a restricted diet was not only slower, but the fat produced was softer than normal. They indicated that this was due to an increase in the amounts of linoleic and oleic acids. Shorland and de la Mare (1945a) found that fat from slower growing hogs contained more linoleic acid, because most of the deposited fat was derived from the diet. Greer et al. (1965) reported that linoleic acid increased as the feed level was restricted to 85% of full feed. However, they noted that further restriction of the feed intake to 70% caused a decrease of linoleic acid from that obtained on 85% full feed.

Greer et al. (1965) further reported that the total saturated fatty acid content of the outer backfat layer decreased as feed intake was restricted to 85% of full feed on both corn and barley rations. By further restriction of feed intake to 70%, they noted a further decrease in the saturated acids from hogs on a corn ration, but a slight increase on a barley ration. They found that stearic acid behaved similar to the saturated acids. On both rations, they found that palmitic acid decreased as the feed level was restricted to 85%, but that it increased as feed level was further restricted to 70%. These workers found no change in the fatty acid composition from the intramuscular fat of the Longissimus dorsi muscle as feed level was restricted.

Merkel (1966) found a steady decrease of total saturated fatty acids from both the inner and outer layers of backfat as feed intake was restricted to 57%. He found that this change was due to a decrease of stearic acid and an increase of linoleic acid.

Hilditch and Pedelty (1940) have reported that in the early stages of inanition, a preferential selection occurs from the reserves of the outer backfat. They noted that prolonged starvation caused the largest degree of mobilization from the inner backfat. They found no great evidence of selectivity in the mobilization of any one fatty acid. However, the two most prominent effects they noted were the preferential

removal of oleic acid during the later stages of inanition, and a definite reluctance in the earlier stages of starvation to mobilize those acids derived from ingested fat (linoleic and the unsaturated 20 and 22 carbon acids).

Effect of Diet upon Serum Cholesterol Levels

Wilens and Plair (1965) reported that severe atherosclerosis is often associated with high values of cholesterol in blood. Weinhouse and Hirsch (1940) and Rabinowitz (1960) stated that cholesterol is present in high concentrations in the lipids of the atheromatous plaques. Their chemical nature resembled that of blood plasma. Swell et al. (1962) indicated that below a certain serum cholesterol level, atherosclerosis does not develop. They also stated that there is a relationship between the level of serum cholesterol and the time required for development of the disease. These workers further reported that the major part of the cholesterol in the plaques originated from serum cholesterol.

Rabinowitz (1960), however, stated that cholesterol in the atheromatous plaques appeared to exchange with or accept circulatory cholesterol only with the greatest of difficulty. Ahrens et al. (1959) and Goldsmith (1961) reported that there is no proof that high serum cholesterol levels cause atherosclerosis.

Swell et al. (1962) stated that aortic cholesterol composition is dependent upon the fatty acids of the dietary fat. They indicated that certain cholesterol esters, and in particular, cholesterol oleate may be preferentially deposited in the aorta. Swell et al. (1960a) reported that the major cholesterol esterfied fatty acid of media and serum was linoleic acid, while for the plaques and liver it was oleic acid. Swell et al. (1960b, 1961) concluded that there may be a distinct mechanism operating, so that cholesterol esters of a more saturated and monoenoic nature are laid down as atherogenesis progresses. Results reported by Evrard et al. (1962) are in agreement with these findings.

Mead (1966) suggested that serum cholesterol levels can be lowered by increasing the ratio of polyunsaturated to saturated fatty acids from the usual 0.4 to 1.1 or more. He indicated that this would occur even with a relatively high dietary fat content. Reiser et al. (1963) stated that the increase in liver cholesterol from unsaturated fat diets suggests that the mechanism by which unsaturated fatty acids maintain lower serum cholesterol is by their influence on transport. He suggested that this could occur as a result of forming labile esters, or by forming unsaturated phosphatides, which may aid in the transport of cholesterol esters across cell membranes. Several workers have substantiated the fact that unsaturated fats lower serum cholesterol

(Ahrens et al., 1954; Ahrens et al., 1957; Okey and Lyman, 1957; Avigan and Steinberg, 1958; and Peifer, 1966). Jagannathan (1962a) believes that the polyunsaturated fatty acid, linoleic acid, is chiefly responsible for this effect.

Keys et al. (1956) disagreed to some extent, explaining that the level of fat in the diet had greater effect on lowering serum cholesterol levels than did the degree of unsaturation. Pollak (1959) reported that Japanese on a highly unsaturated, low fat diet had a higher incidence of cardiovascular disease than natives of Thailand on a highly saturated, high fat diet. Aftergood et al. (1957) and Jagannathan (1962b) indicated that a lowering of serum cholesterol levels by unsaturated fats was apparent only when cholesterol was present in the diet.

Elson (1964) found that soybean oil was more effective than lard in lowering the serum cholesterol level of rats, even though both the lard and oil contained 34% polyunsaturated fatty acids. Hilditch and Stainsby (1935) and Mattson et al. (1964) indicated that lard triglycerides contain the saturated fatty acids primarily at the β-position. Mattson and Volpenheim (1963) found that the saturated fatty acids of vegetable oil are mainly located at the α- and α′- positions.

EXPERIMENTAL PROCEDURE

Experimental Animals

A total of 21 Hampshire X Yorkshire hogs, including 9 barrows and 12 gilts, were used in this experiment. They were obtained from the Michigan State University Swine Farm and were fed at the University Swine Barn. At the start of the experiment, the hogs weighed an average of 97 lbs. They were randomly divided into two lots of six, each containing three barrows and three gilts, and one lot of nine, containing three barrows and six gilts.

Treatments

One lot of six hogs was designated as the control (Lot A) and was fed a basal corn-soybean oil meal finishing ration (Appendix L). The other lot of six (Lot B) was fed a basal barley-soybean oil meal ration containing 10% safflower oil (Appendix L). The lot of nine (Lot C) was fed the same ration as Lot B until all of the hogs reached an average weight of about 158 lbs. At this time, three hogs from both Lots A and B were slaughtered and were identified as the initial control and the initial safflower oil groups, respectively. The remaining hogs from Lots A and B were continued on their respective diets, while Lot C was changed to a basal barley-soybean oil meal ration containing 10% tallow

(Appendix L). At each two week interval, three hogs were slaughtered from Lot C, and were identified as the 2 week, 4 week, and 6 week tallow groups, respectively. At the end of the sixth week, when the hogs had reached a market weight of about 240 lbs., the remaining three hogs in both Lots A and B were also slaughtered. They were identified as the final control and the final safflower oil groups, respectively.

The rations of Lots A, B, and C were found to contain about 2.8%, 8.5%, and 11.2% fat, respectively. The ration for Lot B contained less fat than expected because some of the safflower oil of the ration was absorbed by the burlap bags containing the feed. Some of the safflower oil had also seeped through the bags and was found on the floor of the feed room.

Rate of gain was calculated for the hogs by groups. Feed efficiency was calculated for the hogs by lots. Each of the treatment groups contained at least one barrow and one gilt.

Slaughtering Procedure and Subsequent Carcass Evaluation

The hogs were electrically stunned, shackled, stuck, and allowed to bleed. After bleeding they were scalded and dehaired. The carcasses were then singed, eviscerated, split into halves, and washed. The carcasses were placed in a cooler at approximately 3°C. and allowed to chill.

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After chilling for 24 hours, a subjective carcass firmness rating was placed on each of the carcasses by three graduate students well acquainted with pork carcass evaluation. A scale of 1 to 5 was used with 1 being very soft and 5 being very hard. After slaughter and during subsequent processing, the following carcass data were collected: carcass weight and length, backfat thickness, loin eye area, and weights of trimmed ham, loin, shouder, belly, lean cuts, primal cuts, fat trim, lean trim, and leaf fat and kidney.

Samples for Analysis

Fat samples were collected from the leaf fat and from the subcutaneous fat over the first rib, last rib, and last lumbar vertebra. At the time of analysis, the subcutaneous fat samples were separated into inner and outer layers, using the connective tissue septum as the point of separation. A section of Longissimus dorsi muscle was removed at the tenth rib for subsequent intramuscular fat analysis. Samples of the rations were also collected. All fat samples were placed in polyethylene bags, sealed under vacuum, and were frozen and stored at -30°C. until needed for analysis.

A loin roast was removed, wrapped in freezer paper, frozen, and stored at -30°C. until needed for taste panel evaluation. A pork chop was also frozen and ultimately used for the Warner-Bratzler shear test for tenderness.

Extraction of Lipids from Samples

The lipids from the Longissimus dorsi muscle and feed samples were extracted by a modification of the method suggested by Ostrander and Dugan (1962). Each sample was placed in a VirTis flask with 130 ml. absolute methanol and was macerated for five minutes at medium speed. The sample was transferred to a Waring Blender jar along with 130 ml. chloroform, part of which was used to rinse the VirTis flask. The sample was blended for five minutes. To precipitate the protein in the sample, 65 ml. distilled water containing 1.0 - 1.5 gm. $Zn(C_2H_3O_2)_2$ was added and blended for 10 seconds. The sample was filtered by suction with a Buchner funnel using Whatman No. 1 filter paper. In order to avoid oxidation, nitrogen gas was directed over the sample during this process. The Waring Blender jar was rinsed with a small amount of chloroform and added to the Buchner funnel. The filtrate was transferred to a separatory funnel and the heavy chloroform layer was removed. The chloroform was removed from the lipid under reduced pressure by means of a rotating flask evaporator.

Preparation of Methyl Esters

Methyl esters of the lipid samples were made by utilizing a method developed by McGinnis and Dugan (1965) and Dugan et al. (1966). A 1.0 gm. fat sample was suspended in 20 ml. diethyl ether

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and homogenized with a VirTis homogenizer. The homogenate was transferred to a 125 ml. Erlenmeyer flask mounted in an ice bath on a magnetic stirrer. Under a constant stream of nitrogen gas, 2.5 ml. of concentrated H_2SO_4 was added dropwise to the flask. The flask was stoppered and stirred for ten minutes. Several drops of alcoholic phenolphthalein were then added. The mixture was titrated with 3.6 N methanolic KOH. The neutral mixture was transferred to a separatory funnel. The reaction flask was rinsed with diethyl ether, which was also added to the funnel. The solvent was washed with cold distilled water. The aqueous layer was discarded and the diethyl ether layer was dried over anhydrous Na_2SO_4. The sample was filtered through Whatman No. 1 filter paper. The solvent was partially removed under a stream of nitrogen gas. The resulting solution of methyl esters of fatty acids was injected into the gas chromatograph for qualitative and quantitative analysis.

Gas Chromatography

A Barber-Coleman, Model 20, gas chromatograph equipped with a radium ionization detector and a Barber-Coleman recorder was used. For most of the analyses, the following adjustments were maintained: argon gas pressure, 27 lbs.; argon gas flow rate, 154 ml. per min.; injector port and detector temperature, 240°C.; column temperature,

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175°C.; cell voltage, 1250 V.; sensitivity, 1×10^{-7} amps. full scale; and split flow, 200 ml. per min. The column, 6 ft. by 1/4 in. copper tubing, was packed with 12% ethylene glycol succinate on 60/70 mesh Anakron A. The column was coiled to a diameter of 5 in. and pre-conditioned at 200°C. with an argon gas flow rate of 150 ml. per min. for a minimum of 24 hours.

The detection system was checked for quantitative accuracy by injecting aliquots of a known mixture of methyl esters of myristic acid, palmitic acid, and stearic acid, and demonstrating that the peak area for each ester relative to the total area was approximately proportional to the relative amounts of the esters injected. The quantitative results reported were taken directly from the areas under the curves as measured by the triangulation method. No correction was made for possible variation in the response of the detector to different molecular species.

For qualitative analysis, the retention times of known methyl esters (99^+ % pure) were compared to the retention times of the unknown methyl esters. When standards were not available, peaks were tentatively identified by semilogarithmic plots of retention volumes against carbon number. The analysis did not include long chain methyl esters with retention times greater than methyl arachidonate.

