# THE EFFECT OF PARING MEAL RATIONS ON FATTY ACID COMPOSITION OF PORK FAT*

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## ABSTRACT

The fatty acid composition of fat from swine fed with rations that contained paring meal was determined by gas-liquid chromatography. Seven fatty acids were detected and quantitatively determined.

Results show that addition of 20% and 30% paring meal to the diet caused a highly significant increase ($P < .01$) in the total content of saturated fatty acids in both backfat and leaf fat as compared to that of the control. A significant decrease of stearic acid was also noted in the backfat but not in the leaf fat.

No significant change in oleic and linoleic percentage in pork fat was observed with the addition of paring meal.

Effect of shifting diet on fatty acid composition decreased significantly ($P < .05$) in the $C_{10}$-$C_{16}$ saturated fatty acid of the backfat and leaf fat as compared with the unshifted group of pigs. This implies that the nature of fatty acids could be altered by changing the ration for a sufficient length of time during the finishing period of fattening pigs.

Addition of paring meal in the ration of pigs has a greater effect on the saturated fatty acids of the leaf fat than the backfat.

## INTRODUCTION

Paring meal is a by-product after extracting the oil from the outside portion of the deshelled coconut meat which is "pared off" in the preparation of shredded coconut meat for food. It is used as feed ingredient in swine ration.

Several observations have been reported regarding the effect of high level of paring meal in swine ration (Castillo et al., 1965; Castillo et al., 1968; Zamora, 1972). However, few literature are available to indicate the effect of such rations on the fatty acid composition of pork fat. Since the fatty acid deposited in animal tissue is strongly affected by the diet (Gunstone, 1967), a study on the fat from swine fed with rations containing different levels of paring meal has been conducted.

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The effect of the removal of paring meal from the rations to pigs upon reaching 75 kg. up to their slaughter weight of 85 kg. was also investigated in order to determine if the nature of fatty acids would be altered by changing the ration for a sufficient length of time during the finishing period of fattening pigs.

## MATERIALS AND METHODS

### A. Samples

Fat samples were obtained from a total of 31 pigs from studies conducted by Zamora (1972) which consisted of 11 Duroc Jersey x Berkshire and 20 Landrace x Yorkshire x Duroc Jersey crossbreds. These samples came from leaf fat and backfat tissues of swine fed with rations that contained zero, 20 and 30% paring meal. Tables 1a – 1d show the formulation of the various rations used during the starter (Rations 1-3), growing (Rations 4-6), growing-finishing (Rations 7-9) and finishing (Rations 10-12) stages of feeding.

**Table 1a. Percentage composition of starter ration fed to pigs from 5 or less to 15 kgs live weight.**

| Feed ingredients | Ration 1 | Ration 2 | Ration 3 |
|---|---|---|---|
| Paring | --- | 20 | 30 |
| Yellow corn | 58 | 42 | 31 |
| Rice bran | 5.35 | --- | --- |
| Soybean oil meal | 13 | 17 | 8.0 |
| Fish meal | 13 | 10.10 | 15 |
| Skim milk | 3.0 | 4.0 | 5.0 |
| Sugar | --- | 3.0 | 6.0 |
| Bone meal | 0.90 | 1.0 | 1.06 |
| Salt | 0.30 | 0.30 | 0.30 |
| Limestone | 0.30 | 0.30 | 0.30 |
| Vitamin premix[a] | 0.15 | 0.20 | 0.25 |
| Coconut oil | 1 | 2 | 3 |
| MHA | 0.10 | 0.10 | 0.10 |
| Total | 100 | 100 | 100 |
| **Calculated Analysis** | | | |
| Crude Protein | 22.51 | 22.54 | 22.71 |
| D.E. (Kcal/kg) | 3592 | 3600 | 3659 |
| Calcium | 1.33 | 1.21 | 1.53 |
| Available P% | 0.63 | 0.59 | 0.78 |