Taste Panel

The loin roasts were cooked in a 180°C. oven to an internal temperature of 87°C. An 18 member consumer-type taste panel evaluated the samples according to a 9-point hedonic scale for tenderness, juiciness, flavor, and overall acceptability. The pork chops were deep-fat fried at 210°C. to an internal temperature of 87°C. They were evaluated for tenderness by the Warner-Bratzler shear test using six cores 1/2 inch in diameter from each chop.

Statistical Analysis

The data collected from the gas chromatographic analysis were punched onto IBM cards. The data were analyzed for sex and treatment differences within each of the fat locations studied by a computer programmed for the least squares method. The following fatty acids were included in the analysis: total saturated acids, myristic acid, palmitic acid, stearic acid, palmitoleic acid, oleic acid, and linoleic acid. Where applicable, Duncan's new multiple-range test, as outlined by Steel and Torrie (1960), was employed to determine which treatment means were significantly different. The computer also ran simple correlations for all of the variables. The results of the taste panel evaluation and the Warner-Bratzler shear test were analyzed for treatment differences by analysis of variance.

RESULTS AND DISCUSSION

Due to the experimental design with an unequal number of barrows and gilts in each treatment, this duscussion will be based on the adjusted means for the fatty acid composition rather than the actual means. Only those fatty acids which were statistically analyzed will be discussed. For a complete fatty acid characterization of the pork fat analyzed, see Appendices C through J.

Although linolenic acid was present in substantial amounts, the data were not statistically analyzed due to difficulty in interpretation of the chromatograms. The peaks were broad and sometimes were partially masked by the peak for methyl linoleate. Thus, it was very difficult to get an accurate estimation of the area for methyl linolenate. The difficulty of interpreting the results for methyl linolenate was indicated by Magidman et al.(1963), who reported that this peak may have included other esters.

The present discussion will be concerned only with the relative fatty acid changes, since Longenecker (1939b) stated that the change in the total amount of fat must also be considered.

Although information was obtained for carcass data, rate of gain, and feed efficiency, the data will not be discussed herein. The available information is included in Appendices A and B.

Fatty Acid Composition of the Rations

Table 1 gives the fatty acid composition of the rations used in this experiment. The control ration contained a greater proportion of total saturated fatty acids than did the 10% safflower oil ration. The greater amount of saturation was accounted for by higher levels of both palmitic and stearic acids. The 10% safflower oil diet contained a larger amount of linoleic acid than did the control ration, whereas the control ration contained higher levels of palmitoleic and oleic acids.

TABLE 1

FATTY ACID CONTENT OF THE RATIONS(%)[1,2]

	Rations		
Fatty Acid	Control	10% Safflower Oil	10% Tallow
14:0	+	+	1.00
16:0	10.04	6.47	23.40
18:0	1.24	0.71	5.99
Total saturated	11.28	7.18	30.39
16:1	1.20	0.87	5.29
18:1	22.24	8.17	42.91
18:2	63.67	82.18	20.18
18:3	1.61	1.60	1.23

[1]See Appendix M for the fatty acid composition of the safflower oil and tallow used in the rations.

[2]For ration ingredients see Appendix L.

+= traces, but the amount was too small to measure.

The 10% tallow ration contained a considerably larger amount of total saturated fatty acids than either of the other rations, with myristic, palmitic, and stearic acids all being present in greater proportions. The 10% tallow ration contained a lower level of linoleic acid and higher levels of oleic and palmitoleic acids than the other diets.

TABLE 2

EFFECT OF TREATMENT ON CARCASS FIRMNESS[1,2]

Treatment	Carcass firmness score
Control, initial	4.33
Control, final	5.00
Safflower oil, initial	2.33
Safflower oil, final	2.78
Tallow, 2 weeks	3.44
Tallow, 4 weeks	2.78[3]
Tallow, 6 weeks	4.00

[1]See Appendix A for firmness scores of each carcass.

[2]Carcass firmness scores were as follows: 1= very soft, 2= soft, 3= slightly hard, 4= hard, 5= very hard.

[3]Leaf fat firmness scores were used because the carcasses were processed prior to scoring.

Carcass Firmness

The average carcass firmness scores for each of the treatment groups are listed in Table 2. It can be seen that the safflower oil-fed hogs produced softer carcasses than the control hogs. This is in direct agreement with much of the early research summarized by Hankins and Ellis (1926), who reported that feeds high in oil produce soft carcasses.

Further examination of Table 2 shows that although carcasses from the tallow-fed hogs were not as firm as the control carcasses, they were firmer than the carcasses produced from the safflower oil ration. This indicates that the tallow had a hardening effect upon the carcasses of hogs previously fed safflower oil.

From Table 2, it can also be seen that the carcasses in the final control group are firmer than those in the initial control group. This is consistent with the findings of Ellis and Hankins (1925), who reported a hardening effect due to maturity. Apparently maturity has an effect, even when hogs are on a high fat ration, as the carcasses from the final safflower oil group were firmer than those in the initial safflower oil group. Thus, it is difficult to conclude whether the difference in carcass firmness between the 2 week tallow group and the 6 week tallow group is due to maturity or the increased time on the hardening ration.

TABLE 3

ADJUSTED MEANS OF TOTAL SATURATED FATTY ACID CONTENTS BY TREATMENTS AND SAMPLE SITES (%)[1,2]

Sample site	Treatment: Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow, 6 weeks
Inner backfat over first rib**	32.66^{ab}	35.14^{a}	23.97^{c}	26.51^{bc}	30.41^{abc}	32.62^{ab}	30.65^{abc}
Outer backfat over first rib	28.89^{ab}	31.49^{a}	25.12^{b}	26.26^{b}	28.49^{ab}	29.32^{ab}	28.65^{ab}
Inner backfat over last rib**	32.78^{abc}	36.13^{a}	26.20^{c}	27.51^{bc}	28.17^{bc}	34.56^{ab}	31.88^{abc}
Outer backfat over last rib**	28.28^{ab}	31.86^{a}	24.20^{b}	24.57^{b}	26.60^{ab}	30.94^{a}	29.22^{ab}
Inner backfat over last lumbar vertebra**	33.98^{a}	34.72^{a}	25.16^{c}	28.07^{bc}	30.01^{abc}	34.01^{a}	32.18^{ab}
Outer backfat over last lumbar vertebra*	32.21^{ab}	32.97^{a}	25.80^{c}	27.99^{bc}	28.49^{abc}	30.34^{abc}	29.73^{abc}
Leaf fat**	37.10^{a}	38.58^{a}	28.46^{b}	34.21^{ab}	35.38^{a}	36.55^{a}	36.83^{a}
Intramuscular from Longissimus dorsi	30.12	28.76	28.81	30.52	29.26	30.61	30.21

[1]See Appendices C through J for original data.

[2]Values not having the same letter superscripts are significantly different at the level of significance indicated within the fat locations. When no treatment difference is indicated, Duncan's test was conducted at $P < .05$.

** Treatment difference significant at $P < .01$.

* Treatment difference significant at $P < .05$.

Effect of Treatment upon Fatty Acid Composition

Table 3 lists the adjusted means of the total saturated fatty acid content for treatment groups within each of the sample sites studied. The only sample location, which did not exhibit some treatment effect, was the intramuscular fat. There was no significant difference in the proportion of total saturated fatty acids due to treatment for the intramuscular fat obtained from the Longissimus dorsi muscle.

For the remaining locations, the fat from control carcasses was more saturated than that produced from safflower oil. This would be expected because the control ration contained a greater proportion of saturated fatty acids than the safflower oil ration. Furthermore, the greater proportion of fat in the safflower oil ration would also be expected to contribute to a greater amount of unsaturation as Dahl and Persson (1965) indicated that there is a selective deposition of dietary polyunsaturated fatty acids in pig fat. Since the control ration had a lower level of fat, the hogs may have necessarily synthesized some of the fatty acids deposited (Ellis and Hankins, 1925; and Ellis and Zeller, 1930). The fatty acids synthesized from non-lipid sources are usually saturated (Ellis and Hankins, 1925; and White et al., 1964).

Fat from the final control hogs tended to contain a higher level of total saturated fatty acids than that from the initial control hogs. This is in agreement with results reported by Sink et al. (1964), who

indicated that a selective deposition of saturated fatty acids occurs as a result of increasing weight or maturity. Ellis and Hankins (1925) stated that as hogs mature, they synthesize more of the fat they deposit, thus increasing the degree of saturation. Apparently this effect is somewhat evident, even in hogs on a high fat ration, as the fat from the final safflower oil group tended to be more saturated than that from the initial safflower oil group.

The hogs fed tallow for 2 weeks produced fat that was always more saturated than that from either of the safflower oil groups. This would be expected because the tallow ration contained a much higher level of saturated fatty acids than the safflower oil diet. The level of total saturated fatty acids in the fat from hogs fed tallow for 4 weeks approached the level found in the fat from controls. It is difficult to determine how much of the hardening effect was due to maturity and how much was due to diet. However, changes in the tallow groups were more extensive than those in the safflower oil groups. Thus, the tallow diet appeared to increase the level of total saturated fatty acids.

There is no explanation as to why fat from hogs fed tallow for 6 weeks tended to be less saturated than that from hogs fed tallow for 4 weeks. Since the tallow ration contained a greater proportion of

saturated fatty acids than the control ration, it would be expected that the fat from the tallow-fed hogs would become more saturated than the fat from the control hogs. This did not happen, probably because the tallow ration contained a higher level of fat and the hogs tended to selectively deposit the unsaturated fatty acids of the diet.

The adjusted means for the palmitic acid content are listed in Table 4. There was essentially no difference in the palmitic acid content of the intramuscular fat between treatment groups. In the remaining sample locations, the fat from control hogs contained a higher level of palmitic acid than that from safflower oil-fed hogs. This was expected since the control ration contained a greater proportion of palmitic acid than the safflower oil ration. Since the level of fat was less in the control ration, the hogs probably synthesized many of the fatty acids, thus, elevating the palmitic acid level of depot fat above that explained by the diet (Ellis and Hankins, 1925; and Longenecker, 1939a).

The data in Table 4 indicate that maturity has little or no effect on the palmitic acid content. There was little difference in the level of palmitic acid for the initial samples from the controls and the final samples. This is contradictory to the results of Sink et al. (1964), who reported an increase in palmitic acid due to maturity. While there

TABLE 4

ADJUSTED MEANS OF PALMITIC ACID CONTENT BY TREATMENTS AND SAMPLE SITES (%)[1,2]

Sample site	Treatment: Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow 6 weeks
Inner backfat over first rib**	24.56^{ab}	25.68^{a}	18.42^{c}	19.08^{bc}	22.72^{abc}	22.39^{abc}	21.89^{abc}
Outer backfat over first rib*	22.96^{ab}	24.59^{a}	19.80^{bc}	19.33^{c}	22.08^{abc}	22.53^{abc}	20.76^{bc}
Inner backfat over last rib**	24.72^{ab}	25.66^{a}	19.26^{c}	18.88^{c}	20.13^{bc}	24.73^{ab}	21.83^{abc}
Outer backfat over last rib**	22.21^{a}	24.68^{a}	19.01^{bc}	17.83^{c}	19.99^{bc}	23.14^{ab}	21.29^{abc}
Inner backfat over last lumbar vertebra**	25.99^{a}	24.89^{ab}	18.13^{c}	19.38^{bc}	21.53^{abc}	24.09^{abc}	21.93^{abc}
Outer backfat over last lumbar vertebra*	24.31^{a}	23.84^{ab}	20.68^{bc}	19.68^{c}	21.37^{abc}	21.81^{abc}	21.08^{abc}
Leaf fat**	27.14^{a}	26.64^{ab}	20.18^{c}	22.83^{bc}	24.98^{ab}	25.33^{ab}	24.90^{ab}
Intramuscular from Longissimus dorsi	24.22	23.00	22.53	24.20	22.85	23.99	23.86

[1]See Appendices C through J for original data.

[2]Any values not having the same letter superscripts are significantly different at the level of significance indicated within the fat location. When no treatment difference is indicated, Duncan's test was conducted at $P<.05$.