[a] *1 kg of the premix contributes the following: Vit. A, 3000 I.U.; Vit. $D_3$, 400 I.U.; Vit. E, 1,000 I.U.; Vit. $B_{12}$, 2 mg; Fe, 20,000 mg; Mn, 10,000 mg; Cu, 1,500 mg; Zn, 40,000 mg.*

Table 1b. Percentage composition of growing rations fed to pigs from 15 to 30 kgm live weight.

| Feed ingredients | Ration | | |
|---|---|---|---|
| | 4 | 5 | 6 |
| Paring meal | --- | 20 | 30 |
| Yellow corn | 55 | 40.5 | 36 |
| Rice bran | 17.25 | 13.75 | 6.10 |
| Soybean oil meal | 17 | 12.5 | 11 |
| Fish meal | 9 | 8.5 | 9 |
| Sugar | --- | 3 | 6 |
| Bone meal | 1 | 1 | 1.1 |
| Salt | 0.30 | 0.30 | 0.30 |
| Limestone | 0.30 | 0.30 | 0.30 |
| Vitamin premix[a] | 0.15 | 0.15 | 0.20 |
| Total | 100 | 100 | 100 |
| **Calculated Analysis** | | | |
| Crude protein (%) | 18.77 | 18.58 | 18.71 |
| D.E. (Kcal/kg) | 3513 | 3330 | 3412 |
| Calcium (%) | 1.11 | 1.07 | 1.13 |
| Total Phosphorous (%) | 0.66 | 0.72 | 0.72 |
| Available P (%) | 0.52 | 0.54 | 0.56 |

[a] *Same as in Table 1a.*

Table 1c. Percentage composition of growing-finishing rations fed to pigs from 30 to 50 kgm weights.

| Feed ingredients | Ration | | |
|---|---|---|---|
| | 7 | 8 | 9 |
| Paring meal | --- | 20 | 30 |
| Yellow corn | 61.75 | 42 | 34 |
| Rice bran | 17.25 | 17.5 | 14.1 |
| Soybean oil meal | 10.25 | 8.5 | 6.75 |
| Fish meal | 9 | 7.25 | 7.25 |
| Sugar | --- | 3 | 6 |
| Bone meal | 1 | 1 | 1.1 |
| Salt | 0.30 | 0.30 | 0.30 |
| Limestone | 0.30 | 0.30 | 0.30 |
| Vit-min premix[a] | 0.15 | 0.15 | 0.20 |
| Total | 100 | 100 | 100 |
| **Calculated Analysis** | | | |
| Crude protein (%) | 16.83 | 16.63 | 16.65 |
| D.E. (Kcal/kg) | 3421 | 3420 | 3397 |
| Calcium | 1.09 | 0.99 | 1.02 |
| Total Phosphorous (%) | 0.62 | 0.66 | 0.72 |
| Available P (%) | 0.51 | 0.53 | 0.53 |

[a] *Same as in Table 1a.*

**Table 1d. Percentage composition of growing-finishing ration fed to pigs from 50-75 kgm live weight.**

| Feed ingredients | Ration | | |
|---|---|---|---|
| | 10 | 11 | 12 |
| Paring meal | --- | 20 | 30 |
| Yellow corn | 56.5 | 42 | 33.75 |
| Rice bran | 28.25 | 23 | 19.6 |
| Soybean oil meal | 7 | 5.25 | 4.5 |
| Fish meal | 6.5 | 5 | 4.25 |
| Sugar | --- | 3 | 6 |
| Bone meal | 1 | 1 | 1.1 |
| Limestone | 0.30 | 0.30 | 0.30 |
| Salt | 0.30 | 0.30 | 0.30 |
| Vit-min premix[a] | 0.15 | 0.15 | 0.20 |
| Total | 100 | 100 | 100 |
| **Calculated Analysis** | | | |
| Crude Protein (%) | 34.43 | 14.53 | 14.49 |
| D.E. (Kcal/kg) | 3398 | 3393 | 3473 |
| Calcium (%) | 0.94 | 0.86 | 0.85 |
| Total Phosphorous (%) | 0.62 | 0.64 | 0.66 |
| Available P (%) | 0.46 | 0.45 | 0.54 |

Each treatment had six individually penned and fed pigs. Half of the pigs fed with the different levels of paring meal were shifted to the finishing control ration upon reaching 76 kg weight. All pigs were slaughtered at 85 kg weights.

Samples were heated for 10 minutes to extract the fat. Twenty individual samples were obtained, 10 samples of leaf fat and 10 samples of backfat.

## B. Analysis

### 1. Esterification.

The fat samples were esterified using 5% methanolic hydrogen chloride solution in anhydrous methanol (Stoffel et al., 1959). To 10 mg of fat in a 15 ml tube fitted with a screw cap, 2 ml of freshly prepared methanolic hydrogen chloride solution was added. The mixture was placed in an oven at 70°C for 12 hours. Thereafter, the mixture was shaken vigorously and the two layers were allowed to separate. The hexane-layer containing the fatty acid esters was withdrawn for chromatographic analysis.

### 2. Gas-Liquid Chromatography (GLC).

One microliter of sample was injected into the Perkin-Elmer 900 Gas Chromatograph equipped with a hydrogen flame-ionization

detector and a 6 feet by 1/8 inch stainless steel column packed with a 15% diethylene glycol succinate (DEGS) in Chromosorb W 80/100 mesh. The carrier gas (nitrogen) flow rate at the column outlet was 55 ml per minute. The column temperature was programmed from 80-90°C at the rate of 24 per minute with an initial time of one minute. The recorder was a Servo/riter II, Texas Instruments, Inc. with a chart speed of 1 inch per minute. Each chromotogram run took about 20 minutes.

Identification of peak was done by comparing the retention time of each component with those of methyl ester standards (methyl esters of caproic, capric, caprylic, lauric, myristic, palmitic, stearic, oleic and linoleic acid from Applied Science Laboratories). Retention time was measured from injection to peak center for each component.

Percentage composition was calculated by measuring the peak area of the components and getting the relative percentage based on the total area measured.

$$\text{Peak area} = \tfrac{1}{2} \text{ base width} \times \text{peak height}$$

$$\%\ \text{component A} = \frac{\text{area of peak A}}{\text{total peak area}} \times 100$$

$$\text{Total Peak Area} = \text{Area Peak A} + \text{Area Peak B} + + + \ldots$$

## RESULTS AND DISCUSSION

### Fatty Acid Composition of Backfat from Swine Fed Rations Containing Different Levels of Paring Meal

The gas chromatogram obtained in the analysis of backfat from swine fed with 0, 20 and 30 percent levels of paring meal are shown in Figures (1-3). The computed fatty acid of backfat samples is presented in Table 1. Seven fatty acids were detected by gas-liquid chromatography (GLC), namely: capric, lauric, myristic, palmitic, stearic, oleic and linoleic acid.

Fatty acid composition from the backfat of the animals showed a certain pattern of distribution. Oleic acid was the major fatty acid component followed by palmitic, stearic, and linoleic. Minor fatty acid constituents were lauric, myristic and capric acids.

The highest percentage of fatty acid in the fat samples from the control animals was oleic acid which was 42.9% (Table 2). The amount of palmitic was 30.25% while stearic and linoleic acid were present in about the same amounts which were 14.10% and 13.63%, respectively. The percentage of myristic acid was 3.2% while the other two minor fatty acid constituents namely: lauric and capric acid were both below 1%.