** Treatment difference significant at $P<.01$.

* Treatment difference significant at $P<.05$.

was a slight increase of total saturated fatty acids in safflower oil-fed hogs due to maturity (Table 3), there was no difference in the palmitic acid content.

Fat from hogs fed tallow for 2 weeks tended to contain a larger proportion of palmitic acid than the fat from either of the safflower oil groups. The level of palmitic acid after feeding tallow for 4 weeks tended to approach the level found in the control animals. Apparently, the high level of palmitic acid in the tallow ration had some effect upon increasing it above that found in the hogs fed safflower oil.

Even though the level of palmitic acid was much higher in the tallow ration than in the control ration, the proportion of palmitic acid in the fat from the tallow-fed hogs never exceeded the proportion found in the fat of control hogs. The level of fat in the tallow ration was probably high enough that the hogs did not synthesize many fatty acids, and thus they preferentially deposited fatty acids other than palmitic. There is no obvious explanation as to why the level of palmitic acid was lower in the fat from hogs fed tallow for 6 weeks than it was after feeding tallow for 4 weeks.

Table 5 lists the adjusted means for stearic acid. There is no apparent explanation why these values are somewhat lower than those reported by Magidman et al. (1963) and Sink et al. (1964). Statistical

TABLE 5

ADJUSTED MEANS OF STEARIC ACID CONTENT BY TREATMENTS AND SAMPLE SITES (%)[1,2]

Sample site	Treatment: Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow 6 weeks
Inner backfat over first rib	7.24^{ab}	8.50^{a}	4.88^{b}	6.73^{ab}	6.78^{ab}	9.46^{a}	7.85^{ab}
Outer backfat over first rib	5.05	5.89	4.44	6.07	5.50	5.91	6.70
Inner backfat over last rib	7.14	9.45	6.24	7.92	7.36	8.97	9.05
Outer backfat over last rib	5.27^{ab}	5.93^{ab}	4.40^{b}	5.78^{ab}	5.72^{ab}	6.98^{a}	6.96^{a}
Inner backfat over last lumbar vertebra	7.03	8.81	6.42	8.04	7.60	9.07	9.33
Outer backfat over last lumbar vertebra	6.91	7.94	4.23	7.40	6.34	7.76	7.62
Leaf fat	9.02	10.88	7.48	10.55	9.61	10.29	10.90
Intramuscular from Longissimus dorsi	5.29	5.17	5.51	5.51	5.69	5.80	5.54

[1] See Appendices C through J for original data.

[2] Values not having the same letter superscripts are significantly different at $P < .05$.

analysis detected no difference between treatments in any of the sample locations. Even though the stearic acid content of the intramuscular fat was quite constant between treatments, the remaining fat locations from control hogs tended to contain a greater proportion of stearic acid than the same sites from safflower oil-fed hogs. The difference was especially evident for the initial samples. This would be expected since the control ration contained a higher level of stearic acid than the safflower oil ration. As the control ration contained a lower level of fat, the control hogs probably synthesized more stearic acid than those fed safflower oil (White et al., 1964).

Examination of the data in Table 5 also indicated the effect of maturity. The fat from the control hogs at the final sampling period contained a higher level of stearic acid than at the initial sampling period. The effect seemed even more evident when comparing the stearic acid content in fat from the initial and final groups of safflower oil-fed hogs. As the hogs matured, they appeared to selectively synthesize and deposit stearic acid. These findings are in agreement with those of Sink et al. (1964).

The fat from hogs fed tallow for 2 weeks tended to contain more stearic acid than that from the initial safflower oil group. Fat from hogs fed tallow for 4 or 6 weeks tended to contain more stearic acid than that from the final safflower oil group. This indicates that feeding

tallow tended to increase the level of stearic acid in the fat from hogs previously fed safflower oil. This was expected because the tallow ration contained more stearic acid than the safflower oil ration.

Even though the tallow ration contained more stearic acid than the control ration, there was essentially no difference in the stearic acid content between the fat from control hogs or tallow-fed hogs. Since the tallow ration also contained a higher level of fat than the control ration, this would indicate that fatty acids other than stearic are preferentially deposited.

The adjusted means for the myristic acid content are listed in Table 6. The only fat location exhibiting a definite treatment effect from myristic acid was that of the intramuscular fat. In this location, the controls tended to have the lowest level of myristic acid. In the remaining locations, fat from control hogs tended to contain a higher level of myristic acid than fat from hogs fed safflower oil. Since the myristic acid content of the two rations is about the same and the safflower oil ration contains more fat than the control, results suggest that either the control hogs synthesized myristic acid or that fatty acids other than myristic are preferentially deposited.

Fat from hogs fed tallow tended to contain as much myristic acid as the fat from control animals. Since the tallow ration contained a

TABLE 6

ADJUSTED MEANS OF MYRISTIC ACID CONTENT BY TREATMENTS AND SAMPLE SITES (%)[1,2]

Sample site	Treatment: Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow, 6 weeks
Inner backfat over first rib	0.86	0.96	0.67	0.70	0.92	0.77	0.91
Outer backfat over first rib	0.88	1.01	0.89	0.85	0.91	0.88	1.04
Inner backfat over last rib	0.92	1.01	0.70	0.70	0.68	0.85	1.00
Outer backfat over last rib	0.80^{b}	1.24^{a}	0.78^{b}	0.83^{ab}	0.90^{ab}	0.82^{b}	0.98^{ab}
Inner backfat over last lumbar vertebra	0.97^{ab}	1.02^{a}	0.61^{b}	0.65^{ab}	0.88^{ab}	0.86^{ab}	0.92^{ab}
Outer backfat over last lumbar vertebra	0.99	1.19	0.90	0.91	0.79	0.78	1.03
Leaf	0.93	1.06	0.80	0.83	0.79	0.93	1.03
Intramuscular from Longissimus dorsi**	0.61^{bc}	0.59^{c}	0.78^{abc}	0.81^{ab}	0.72^{abc}	0.82^{a}	0.82^{a}

[1]See Appendices C through J for original data.

[2]Values not having the same letter superscript are significantly different at the level of significance indicated within the fat location. When no treatment difference is indicated, Duncan's test was conducted at $P < .05$.

**Treatment difference significant at $P < .01$.

higher level of fat and more myristic acid than the control ration, this indicates that dietary myristic acid is not selectively deposited.

There seemed to be a slight effect due to maturity as the fat from the final control group contained more myristic acid than fat from the initial control group. This would indicate that a selective synthesis and deposition of myristic acid may occur as the hogs became older.

Table 7 lists the adjusted means of the linoleic acid content by treatments and sample sites. There was a highly significant treatment difference in all of the fat locations studied. However, the effects were much less evident in the intramuscular fat than in the remaining locations. Except for the linoleic acid content in the leaf fat from both control groups, the level of linoleic acid in the intramuscular fat tended to be lower than for the remaining fat locations. These findings agree with those of Ostrander and Dugan (1962), and Greer et al. (1965), who reported that backfat contained more linoleic acid than intramuscular fat.

Fat from hogs fed safflower oil contained significantly more linoleic acid than that from control or tallow-fed hogs. This was expected since the safflower oil ration contained more linoleic acid than either of the other rations.

Since the level of linoleic acid is lower in samples from the final controls than the initial controls, this would indicate that maturity has an effect upon decreasing the linoleic acid content. These findings agree with those of Sink et al. (1964).

TABLE 7

ADJUSTED MEANS OF LINOLEIC ACID CONTENT BY TREATMENTS AND SAMPLE SITES (%)[1,2]

Sample site	Treatment: Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow, 6 weeks
Inner backfat over first rib**	16.83^{cd}	12.62^{d}	39.00^{a}	38.62^{a}	29.61^{b}	23.28^{bc}	20.69^{c}
Outer backfat over first rib**	16.29^{cd}	13.92^{d}	34.84^{a}	36.25^{a}	28.63^{b}	20.48^{c}	19.44^{c}
Inner backfat over last rib**	14.61^{cd}	12.22^{d}	37.25^{a}	38.79^{a}	30.80^{b}	20.75^{c}	18.71^{cd}
Outer backfat over last rib**	16.00^{c}	13.87^{c}	36.00^{a}	38.82^{a}	28.52^{b}	19.13^{c}	19.78^{c}
Inner backfat over last lumbar vertebra**	14.76^{de}	12.88^{e}	38.30^{a}	37.99^{a}	29.74^{b}	22.26^{c}	19.68^{cd}
Outer backfat over last lumbar vertebra**	13.90^{d}	13.17^{d}	35.96^{a}	35.55^{a}	27.89^{b}	21.83^{c}	19.14^{cd}
Leaf fat **	11.97^{d}	11.71^{d}	36.72^{a}	34.86^{a}	26.05^{b}	21.00^{bc}	18.66^{c}
Intramuscular from Longissimus dorsi**	14.32^{cd}	12.52^{d}	21.10^{ab}	22.98^{a}	19.14^{abc}	17.66^{bc}	16.31^{bcd}

[1]See Appendices C through J for original data.

[2]Values not having the same letter superscript are significantly different at the level of significance indicated within the fat location.

** Treatment difference significant at $P < .01$.

Apparently the tallow exerted a significant effect upon lowering the linoleic acid content of the depot fat from the hogs previously fed safflower oil. Examination of Table 7 shows that, except for intramuscular fat, samples from hogs fed tallow for 2 weeks contained significantly less linoleic acid than those from the safflower oil groups. In most cases, there was significantly less linoleic acid in the fat from hogs fed tallow for 4 weeks as compared to those fed tallow for 2 weeks. After 6 weeks on tallow, the linoleic acid content tended to be lower than that from hogs fed tallow for 4 weeks, but greater than that from control hogs.

Examination of the linoleic acid content of the rations (Table 1) and of the depot fats (Table 7), indicated that the linoleic acid content in depot fat tends to parallel the total amount in the ration. This would suggest a preferential deposition of linoleic acid. These results are in agreement with much of the earlier work (Ellis and Isbell, 1926a; Banks and Hilditch, 1932; Hilditch et al., 1939; Shorland and de la Mare, 1945a; and Dahl and Persson, 1965).

The adjusted means of the oleic acid content are listed in Table 8. There was a highly significant treatment difference at all of the fat locations studied. As with linoleic acid, differences in the oleic acid content were much less evident in the intramuscular fat than in the remaining fat locations. The levels of oleic acid tended to be slightly higher in the intramuscular fat than in the other fat locations. This is

TABLE 8

ADJUSTED MEANS OF OLEIC ACID CONTENT BY TREATMENTS AND SAMPLE SITES (%)[1,2]

Sample site	Treatment: Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow, 6 weeks
Inner backfat over first rib**	44.75^{ab}	45.83^{a}	31.67^{d}	30.16^{d}	33.95^{cd}	39.13^{bc}	42.77^{ab}
Outer backfat over first rib**	47.79^{a}	46.41^{a}	33.80^{b}	31.77^{b}	36.69^{b}	44.79^{a}	45.48^{a}
Inner backfat over last rib**	46.23^{a}	45.67^{a}	30.67^{c}	29.63^{c}	36.19^{b}	40.66^{ab}	41.70^{ab}
Outer backfat over last rib**	49.27^{a}	46.67^{ab}	33.15^{d}	32.55^{d}	38.99^{c}	44.45^{b}	43.92^{b}
Inner backfat over last lumbar vertebra**	44.93^{a}	46.02^{a}	31.58^{de}	29.58^{e}	34.57^{cd}	38.63^{bc}	40.42^{b}
Outer backfat over last lumbar vertebra**	46.78^{a}	46.71^{a}	31.27^{c}	31.71^{c}	38.13^{b}	43.06^{a}	43.90^{a}
Leaf fat **	45.23^{a}	43.48^{a}	29.95^{de}	25.87^{e}	33.16^{cd}	36.83^{bc}	40.48^{ab}
Intramuscular from Longissimus dorsi**	48.44^{ab}	52.40^{a}	43.31^{bc}	40.68^{c}	44.31^{bc}	44.49^{bc}	47.26^{ab}

[1]See Appendices C through J for original data.