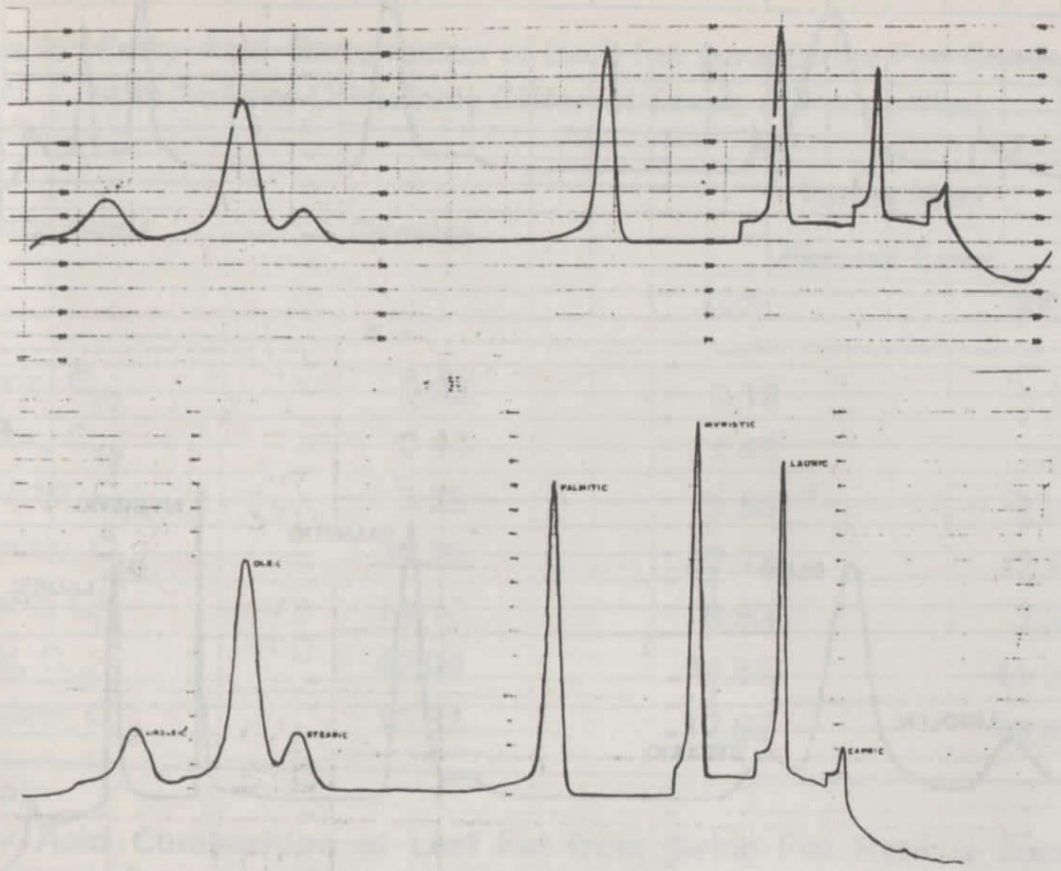


Fig. 1. Gas chromatograms of fatty acids from backfat of swine fed with rations without paring meal.