[2]Values not having the same letter superscript are significantly different at the level of significance indicated within the fat location.

** Treatment difference significant at $P<.01$.

in agreement with the findings of Ostrander and Dugan (1962) and Greer et al. (1965).

Fat from the safflower oil-fed hogs contained significantly less oleic acid than the fat from control hogs. This would be expected since the control ration contained a greater proportion of oleic acid than the safflower oil ration.

The level of oleic acid in samples from hogs fed tallow for 2 weeks was greater than that in samples from either of the safflower oil groups. The amount of oleic acid in fat from hogs fed tallow for 6 weeks was not greatly different than that from controls. Since the tallow ration contained a larger amount of oleic acid than either of the other rations, it would be expected that the oleic acid content in the fat from the tallow-fed hogs would increase more extensively than it did. Apparently the amount of oleic acid deposited in the fat depots of the hog is not markedly influenced by the content in the feed. This is in agreement with the results of Blumer et al. (1957).

Table 9 lists the adjusted means of the palmitoleic acid content by treatments and sample sites. Only two of the fat locations were shown to be significantly influenced by treatments. However, Duncan's test at the $P < .05$ level indicated that significant differences occurred in all of the sample sites except the leaf fat. There was a tendency for the level of palmitoleic acid to be lower in the fat from safflower oil-fed hogs than it was in the fat from control hogs.

TABLE 9

ADJUSTED MEANS OF PALMITOLEIC ACID CONTENT BY TREATMENTS AND SAMPLE SITES (%)[1,2]

Sample site	Treatment: Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow, 6 weeks
Inner backfat over first rib	4.52^{ab}	5.11^{a}	3.84^{ab}	3.31^{b}	4.37^{ab}	3.71^{ab}	4.52^{ab}
Outer backfat over first rib	5.56^{ab}	6.81^{a}	4.44^{ab}	3.62^{b}	4.61^{ab}	3.84^{b}	4.90^{ab}
Inner backfat over last rib*	5.32^{a}	4.54^{abc}	4.02^{abcd}	2.72^{d}	3.52^{bcd}	2.92^{cd}	5.25^{ab}
Outer backfat over last rib	5.15^{ab}	5.90^{a}	4.87^{ab}	2.93^{b}	4.26^{ab}	4.10^{ab}	4.97^{ab}
Inner backfat over last lumbar vertebra	4.98^{ab}	4.99^{ab}	3.54^{ab}	3.00^{b}	4.05^{ab}	3.64^{ab}	5.57^{a}
Outer backfat over last lumbar vertebra	5.65^{a}	5.48^{a}	4.80^{ab}	3.34^{b}	4.13^{ab}	3.22^{b}	5.02^{ab}
Leaf fat	4.59	5.32	3.61	3.63	4.00	4.28	4.26
Intramuscular from Longissimus dorsi *	5.70^{abc}	4.90^{cd}	5.12^{bcd}	4.71^{d}	5.85^{ab}	6.03^{a}	5.15^{bcd}

[1]See Appendices C through J for original data.

[2]Values not having the same letter superscript are significantly different at the level of significance indicated within the fat location. When no treatment difference is indicated, Duncan's test was conducted at P .05.

* Treatment difference significant at $P < .05$.

There was not much difference in the level of palmitoleic acid between the samples from the initial safflower oil group and that from the tallow group after 2 weeks. The proportion of palmitoleic acid in the fat from hogs fed tallow for 6 weeks tended to be greater than that in fat from hogs fed safflower oil. This indicates that dietary tallow increased the palmitoleic acid content in the fat from hogs previously fed safflower oil. There is no apparent explanation as to why the level of palmitoleic acid was lower in the fat from hogs fed tallow for 4 weeks than it was in the fat from the 2 week or 6 week tallow group.

It is noted that the amount of palmitoleic acid in the tallow ration was much greater than in either of the other rations (Table 1). Thus, it might be expected that fat from hogs fed tallow for 6 weeks would contain a higher level of palmitoleic acid than the fat produced from the control ration. Since this did not happen, it is possible that palmitoleic acid is not selectively deposited from dietary fat.

Table 10 summarizes the fatty acid composition of backfat. The greatest changes due to diet occurred for linoleic and oleic acids. Changes in the amount of linoleic acid can be almost entirely explained by the amounts in the rations. The evidence presented indicates that hogs preferentially deposit dietary linoleic acid. However, the changes in the level of oleic acid can not be explained by diet nearly as well as those of linoleic acid. This would suggest that some other factor may control the level of oleic acid in depot fat.

TABLE 10

AVERAGES OF THE ADJUSTED MEANS OF THE FATTY ACID CONTENT IN BACKFAT BY TREATMENTS (%)[1,2]

Fatty acid	Treatment						
	Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow, 6 weeks
Total saturated	31.47	33.72	25.08	26.82	28.70	31.96	30.38
16:0	24.12	24.89	19.22	19.03	21.30	23.12	21.46
18:0	6.44	7.76	5.10	6.99	6.55	8.02	7.92
14:0	0.90	1.08	0.76	0.77	0.85	0.83	0.98
18:2	15.40	13.11	36.89	37.67	29.20	21.29	19.57
18:1	46.62	46.22	32.02	30.90	36.42	41.78	43.03
16:1	5.20	5.47	4.25	3.16	4.16	3.57	5.04

[1]See Appendices C through J for original data.

[2]See Tables 3 through 9 for adjusted means at each of the backfat sites.

It is evident that there is a definite change in the total saturated fatty acid content of backfat, which can be attributed to diet. Much of the change is accounted for by the level of palmitic acid, but myristic and stearic acids are also affected in a similar manner. Although much of the change in saturated fatty acid composition can be attributed to differences of the various saturated fatty acids in the diet, diet does not seem to explain all of the alterations.

The preferential deposition of linoleic acid appeared to have an effect upon lowering the degree of saturation. These results agree with those of Ellis and Hankins (1925), Ellis and Zeller (1930), and Sink et al., (1964), but disagree with those of Shorland and de la Mare (1945b) and Dahl (1958), who indicated that as the oleic acid content increased, the degree of saturation decreased.

Results suggest that the hog attempts to maintain a more constant level of total saturated fatty acids than can be explained by the level of linoleic acid. The hog appears to accomplish this by regulating the deposition of oleic acid. Dahl and Persson (1965) previously reported similar results. Palmitoleic acid seems to behave in much the same manner as oleic acid.

By examining the fatty acid composition of the control groups (Table 10), the effects of maturity can be studied. As hogs mature,

the degree of saturation seems to increase about the same amount as the linoleic acid content decreases. The level of myristic, palmitic, and stearic acids all increase, but the increase in stearic acid is the greatest. The effects of maturity upon the levels of stearic acid are also evident in the backfat from safflower oil-fed hogs. Maturity seems to have little effect upon the levels of oleic and palmitoleic acids.

A comparison of the fatty acid composition of backfat from control and safflower oil-fed hogs (Table 10) indicates that diet can have a pronounced effect upon increasing the unsaturated fatty acid content, particularly of linoleic acid, to an extent where it may compare favorably with vegetable oils. Thus, pork fat might be used to advantage in human diets to maintain a low serum cholesterol level. However, before making such a postulation, the work of Elson (1964), who reported that the triglyceride structure of lard did not adapt itself to reducing serum cholesterol levels, must be further investigated.

The question arises as to the reason why the degree of saturation was less in the fat from the group on tallow for 6 weeks as compared to the group on the same ration for 4 weeks. Most of this change appears to be due to a decrease in palmitic acid. It was suspected that environmental temperature may have exerted an influence (Henriques and Hansen, 1901; Sinclair, 1936). However, in checking with the U. S. Weather Bureau, it was found that there was essentially no

difference in the average daily mean temperature for either the one or the two week period before the slaughter of the groups concerned.

Carcass firmness scores (Table 2) appear to be directly related to the degree of saturation and inversely related to the linoleic acid content of backfat (Table 10). Bhattacharya and Hilditch (1931) and Banks and Hilditch (1932) indicated that soft fat was due to a high level of linoleic acid. Hilditch et al. (1939) disagreed slightly, stating that increases in the levels of both linoleic and oleic acids caused a soft fat. However, Blumer et al. (1957) reported that the oleic acid content has little effect on fat firmness.

Rapidity of Fatty Acid Changes in Response to Diet

Results indicate that the major changes in fatty acid composition occur within 4 - 5 weeks on any given diet. The fatty acid composition of the fat from the final safflower oil group (as seen in Table 10 and as statistically analyzed in Tables 3 - 9) was not significantly different from that of the initial safflower oil group. Although the linoleic acid content was found to change markedly as a result of diet, the level of the initial and final safflower groups was practically identical. Examination of the changes in the fatty acid pattern of fat from pigs fed tallow showed that the major alterations occurred during the first 4 weeks.

Differences in Fatty Acid Changes due to Sample Sites

The fatty acid composition of intramuscular fat was affected much less than that of leaf fat or backfat (Tables 3- 9). Table 3 indicates that the degree of saturation of the intramuscular fat remained fairly constant in the present study. This is consistent with the results of Greer et al. (1965), who reported no change in the total saturated fatty acid content of intramuscular fat from hogs fed corn or barley rations at various levels of energy intake. There was no appreciable difference due to diet for palmitic or stearic acid contents of intramuscular fat (Tables 4 - 5). The myristic acid content of the intramuscular fat was affected more than that of backfat or leaf fat.

The amount of linoleic and oleic acid in the intramuscular fat was affected by diet, but the changes were much less extensive than they were in the leaf fat or backfat (Tables 8 - 9). The changes of these two acids in the intramuscular fat also appeared to occur more slowly than at the other sample sites. Even though the linoleic acid content of the intramuscular fat was altered, a constant degree of saturation was maintained because the level of oleic acid changed to compensate for the linoleic acid change.

Table 11 compares the fatty acid composition between the inner and outer layers of backfat. The data presented indicate that the inner backfat layer undergoes more extensive changes than the outer layer.

TABLE 11

AVERAGES OF THE ADJUSTED MEANS FOR THE FATTY ACID COMPOSITION OF THE INNER AND OUTER LAYERS OF BACKFAT BY TREATMENT (%) [1,2]

Fatty acid	Backfat layer	Treatment: Control, initial	Control, final	Safflower oil, initial	Safflower oil, final	Tallow, 2 weeks	Tallow, 4 weeks	Tallow, 6 weeks
Total saturated	inner	33.14	35.33	25.11	27.36	29.53	33.73	31.57
	outer	29.79	32.11	25.04	26.27	27.86	30.20	29.20
16:0	inner	25.09	25.41	18.60	19.11	21.46	23.74	21.88
	outer	23.16	24.37	19.83	18.95	21.15	22.49	21.04
18:0	inner	7.14	8.92	5.85	7.56	7.25	9.17	8.74
	outer	5.74	6.59	4.36	6.42	5.85	6.88	7.09
14:0	inner	0.92	1.00	0.66	0.68	0.83	0.83	0.94
	outer	0.89	1.15	0.86	0.86	0.87	0.83	1.02
18:2	inner	15.40	12.57	38.18	38.47	30.05	22.10	19.69
	outer	15.40	13.65	35.60	36.87	28.35	20.48	19.45
18:1	inner	45.30	45.84	31.31	29.79	34.90	39.47	41.63
	outer	47.95	46.60	32.74	32.01	37.94	44.10	44.43
16:1	inner	4.94	4.88	3.80	3.01	3.98	3.42	5.11
	outer	5.45	6.06	4.70	3.30	4.33	3.72	4.96

[1]See Appendices C through J for original data.

[2]See Tables 3 through 9 for adjusted means at each of the backfat sites.

These results agree with those previously reported by Bhattacharya and Hilditch (1931), but are in contrast to the work of Garton et al. (1952). There is also some evidence (Tables 3, 4, and 7) that backfat from over the last rib is affected less extensively than that from over the first rib or last lumbar vertebra.