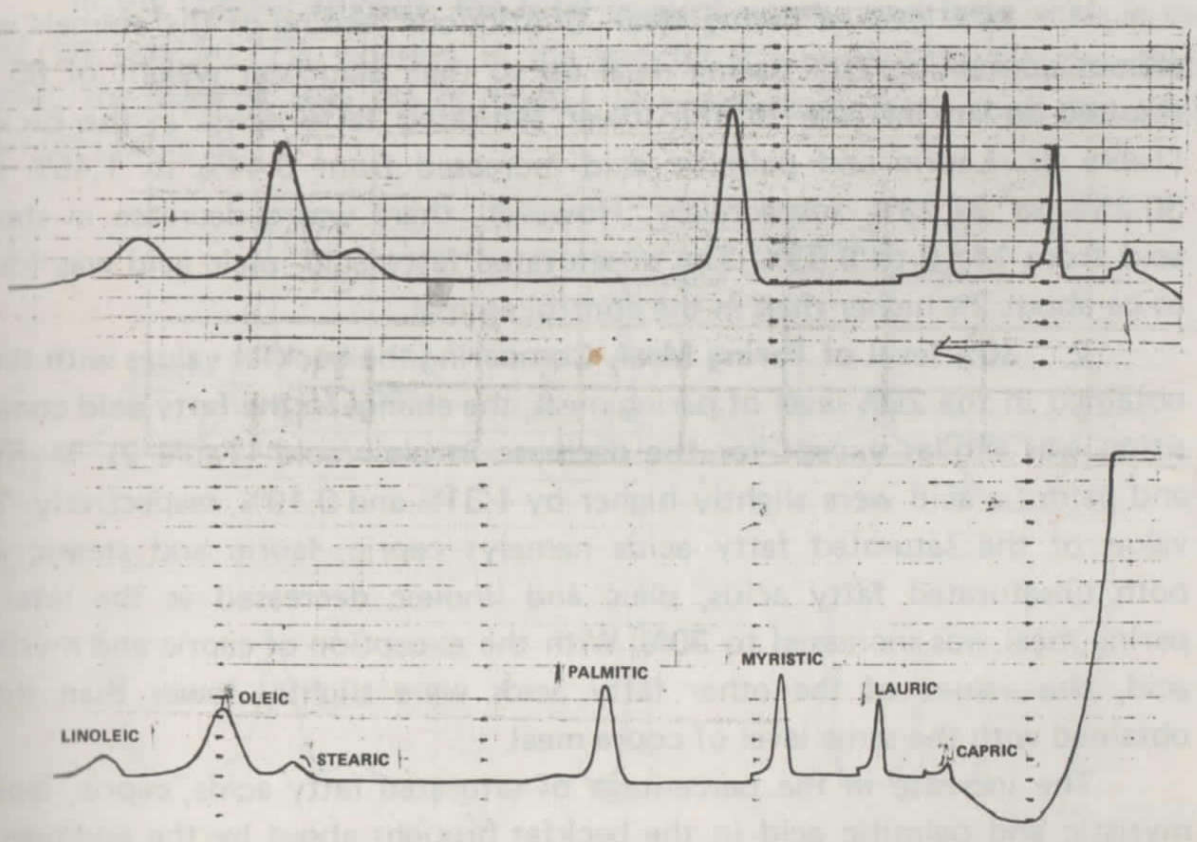


Fig. 2. Gas chromatograms of fatty acids from backfat of swine fed with rations containing 20% paring meal.