The data in Table 11 reveal that the inner backfat layer from control hogs contained about 3.3% more total saturated fatty acids than the outer layer. In the safflower oil-fed hogs, the outer layer of backfat was nearly as saturated as the inner layer. The data shown in Table 3 indicate that the outer layer of backfat from safflower oil-fed hogs was sometimes more saturated than the inner layer at the sites of the first rib and last lumbar vertebra. However, the inner layer from over the last rib still contained about 2% more saturated fatty acids than the outer. In backfat from the tallow-fed hogs, the inner layers were more saturated than the outer layers at all of the backfat locations studied. This confirms the postulation that the inner backfat layer is affected more extensively by diet than the outer layer.

The changes in the total saturated fatty acids of the two backfat layers were mainly accounted for by palmitic acid. Table 11 indicates that in control hogs the inner backfat layer contained more palmitic acid than the outer. In the safflower oil-fed hogs, however, the outer layer of backfat contained just as much or more palmitic acid than the

inner layer. In the backfat from tallow-fed hogs, the inner layer again contains more palmitic acid than the outer layer. The differences in backfat from over the last rib as compared to that from over the first rib and last lumbar vertebra as noted for total saturated fatty acids, were also evident for palmitic acid (Table 4).

Table 11 shows that the linoleic acid content in the outer backfat layer of the control hogs was just as great or greater than it was in the inner layer. However, the inner layer of backfat from pigs fed safflower oil contained more linoleic acid than the outer layer. This same relationship was apparent in the backfat from the tallow-fed hogs, but the difference became progressively less as the length of time on tallow was increased. Inspection of Table 7 shows that the effects just discussed were more evident in the backfat from over the first rib and last lumbar vertebra than they were in backfat from over the last rib.

Apparently the inner backfat layer does not undergo greater changes than the outer layer for all of the fatty acids. The inner layer of backfat contained more stearic and less oleic acid than the outer layer in all of the treatment groups (Table 11). Except for the backfat from the initial control group, the outer layer contained just as much or more myristic acid than the inner layer. The outer backfat layer contained more palmitoleic acid than the inner layer in all treatments except for the 6 week tallow group.

Examination of Tables 3- 9 indicate that the fatty acid changes occurring in leaf fat are intermediate in degree between those of the inner and outer layers of backfat. Bhattacharya and Hilditch (1931) had previously stated that the fatty acid changes in the leaf fat were very similar to those of the inner layer of backfat.

Effect of Sex upon the Fatty Acid Composition

The adjusted means for each of the fatty acids according to sex are listed in Table 12. These data show that significant sex differences occur for total saturated fatty acids, palmitic acid, stearic acid, and linoleic acid. There were no differences attributable to sex in any of the fat locations for myristic acid, oleic acid, and palmitoleic acid. There was essentially no difference due to sex for any of the fatty acids in the intramuscular fat.

Barrows contained more total saturated fatty acids in the leaf fat and backfat than gilts. The levels of palmitic and stearic acid in the leaf fat and backfat of barrows were higher than those in the same sample sites of gilts. The difference in degree of saturation appeared to be accounted for by the level of linoleic acid, since the fat from gilts contained more linoleic acid than that from barrows.

It might be expected that the reason fat from barrows was more saturated than that from gilts is because barrows tend to have a greater

TABLE 12

ADJUSTED MEANS OF THE FATTY ACID COMPOSITION IN FAT FROM BARROWS AND GILTS BY SAMPLE SITES (%)[1]

	Fatty acid					
	Total saturated		16:0		18:0	
Sample site	Barrow	Gilt	Barrow	Gilt	Barrow	Gilt
Inner backfat over first rib	31.41	29.15	22.77	21.44	7.78	6.93
Outer backfat over first rib	29.75*	26.82	22.92**	20.52	5.89	5.41
Inner backfat over last rib	32.70*	29.37	22.97	21.38	8.88*	7.16
Outer backfat over last rib	29.59**	26.32	22.09*	20.24	6.53*	5.20
Inner backfat over last lumbar vertebra	32.96**	29.36	23.09	21.47	9.00*	7.08
Outer backfat over last lumbar vertebra	30.88*	28.42	22.58	21.07	7.37	6.40
Leaf fat	37.90**	32.70	26.00**	23.15	10.93*	8.72
Intramuscular from Longissimus dorsi	30.18	29.34	23.94	23.10	5.46	5.54

[1]See Appendices C through J for original data.

** Sex difference significant at $P<.01$.

* Sex difference significant at $P<.05$.

TABLE 12 - Continued

Fatty acid							
14:0		18:2		18:1		16:1	
Barrow	Gilt	Barrow	Gilt	Barrow	Gilt	Barrow	Gilt
0.86	0.79	24.31*	27.30	38.62	38.02	4.11	4.28
0.96	0.88	22.45**	26.08	41.25	40.67	4.84	4.81
0.85	0.83	23.31*	26.15	38.79	38.57	3.69	4.40
0.96	0.85	22.78**	26.40	41.35	41.23	4.60	4.59
0.88	0.81	23.26**	26.91	37.78	38.14	4.35	4.15
0.93	0.95	22.76	25.08	40.26	40.19	4.50	4.55
0.98	0.84	20.10**	25.47	36.50	36.36	4.17	4.31
0.77	0.70	17.85	17.58	45.27	46.40	5.44	5.26

backfat thickness. Thus, a greater proportion of the depot fat from barrows would have been synthesized from non-lipid sources, tending to make it more saturated (Ellis and Hankins, 1925). On examining the backfat thickness of each hog (Appendix A) as opposed to the degree of saturation of the various fat locations (Appendices C - J), it is found that the more highly saturated fat from barrows is not always explained by differences in backfat thickness. Thus, some other factor must be responsible for the sex difference, although the reason is not evident from this study.

Correlation Coefficients of the Individual Fatty Acids with Degree of Saturation.

Table 13 lists the simple correlation coefficients between the % of the various fatty acids and the % of total saturated fatty acids for each of the sample sites. A high positive correlation was evident between the palmitic acid content and the total saturated fatty acid content. In all of the fat locations, except for the intramuscular fat, there was a high negative correlation between the linoleic acid content and the degree of saturation. This would indicate that the levels of total saturated fatty acids in leaf fat and backfat are directly controlled by palmitic acid, and inversely controlled by linoleic acid.

TABLE 13

SIMPLE CORRELATION COEFFICIENTS BETWEEN EACH OF THE FATTY ACIDS AND THE AMOUNT OF TOTAL SATURATED FATTY ACIDS BY SAMPLE SITES

Sample site	Fatty acid 16:0	18:0	14:0	18:2	18:1	16:1
Inner backfat over first rib	0.93	0.77	0.67	-.86	0.61	0.44
Outer backfat over first rib	0.91	0.53	0.51	-.67	0.38	0.36
Inner backfat over last rib	0.91	0.72	0.63	-.83	0.64	0.10
Outer backfat over last rib	0.94	0.72	0.55	-.81	0.59	0.27
Inner backfat over last lumbar vertebra	0.87	0.52	0.68	-.87	0.69	0.32
Outer backfat over last lumbar vertebra	0.74	0.68	0.60	-.80	0.60	0.18
Leaf fat	0.86	0.77	0.68	-.76	0.46	0.20
Intramuscular from Longissimus dorsi	0.96	0.33	0.29	-.03	-.28	0.11

Effect of Diet upon Palatability

The taste panel scores and shear values of the samples by treatments are listed in Table 14. It can be seen that there was a tendency for the loin roast samples from both the safflower oil and tallow-fed hogs to be preferred over the control samples. However, analysis of variance showed that there was no significant difference due to treatment for

tenderness, juiciness, flavor, overall acceptability, and Warner-Bratzler shear values. This suggests that none of the rations used in this experiment had any deleterious effects upon the eating qualities of the pork produced.

TABLE 14

EFFECT OF TREATMENT UPON TASTE PANEL SCORES AND WARNER-BRATZLER SHEAR VALUES[1]

Treatment	Overall acceptability[2]	Flavor[2]	Juiciness[2]	Tenderness Panel[2]	Tenderness Shear[2]
Control, initial	5.87	6.09	5.22	6.39	10.48
Control, final	5.93	5.71	5.59	6.76	8.92
Safflower oil, initial	6.07	6.37	5.46	6.24	9.18
Safflower oil, final	6.19	6.35	5.80	6.04	10.80
Tallow, 2 weeks	6.20	6.48	6.11	6.22	9.73
Tallow, 4 weeks	5.98	6.11	5.80	6.59	9.91
Tallow, 6 weeks	6.15	6.24	6.00	6.17	10.10

[1]See Appendix K for the data of each sample.

[2]Analysis of variance showed no treatment difference.

SUMMARY AND CONCLUSIONS

A study was made to determine the effects of diet upon the fatty acid composition of leaf fat, intramuscular fat from the Longissimus dorsi muscle, and both the inner and outer layers of backfat from over the first rib, last rib, and last lumbar vertebra. The effects of a 10% safflower oil ration were compared to a control ration. In addition, the effects of a 10% tallow ration upon the fatty acid composition of hogs previously fed 10% safflower oil were also studied.

Carcasses from the control hogs were definitely firmer than those from safflower oil-fed hogs. Feeding tallow to hogs previously fed safflower oil improved carcass firmness. However, the carcasses from hogs fed tallow for 6 weeks were still not as firm as the control carcasses. In both the control and safflower oil-fed hogs, the carcasses from the final groups were firmer than those from the respective initial groups.

The leaf fat and backfat from hogs fed safflower oil contained less total saturated fatty acids than that from control hogs. This difference was mainly due to palmitic acid, but the levels of myristic and stearic acids were slightly lower in the fat from the safflower oil-fed hogs than that from controls. There was an increase in all of the saturated fatty acids in the fat of tallow-fed hogs over those fed safflower oil.

Fat from safflower oil-fed hogs contained significantly more linoleic acid and significantly less oleic acid than the fat from control hogs. Feeding tallow tended to restore the levels of linoleic and oleic acids to the levels in the fat of control animals.

The major fatty acid changes due to diet occurred within 4 - 5 weeks. This became evident when comparing the fatty acid composition of the fat from the initial and final safflower oil groups, and again when comparing the composition of fat from hogs fed tallow for 2, 4, and 6 weeks.

The fatty acid composition of the intramuscular fat was affected much less by diet than was the composition of the leaf fat or backfat. The inner layer of backfat underwent more extensive changes than the outer layer. The effect was less evident in backfat from over the last rib than it was over the first rib or last lumbar vertebra. Leaf fat was affected less than the inner backfat layer, but more than the outer layer of backfat.

The palmitic acid content had a high positive correlation with the level of total saturated fatty acids, while the linoleic acid content had a high negative correlation with the degree of saturation. Linoleic acid in the diet appeared to be preferentially deposited in the depot fat of the hog, and thereby tended to lower the level of total saturated fatty acids. In an attempt to maintain a constant degree of saturation, the hog apparently varies the level of oleic acid to compensate for the changes in linoleic acid.

The degree of saturation appeared to be responsible for carcass firmness. Since the level of linoleic acid influences the degree of saturation, it is possible that the linoleic acid content exerted a greater effect upon carcass firmness than the degree of saturation.

It was found that ration could alter the fatty acid composition of pork fat to an extent where it may have a favorable effect upon lowering serum cholesterol levels of humans. However, the adverse effects of the triglyceride structure of lard upon this phenomena must be further investigated.

There was a slight tendency for the loin samples of the safflower oil and tallow-fed hogs to be preferred over the control samples. However, there was no significant difference in the consumer preference of loin roasts from any of the treatment groups.

The depot fat from barrows contained a higher level of total saturated fatty acids than did that of gilts. The leaf fat and backfat of barrows contained more palmitic and stearic acids than did similar fat samples from gilts. Gilts deposited a higher level of linoleic acid in their depot fat than did barrows. There was no sex difference in the fatty acid composition of the intramuscular fat.

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APPENDIX

APPENDIX A

SLAUGHTER AND CARCASS DATA

Hog no.	Treatment[1]	Sex[2]	Slaughter wt.(lbs.)	Carcass wt.(lbs.)	Dressing %	Carcass length (inches)	Carcass firmness[3]
1	CY	B	149	104.0	69.8	27.4	4.67
2	CY	G	159	109.0	68.6	27.4	4.33
3	CY	G	130	91.0	70.0	26.8	4.00
4	CO	B	240	181.0	75.4	30.6	5.00
5	CO	B	220	161.5	73.4	29.8	5.00
6	CO	G	215	162.5	75.6	30.0	5.00
7	OY	B	157	112.0	71.3	28.7	2.33
8	OY	B	156	111.0	71.2	27.4	2.67
9	OY	G	152	108.5	71.4	27.4	2.00
10	OO	B	250	187.0	74.8	30.2	2.67
11	OO	G	260	197.5	76.0	31.1	2.67
12	OO	G	212	162.5	76.6	29.9	3.00
13	T2	B	172	125.0	72.7	27.4	3.67
14	T2	G	188	139.0	73.9	28.9	3.33
15	T2	G	174	125.0	71.8	28.9	3.33
16	T4	B	206	158.0	76.7	28.9	2.33*
17	T4	G	192	145.5	75.8	30.2	2.67*
18	T4	G	210	160.5	76.4	30.4	3.33*
19	T6	B	258	196.5	76.2	30.1	3.67
20	T6	G	224	167.5	74.8	30.8	4.00
21	T6	G	240	181.0	75.4	30.2	4.33

[1]CY - control, initial; CO - control, final; OY - safflower oil, initial, OO - safflower oil, final; T2 - tallow, 2 weeks; T4 - tallow, 4 weeks; T6 - tallow, 6 weeks.

[2]B - barrow; G - gilt.

[3]1 - very soft; 2 - soft; 3 - slightly hard; 4 - hard; 5 - very hard.

*These are leaf fat firmness scores as the carcasses were processed before the committee had a chance to evaluate them.

APPENDIX A

SLAUGHTER AND CARCASS DATA (CONT.)

Hog no.	Backfat thickness (mm.) 1st rib	7th rib	Last rib	Last Lumbar	Average backfat thickness[4] (mm.)	(inches)	Loin eye area (sq. inches) 10th rib	Last rib
1	40	20	22	17	26.3	1.03	3.34	3.37
2	41	25	27	23	30.3	1.19	3.55	3.78
3	38	18	17	16	23.7	0.93	3.03	3.42
4	65	37	36	45	48.7	1.92	4.94	4.86
5	45	36	32	31	36.0	1.42	4.25	4.49
6	50	33	33	27	36.7	1.44	4.41	5.03
7	43	30	22	26	30.3	1.19	3.04	3.47
8	47	30	31	31	36.3	1.43	3.09	3.10
9	40	28	21	22	27.7	1.09	3.65	4.07
10	70	51	51	45	55.3	2.18	5.19	4.06
11	53	42	43	43	46.3	1.82	5.98	5.12
12	55	28	32	33	40.0	1.58	4.21	3.70
13	48	38	33	37	39.3	1.55	3.54	3.29
14	52	35	27	32	37.0	1.46	3.81	4.54
15	50	24	27	24	33.7	1.33	4.04	4.18
16	53	47	42	37	44.0	1.73	4.76	4.90
17	52	27	32	32	38.7	1.53	4.14	4.34
18	48	36	35	34	39.0	1.54	4.85	5.28
19	60	44	42	45	49.0	1.93	5.13	4.86
20	55	32	32	31	39.3	1.55	5.12	4.86
21	65	47	52	42	53.0	2.09	4.96	4.70

[4]Average backfat thickness is the mean of all the values except that from over the 7th rib.

APPENDIX A

SLAUGHTER AND CARCASS DATA (CONT.)

	Trimmed ham			Trimmed loin			Trimmed shoulder			Lean cuts		
Hog no.	lbs.	% live wt.	% carcass wt.	lbs.	% live wt.	% carcass wt.	lbs.	% live wt.	% carcass wt.	lbs.	% live wt.	% carcass wt.
1	21.6	14.5	20.8	17.6	11.8	16.9	20.8	14.0	20.0	60.0	40.3	57.7
2	23.7	14.9	21.7	19.2	12.1	17.6	21.1	13.3	19.4	64.0	40.3	58.7
3	19.4	14.9	21.3	17.6	13.5	19.3	16.8	12.9	18.5	53.8	41.4	59.1
4	32.8	13.7	18.1	28.3	11.8	15.6	32.0	13.3	17.7	93.1	38.8	51.4
5	28.8	13.1	17.8	26.6	12.1	16.5	28.4	12.9	17.6	83.8	38.1	51.9
6	32.0	14.9	19.7	27.8	12.9	17.1	28.0	13.0	17.2	87.8	40.8	54.0
7	21.1	13.4	18.8	18.2	11.6	16.3	19.8	12.6	17.7	59.1	37.6	52.8
8	21.6	13.8	19.5	18.3	11.7	16.5	20.5	13.1	18.5	60.4	38.7	54.4
9	23.5	15.5	21.7	20.8	13.7	19.2	18.4	12.1	17.0	62.7	41.3	57.8
10	29.9	12.0	16.0	27.4	11.0	14.7	34.2	13.7	18.3	91.5	36.6	48.9
11	37.2	14.3	18.8	30.6	11.8	15.5	33.0	12.7	16.7	100.8	38.8	51.0
12	29.6	14.0	18.2	24.8	11.7	15.3	27.5	13.0	16.9	81.9	38.6	50.4
13	23.6	13.7	18.9	18.8	10.9	15.0	21.1	12.3	16.9	63.5	36.9	50.8
14	27.8	14.8	20.0	23.2	12.3	16.7	25.9	13.8	18.6	76.9	40.9	55.3
15	24.8	14.2	19.8	21.1	12.1	16.9	24.0	13.8	19.2	69.9	40.2	55.9
16	29.9	14.5	18.9	27.2	13.2	17.2	27.4	13.3	17.3	84.5	41.0	53.5
17	27.7	14.4	19.0	23.5	12.2	16.2	26.7	13.9	18.4	77.9	40.6	53.5
18	31.0	14.8	19.3	26.6	12.7	16.6	29.1	13.9	18.1	86.7	41.3	54.0
19	33.5	13.0	17.0	29.0	11.2	14.8	31.4	12.2	16.0	93.9	36.4	47.8
20	32.1	14.3	19.2	27.6	12.3	16.5	31.2	13.9	18.6	90.9	40.6	54.3
21	31.7	13.2	17.5	27.3	11.4	15.1	30.4	12.7	16.8	89.4	37.2	49.4

APPENDIX A

SLAUGHTER AND CARCASS DATA (CONT.)

	Trimmed belly			Primal cuts			Fat trim			
Hog no.	lbs.	% live wt.	% carcass wt.	lbs.	% live wt.	% carcass wt.	lbs.	% live wt.	% carcass wt.	Lean trim lbs.	Leaf fat and kidney (lbs.)
1	11.9	8.0	11.4	71.9	48.3	69.1	18.6	12.5	17.9	2.7	2.2
2	12.9	8.1	11.8	76.9	48.4	70.6	17.2	10.8	15.8	1.9	3.0
3	10.1	7.8	11.1	63.9	49.2	70.2	13.6	10.5	14.9	2.6	1.5
4	24.3	10.1	13.4	117.4	48.9	64.9	44.7	18.6	24.7	5.1	6.8
5	22.4	10.2	13.9	106.2	48.3	65.8	50.0	22.7	31.0	5.6	5.5
6	21.9	10.2	13.5	109.7	51.0	67.5	34.5	16.0	21.2	5.3	4.9
7	13.6	8.7	12.1	72.7	46.3	64.9	24.6	15.7	22.0	3.3	2.5
8	14.2	9.1	12.8	74.6	47.8	67.2	25.6	16.4	23.1	2.2	2.8
9	13.7	9.0	12.6	76.4	50.3	70.4	19.8	13.0	18.2	2.7	2.7
10	27.6	11.0	14.8	119.1	47.7	63.7	53.8	21.5	28.8	5.2	8.1
11	25.2	9.7	12.8	126.0	48.5	63.8	49.0	18.8	24.8	5.8	4.7
12	23.0	10.8	14.2	104.9	49.5	64.6	40.8	19.2	25.1	6.9	5.5
13	15.7	9.1	12.6	79.2	46.0	63.4	30.8	17.9	24.6	3.7	3.1
14	16.8	8.9	12.1	93.7	49.8	67.4	27.8	14.8	20.0	4.4	3.3
15	14.4	8.3	11.5	84.3	48.4	67.4	24.5	14.1	19.6	3.6	2.7
16	19.8	9.6	12.5	104.3	50.6	66.0	39.1	19.0	24.7	3.9	6.7
17	19.9	10.4	13.7	97.8	50.9	67.2	31.7	16.5	21.8	3.9	4.5
18	19.9	9.5	12.4	106.6	50.8	66.4	34.2	16.3	21.3	4.5	5.6
19	26.4	10.2	13.4	120.3	46.6	61.2	53.6	20.8	27.3	6.4	5.9
20	22.9	10.2	13.7	113.8	50.8	67.9	37.2	16.6	22.2	4.1	4.7
21	25.4	10.6	14.0	114.8	47.8	63.4	50.0	20.8	27.6	5.7	7.2

APPENDIX B

RATE OF GAIN AND FEED EFFICIENCY

Treatment[1]	Time period	Wt. gained (lbs.	Rate of gain (lbs./day)	Feed Consumed (lbs.)	Feed efficiency (lbs. feed/ lbs. gain)
CY	0 - 5th week (34 days)	159	1.56	1050	2.99
CO	0 - 5th week (35 days)	192	1.83		
CO	5th-7th week (13 days)	53	1.36	399*	2.93
CO	7th-9th week (14 days)	83	1.98		
CO	9th-11th week (14 days)	73	1.74	246	3.37
OY	0 - 5th week (34 days)	192	1.88	1307	3.23
OO	0 - 5th week (35 days)	213	2.03		
OO	5th-7th week (13 days)	60	1.54	210*	3.50
OO	7th-9th week (14 days)	77	1.83	299	3.88
OO	9th-11th week (14 days)	97	2.31	374	3.86
T2	0 - 5th week (35 days)	178	1.70		
T4	0 - 5th week (35 days)	182	1.73	1619	3.08
T6	0 - 5th week (35 days)	166	1.58		
T2	5th-7th week (13 days)	74	1.90		
T4	5th-7th week (13 days)	83	2.13	740*	3.06
T6	5th-7th week (13 days)	85	2.18		
T4	7th-9th week (14 days)	73	1.74	577	3.87
T6	7th-9th week (14 days)	76	1.81		
T6	9th-11th week (14 days)	101	2.40	353	3.50

[1]CY - control, initial; CO - control, final; OY - safflower oil, initial; OO - safflower oil, final; T2 - tallow, 2 weeks; T4 - tallow, 4 weeks; T6 - tallow, 6 weeks.

*These values are only estimates as there was difficulty in keeping the feed weights recorded properly.

APPENDIX C

FATTY ACID COMPOSITION OF LEAF FAT (%)

	Fatty Acid										
Hog no.[1]	Total sat.	14:0	16:0	18:0	Total unsat.	16:1	18:1	18:2	18:3	20:2*	20:4
1	38.81	0.99	29.04	8.78	61.19	3.25	44.74	12.07	1.13	T	T
2	32.81	0.78	23.76	8.27	67.19	6.21	46.70	13.27	1.01	?	?
3	37.09	0.96	27.21	8.92	62.91	4.37	44.17	13.25	1.12	T	T
4	41.24	1.04	25.89	14.31	58.76	5.43	41.87	10.43	0.84	0.19	T
5	41.65	1.28	29.20	11.17	58.35	6.26	42.48	8.57	0.84	0.20	?
6	35.44	0.92	26.24	8.28	64.56	4.19	46.17	13.45	0.75	T	T
7	31.84	0.93	22.37	8.54	68.16	2.52	31.40	33.05	1.19	T	T
8	30.53	0.92	21.51	8.10	69.47	4.45	31.85	32.05	1.12	T	T
9	25.62	0.61	18.09	6.92	74.38	3.78	26.66	42.37	1.31	0.26	T
10	40.27	0.95	23.36	15.96	59.73	2.67	24.33	31.22	1.10	0.41	?
11	31.16	0.91	23.02	7.23	68.84	2.80	25.62	39.06	1.36	?	?
12	28.60	0.57	20.68	7.35	71.40	5.48	27.60	36.98	1.34	T	?
13	40.11	0.78	28.77	10.56	59.89	4.85	32.95	20.84	1.08	0.17	?
14	32.05	0.62	22.91	8.52	67.95	2.26	35.59	29.05	1.05	T	T
15	31.37	0.90	21.83	8.64	68.63	4.97	30.88	30.94	1.43	0.41	T
16	37.71	0.93	26.18	10.60	62.29	3.89	37.52	19.16	1.72	T	T
17	35.98	1.09	23.89	11.00	64.02	4.94	34.25	23.78	0.89	0.16	T
18	33.36	0.69	24.50	8.17	66.64	4.08	38.66	22.75	0.88	0.27	T
19	35.41	1.05	25.31	9.05	64.59	4.64	41.92	16.39	1.45	0.19	T
20	34.56	0.85	23.50	10.21	65.44	3.40	40.15	20.70	1.18	T	T
21	37.91	1.12	24.45	12.34	62.09	4.81	39.29	17.13	0.73	0.14	T

[1]For treatment and sex of each hog see Appendix A.

*Tentative identification.

T - traces, but amount was too small to measure.

? - indicates that it was difficult to determine whether or not this fatty acid was present.

APPENDIX D

FATTY ACID COMPOSITION OF INNER BACKFAT FROM OVER FIRST RIB(%)

	Fatty acid										
Hog no.[1]	Total sat.	14:0	16:0	18:0	Total unsat.	16:1	18:1	18:2	18:3	20.2*	20:4
1	31.91	0.80	24.44	6.67	68.09	3.85	48.21	14.99	1.04	T	T
2	30.09	0.67	22.29	7.13	69.91	4.60	41.34	22.69	1.28	T	?
3	34.85	1.06	26.28	7.51	65.15	5.19	44.39	14.29	1.28	T	T
4	37.37	0.89	25.41	11.07	62.63	5.57	44.81	10.65	1.36	0.24	T
5	38.11	1.29	28.60	8.22	61.89	5.37	44.53	10.49	1.21	0.29	?
6	31.08	0.73	23.71	6.64	68.92	4.32	48.46	15.24	0.90	T	T
7	25.48	0.75	20.04	4.69	74.52	2.95	31.18	39.11	1.28	T	T
8	22.22	0.62	16.09	5.51	77.78	4.47	32.89	38.63	1.79	T	T
9	25.33	0.67	19.79	4.87	74.67	4.02	31.25	37.77	1.30	0.33	T
10	27.53	0.81	19.88	6.84	72.47	3.03	31.02	36.49	1.15	0.78	?
11	27.12	0.77	20.81	5.54	72.88	3.15	26.74	42.05	0.94	?	?
12	23.74	0.48	15.87	7.39	76.26	3.84	32.41	38.82	1.19	T	T
13	33.13	1.06	24.67	7.40	66.87	5.06	32.35	27.17	1.80	0.49	?
14	30.11	0.76	23.02	6.33	69.89	3.49	35.18	30.35	0.87	T	T
15	26.87	0.90	19.79	6.18	73.13	4.65	34.02	32.79	1.29	0.38	T
16	36.24	0.66	23.95	11.63	63.76	2.89	40.44	19.59	0.84	T	T
17	33.92	0.99	22.55	10.38	66.08	4.06	36.49	24.35	0.88	0.30	T
18	26.58	0.62	20.01	5.95	73.42	4.26	40.15	27.38	1.63	T	T
19	29.22	0.83	21.77	6.62	70.78	4.39	43.04	21.72	1.05	0.58	T
20	28.75	0.64	20.51	7.60	71.25	3.73	42.70	24.30	0.52	T	T
21	32.85	1.22	22.71	8.92	67.15	5.51	42.27	17.53	1.46	0.38	T

[1]For sex and treatment of each hog see Appendix A.

*Tentative identification.

T - traces, but amount was too small to measure.

? indicates that it was difficult to determine whether or not this fatty acid was present.

APPENDIX E

FATTY ACID COMPOSITION OF OUTER BACKFAT FROM OVER FIRST RIB (%)

Hog no.[1]	Fatty acid										
	Total sat.	14:0	16:0	18:0	Total unsat.	16:1	18:1	18:2	18:3	20:2*	20:4
1	31.18	0.89	25.28	5.01	68.82	4.30	47.85	15.32	1.35	T	T
2	24.89	0.81	19.07	5.01	75.11	5.31	51.19	17.12	1.49	?	?
3	29.12	0.89	23.34	4.89	70.88	7.06	44.03	18.24	1.55	T	T
4	34.31	1.06	25.18	8.07	65.69	7.26	46.21	10.42	1.44	0.36	T
5	31.48	1.23	25.09	5.16	68.52	9.23	44.02	13.69	1.40	0.18	?
6	30.14	0.78	24.69	4.67	69.86	3.95	49.28	15.82	0.81	T	T
7	29.27	1.17	22.40	5.70	70.73	3.47	35.21	30.59	1.46	T	T
8	23.82	0.78	18.62	4.42	76.18	5.00	33.92	34.97	1.90	0.39	T
9	23.75	0.75	19.57	3.43	76.25	4.88	32.56	37.14	1.45	0.22	T
10	29.18	0.76	20.54	7.88	70.82	3.20	32.44	33.33	1.05	0.86	?
11	25.48	1.04	19.26	5.18	74.52	3.53	29.07	40.49	1.43	?	?
12	22.64	0.72	17.00	4.92	77.36	4.10	33.51	36.75	2.54	0.46	?
13	30.80	0.96	24.49	5.35	69.20	5.38	35.06	26.88	1.34	0.54	?
14	27.84	0.86	21.30	5.68	72.16	3.56	38.93	28.63	1.04	T	T
15	25.35	0.87	19.24	5.24	74.65	4.88	35.79	32.20	1.26	0.52	T
16	30.01	0.68	24.34	4.99	69.99	2.60	47.56	18.80	0.91	0.12	T
17	31.68	1.13	22.95	7.60	68.32	5.23	39.26	22.56	1.00	0.27	T
18	24.80	0.78	19.11	4.91	75.20	3.68	47.26	21.89	2.05	0.31	T
19	27.77	1.12	21.27	5.48	72.23	4.74	47.25	18.25	1.54	0.35	T
20	27.17	0.92	18.76	7.49	72.83	4.20	43.32	24.06	1.25	T	T
21	28.96	1.04	21.04	6.88	71.04	5.76	45.57	17.83	1.37	0.51	T

[1]For treatment and sex of each hog see Appendix A.

*Tentative identification.

T - traces, but amount was too small to measure.

? indicates that it was difficult to determine whether or not this fatty acid was present.

APPENDIX F

FATTY ACID COMPOSITION OF INNER BACKFAT FROM OVER LAST RIB (%)

Hog no.[1]	Fatty acid										
	Total sat.	14:0	16:0	18:0	Total unsat.	16:1	18:1	18:2	18:3	20:2*	20:4
1	34.75	0.95	26.62	7.18	65.25	3.73	44.90	15.98	0.64	T	T
2	28.37	0.45	20.97	6.95	71.63	5.89	49.42	15.26	1.06	T	T
3	33.56	1.35	25.77	6.44	66.44	6.70	44.27	14.01	1.46	T	T
4	38.74	0.81	25.48	12.45	61.26	5.54	45.10	9.30	1.11	0.21	T
5	39.21	1.26	28.46	9.49	60.79	4.05	44.27	10.87	1.37	0.23	?
6	32.10	0.98	23.85	7.27	67.90	3.67	47.75	15.07	1.41	T	T
7	29.72	0.73	21.45	7.54	70.28	2.34	32.56	34.35	1.03	T	T
8	25.08	0.55	17.51	7.02	74.92	4.52	31.53	36.26	2.00	0.61	?
9	25.47	0.83	19.63	5.01	74.53	4.86	28.03	39.71	1.63	0.30	T
10	32.90	0.94	20.48	11.48	67.10	2.29	29.96	32.80	1.12	0.93	?
11	25.27	0.65	19.04	5.58	74.73	2.71	28.44	42.43	1.15	?	?
12	22.68	0.51	16.34	5.83	77.32	3.51	30.39	42.55	0.75	0.12	?
13	28.44	0.75	20.08	7.61	71.56	3.59	35.94	30.34	1.44	0.25	T
14	27.58	0.57	19.96	7.05	72.42	3.28	39.15	29.29	0.70	T	T
15	26.82	0.71	19.55	6.56	73.18	4.03	33.37	34.19	1.37	0.22	T
16	35.97	0.80	26.24	8.93	64.03	2.94	40.38	19.84	0.87	T	T
17	33.42	1.19	21.86	10.37	66.58	3.55	40.80	20.32	1.39	0.52	T
18	32.62	0.56	25.30	6.76	67.38	2.64	40.68	23.51	0.30	0.25	T
19	29.74	0.90	21.01	7.83	70.26	4.67	43.43	20.05	1.62	0.49	T
20	30.23	1.04	20.20	8.99	69.77	6.29	40.05	20.03	2.66	0.74	T
21	34.00	1.05	23.49	9.47	66.00	5.15	41.51	17.46	1.41	0.46	T

[1]For treatment and sex of each hog see Appendix A.

* Tentative identification.

T - traces, but amount was too small to measure.

? indicates that it was difficult to determine whether or not this fatty acid was present.

APPENDIX G

FATTY ACID COMPOSITION OF OUTER BACKFAT FROM OVER LAST RIB (%)

Hog no.[1]	Fatty acid										
	Total sat	14:0	16:0	18:0	Total unsat.	16:1	18:1	18:2	18:3	20:2*	20.4
1	29.08	0.75	22.56	5.77	70.92	3.60	49.33	17.22	0.77	T	T
2	26.14	0.75	20.88	4.51	73.86	5.77	49.84	16.41	1.84	T	T
3	27.99	0.85	22.27	4.87	72.01	6.08	48.57	16.19	1.17	T	T
4	33.10	1.13	24.06	7.91	66.90	7.14	45.87	12.31	1.25	0.33	T
5	33.20	1.76	26.00	5.44	66.80	6.68	45.37	12.19	2.12	0.44	?
6	30.91	0.89	24.91	5.11	69.09	3.88	48.83	15.29	1.09	T	T
7	28.74	0.98	22.06	5.70	71.26	3.29	35.16	31.55	1.26	T	T
8	24.02	0.69	18.62	4.71	75.98	5.77	32.52	35.23	2.10	0.36	T
9	21.46	0.73	17.27	3.46	78.54	5.55	31.83	39.42	1.38	0.36	T
10	28.99	0.92	19.39	8.68	71.01	2.75	32.01	35.27	0.61	0.37	?
11	22.42	0.72	17.01	4.69	77.58	2.57	32.97	40.75	1.29	?	?
12	20.65	0.80	16.15	3.30	79.35	3.47	32.62	42.24	1.42	T	?
13	27.26	0.83	21.20	5.23	72.74	4.58	40.75	25.64	1.44	0.33	?
14	25.44	0.83	18.92	5.69	74.56	3.48	40.83	29.05	1.20	T	T
15	25.46	0.97	18.92	5.57	74.54	4.71	35.33	32.77	1.45	0.28	T
16	34.77	0.80	26.22	7.75	65.23	3.76	43.09	16.99	1.19	0.20	T
17	29.56	1.00	20.96	7.60	70.44	5.54	44.35	18.72	1.39	0.44	T
18	26.85	0.60	21.33	4.92	73.15	2.99	45.85	23.48	0.75	0.08	T
19	27.28	1.02	20.08	6.18	72.72	5.41	45.26	19.33	2.29	0.43	T
20	27.37	0.74	19.83	6.80	72.63	3.89	43.30	23.83	1.24	0.37	T
21	31.39	1.12	23.03	7.24	68.61	5.62	43.14	17.97	1.34	0.54	T

[1]For treatment and sex of each hog see Appendix A.

* Tentative identification.

T - traces, but amount was too small to measure.

? indicates that it was difficult to determine whether or not this fatty acid was present.

APPENDIX H

FATTY ACID COMPOSITION OF INNER BACKFAT FROM OVER LAST LUMBAR VERTEBRA (%)

	Fatty acid										
Hog no.[1]	Total sat.	14:0	16:0	18:0	Total unsat.	16:1	18:1	18:2	18:3	20:2*	20:4
1	36.01	1.00	28.81	6.20	63.99	3.83	44.28	14.49	1.39	T	T
2	31.78	0.88	22.97	7.93	68.22	5.41	45.25	16.27	1.08	0.21	T
3	32.38	0.99	25.39	6.00	67.62	5.60	45.44	15.35	1.23	T	T
4	36.85	0.93	23.91	12.01	63.15	5.15	46.94	9.44	1.39	0.23	T
5	36.66	1.42	26.28	8.96	63.34	6.31	43.84	11.52	1.28	0.39	?
6	32.44	0.75	25.28	6.41	67.56	3.60	47.09	15.85	1.02	T	T
7	24.63	0.54	16.00	8.09	75.37	2.31	34.39	38.02	0.65	T	T
8	26.62	0.56	18.61	7.45	73.38	3.94	31.49	35.87	1.80	0.28	?
9	26.02	0.76	20.58	4.68	73.98	4.47	28.69	39.20	1.34	0.28	T
10	34.11	0.68	21.69	11.74	65.89	1.73	29.92	32.76	0.80	0.68	?
11	25.83	0.75	19.45	5.63	74.17	3.41	28.11	41.49	1.16	?	?
12	22.46	0.48	16.18	5.80	77.54	3.76	30.87	41.55	1.12	0.24	?
13	32.79	0.97	23.93	7.89	67.21	4.76	33.37	27.01	1.64	0.43	T
14	28.28	0.82	20.31	7.15	71.72	3.45	36.80	30.16	1.31	T	T
15	27.17	0.82	19.54	6.81	72.83	3.84	33.71	33.88	1.12	0.28	T
16	34.72	0.91	25.58	8.24	65.28	5.18	37.74	20.55	1.70	0.10	T
17	32.35	1.01	20.16	11.18	67.65	3.38	38.78	23.60	1.35	0.54	T
18	33.16	0.62	25.72	6.82	66.84	2.26	39.54	24.47	0.57	T	T
19	31.82	0.82	21.43	9.57	68.18	5.96	39.76	20.72	1.37	0.37	T
20	30.22	0.76	20.22	9.24	69.78	5.80	40.38	21.27	1.84	0.49	T
21	32.71	1.15	23.34	8.22	67.29	4.85	41.29	18.87	1.80	0.48	T

[1]For treatment and sex of each hog see Appendix A.

* Tentative identification.

T - traces, but amount was too small to measure.

? indicates that it was difficult to determine whether or not this fatty acid was present.

APPENDIX I

FATTY ACID COMPOSITION OF OUTER BACKFAT FROM OVER LAST LUMBAR VERTEBRA (%)

	Fatty acid										
Hog no.[1]	Total sat	14:0	16:0	18:0	Total unsat.	16:1	18:1	18:2	18:3	20:2*	20:4
1	32.65	1.06	23.95	7.64	67.35	4.96	45.29	15.93	1.17	T	T
2	31.82	0.97	24.03	6.82	68.18	6.54	47.62	11.90	2.12	T	?
3	30.92	0.94	24.19	5.79	69.08	5.48	47.40	15.03	1.17	T	T
4	34.70	1.05	23.17	10.48	65.30	5.02	48.66	9.61	1.75	0.26	T
5	35.32	1.49	26.88	6.95	64.68	7.13	43.83	12.02	1.48	0.22	?
6	30.13	1.03	22.24	6.86	69.87	4.28	47.68	16.73	1.18	T	T
7	28.52	0.99	22.02	5.51	71.48	3.72	33.31	33.02	1.43	T	T
8	25.10	0.70	20.71	3.69	74.90	5.53	29.74	36.90	2.13	0.60	T
9	25.02	0.99	20.06	3.97	74.98	5.12	30.78	36.81	1.81	0.46	T
10	32.79	0.93	21.00	10.86	67.21	1.54	32.33	31.89	0.70	0.73	?
11	26.75	1.15	21.35	4.25	73.25	4.08	31.26	36.78	1.13	T	T
12	23.20	0.66	15.94	6.60	76.80	4.42	31.50	39.13	1.22	0.53	?
13	29.14	0.78	21.76	6.60	70.86	4.43	38.49	26.32	1.35	0.27	T
14	28.07	0.80	21.47	5.80	71.93	3.73	39.41	27.72	1.07	T	T
15	27.02	0.79	20.11	6.12	72.98	4.26	36.45	30.79	1.20	0.28	T
16	30.37	0.70	23.52	6.15	69.63	3.87	43.81	20.88	1.07	T	T
17	33.07	1.02	20.16	11.89	66.93	3.18	39.94	21.65	1.58	0.58	T
18	26.34	0.62	20.98	4.74	73.66	2.64	45.38	24.11	1.19	0.33	T
19	28.80	0.88	21.08	6.84	71.20	5.51	44.37	19.59	1.25	0.48	T
20	27.71	0.70	18.86	8.15	72.29	4.08	43.88	22.13	1.69	0.51	T
21	31.45	1.51	22.55	7.39	68.55	5.51	43.43	16.87	1.92	0.82	T

[1]For treatment and sex of each hog see Appendix A.

* Tentative identification.

T - traces, but amount was too small to measure.

? indicates that it was difficult to determine whether or not this fatty acid was present.

APPENDIX J

FATTY ACID COMPOSITION OF INTRAMUSCULAR FAT FROM LONGISSIMUS DORSI MUSCLE(%)

Hog no.[1]	Fatty acid												
	Total sat.	14:0	16:0	18:0	Total unsat.	15:1*	16:1	17:1*	18:1	18:2	18:3	20:2*	20:4
1	31.00	0.70	25.47	4.83	69.00	0.56	5.73	T	50.15	12.16	0.40	T	T
2	28.38	0.56	22.33	5.49	71.62	1.44	5.59	T	46.36	17.56	0.67	T	T
3	30.56	0.54	24.43	5.59	69.44	0.69	5.68	T	49.38	13.11	0.58	T	T
4	28.25	0.67	22.17	5.41	71.75	0.76	5.12	T	53.91	11.36	0.60	T	T
5	30.59	0.59	25.24	4.76	69.41	0.70	4.96	T	51.12	12.34	0.29	T	T
6	27.86	0.54	22.02	5.30	72.14	1.46	4.70	T	51.59	13.98	0.41	T	T
7	29.42	0.85	23.22	5.35	70.58	0.39	4.65	T	42.92	21.95	0.67	T	T
8	30.27	0.71	23.73	5.83	69.73	1.30	5.53	T	40.63	21.53	0.74	T	T
9	27.17	0.81	21.06	5.30	72.83	0.68	5.27	T	45.81	19.94	1.13	T	T
10	31.01	0.92	24.54	5.55	68.99	0.63	4.63	T	37.25	25.69	0.79	T	T
11	28.14	0.67	22.33	5.14	71.86	0.34	4.37	T	44.00	22.37	0.78	T	T
12	32.00	0.81	25.31	5.88	68.00	0.58	5.05	T	41.34	20.73	0.30	T	T
13	29.96	0.74	23.15	6.07	70.04	0.33	5.35	T	45.93	17.59	0.84	T	T
14	29.89	0.76	23.54	5.59	70.11	0.31	6.23	T	41.98	20.40	1.19	T	T
15	27.51	0.63	21.43	5.45	72.49	1.11	5.87	T	45.59	19.28	0.64	T	T
16	30.48	0.77	23.92	5.79	69.52	0.63	6.81	T	42.61	18.49	0.98	T	T
17	30.15	0.88	23.62	5.65	69.85	0.22	5.22	T	45.43	18.17	0.81	T	T
18	30.78	0.78	24.00	6.00	69.22	0.44	5.98	T	45.99	16.17	0.65	T	T
19	28.66	0.89	22.51	5.26	71.34	0.37	5.48	T	46.97	17.72	0.80	T	T
20	30.75	0.74	24.41	5.60	69.25	0.62	4.56	T	48.58	14.97	0.52	T	T
21	30.81	0.80	24.22	5.79	69.19	0.46	5.31	T	46.78	16.10	0.54	T	T

[1]For treatment and sex of each hog see Appendix A.

* Tentative identification.

T - traces, but amount was too small to measure.

APPENDIX K

TASTE PANEL SCORES AND WARNER-BRATZLER SHEAR VALUES

Hog no.[1]	Overall acceptability	Flavor	Juiciness	Tenderness	
				Panel	Shear
1	6.06	6.17	5.56	6.11	9.41
2	6.22	6.28	5.61	7.11	10.52
3	5.33	5.83	4.50	5.94	11.51
4	5.89	6.06	5.50	6.22	10.06
5	6.56	6.28	6.33	6.94	7.65
6	5.33	4.78	4.94	7.11	9.04
7	6.28	6.72	5.50	6.39	9.52
8	5.83	6.22	5.28	6.00	9.72
9	6.11	6.17	5.61	6.33	8.29
10	6.28	6.50	5.61	6.56	10.08
11	6.28	6.28	5.72	5.94	10.67
12	6.00	6.28	6.06	5.61	11.66
13	6.50	6.61	6.44	6.28	8.23
14	6.39	6.61	6.44	6.50	10.29
15	5.72	6.22	5.44	5.89	10.67
16	6.06	5.56	6.22	7.94	8.12
17	5.50	6.28	5.11	5.00	12.13
18	6.39	6.50	6.06	6.83	9.49
19	6.83	6.89	5.94	6.89	7.96
20	5.61	6.00	6.28	4.94	11.87
21	6.00	5.83	5.78	6.67	10.48

[1]For treatment and sex of each hog see Appendix A.

APPENDIX L

COMPOSITION OF DIETS

10% safflower oil ration	
Ingredients	Amount(lbs.)
Barley	800.0
Safflower oil	100.0
Soybean oil meal(44%)	100.0
Limestone	6.0
Dicalcium phosphate	2.0
Trace mineralized salt (high zinc)	5.0
VATM (Vitamin premix)	5.0
Santoquin	0.125
	1018.125

10% tallow ration	
Ingredients	Amount(lbs.)
Barley	800.0
Tallow	100.0
Soybean oil meal(44%)	100.0
Limestone	6.0
Dicalcium phosphate	2.0
Trace mineralized salt (high zinc)	5.0
VATM (Vitamin premix)	5.0
Santoquin	0.125
	1018.125

Control ration	
Ingredients	Amount(lbs.)
Ground shell corn	868.0
Soybean oil meal(50%)	65.0
Meat scraps(50%)	25.0
Alfalfa meal(17%)	25.0
Limestone	5.0
Dicalcium phosphate	2.0
VATM (Vitamin premix)	5.0
Trace mineralized salt (high zinc)	5.0
	1000.0

APPENDIX M

FATTY ACID COMPOSITION OF THE RATIONS AND OF THE SAFFLOWER OIL AND TALLOW USED IN THE RATIONS (%)

Fatty acid	Ration				
	Control	10% safflower oil	10% tallow	Safflower oil	Tallow
14:0	T	T	1.00	T	0.91
16:0	10.04	6.47	23.40	4.61	21.52
16:1	1.20	0.87	5.29	0.41	4.59
18:0	1.24	0.71	5.99	0.60	6.27
18:1	22.24	8.17	42.91	6.01	49.32
18:2	63.67	82.18	20.18	86.35	16.75
18:3	1.61	1.60	1.23	2.02	0.64
Saturated	11.28	7.18	30.39	5.21	28.70
Unsaturated	88.72	92.82	69.61	94.79	71.30

T - traces but amount was too small to measure.