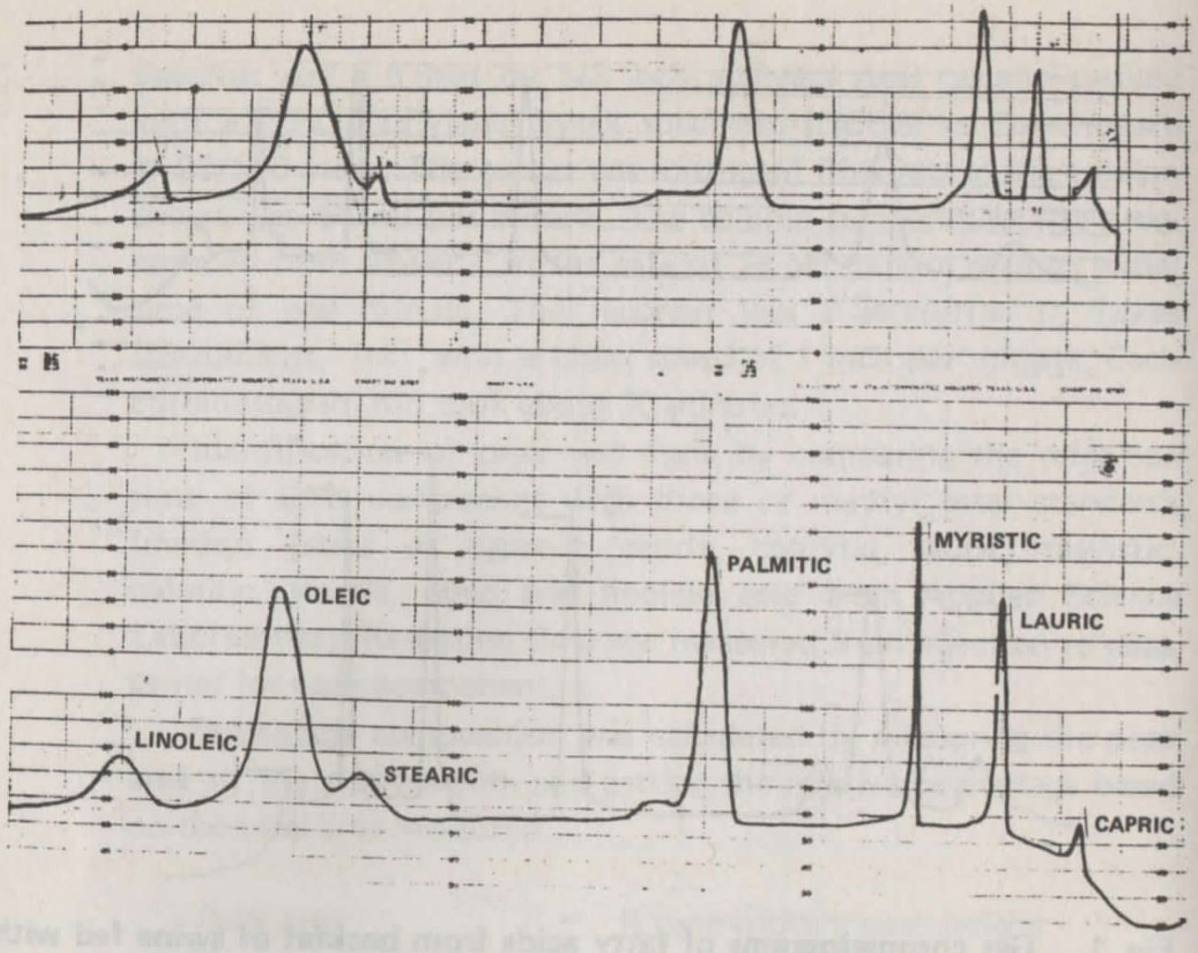


**Fig. 3. Gas chromatograms of fatty acids from backfat of swine fed with rations containing with 30% paring meal.**

**Effect of Paring Meal Rations**

1. **20% level of Paring Meal.** Continuous feeding of the animals with rations containing 20% paring meal up to their slaughter weight of 85 kg. resulted to an increase of the lower saturated fatty acids in the backfat (Table 2). Lauric and palmitic acid increased from 0.44% to 1.45% and 30.25% to 32.23%, respectively. However, there was a decrease in stearic acid from 14.10 to 9.83%. The unsaturated fatty acid, oleic acid was found to be about 2% higher than in the control animal.

2. **30% level of Paring Meal.** Comparing the backfat values with those obtained in the 20% level of paring meal, the change in the fatty acid composition was similar except for the decrease in oleic acid (Table 2). Myristic and palmitic acid were slightly higher by 1.31% and 0.19%, respectively. The value of the saturated fatty acids namely: capric, lauric and stearic and both unsaturated fatty acids, oleic and linoleic decreased as the level of paring meal was increased to 30%. With the exception of capric and myristic acid, the values of the other fatty acids were slightly lower than those obtained with the same level of copra meal.

The increase in the percentage of saturated fatty acids, capric, lauric, myristic and palmitic acid in the backfat brought about by the addition of 20% and 30% paring meal to feed rations was found to be statistically significant ($P < .01$).

Table 2. Fatty Acid Composition of Back Fat from Swine Fed Continuously with Rations Containing Different Levels of Paring Meal.

| Fatty Acids | Control | Paring Meal Percent Level | |
|---|---|---|---|
| | | 20% | 30% |
| Capric, $C_{10}$ | 0.08 | 0.18 | 0.15 |
| Lauric, $C_{12}$ | 0.44 | 1.45 | 1.33 |
| Myristic, $C_{14}$ | 3.28 | 4.89 | 6.20 |
| Palmitic, $C_{16}$ | 30.25 | 32.23 | 32.42 |
| Stearic, $C_{18}$ | 14.10 | 9.83 | 7.38 |
| Oleic, $C_{18}$ | 42.96 | 44.58 | 41.23 |
| Linoleic, $C_{18}$ | 13.63 | 12.86 | 10.81 |

**Fatty Acid Composition of Leaf Fat from Swine Fed Rations Containing Different Levels of Paring Meal**

Figures 4, 5 and 6 show the chromatograms obtained in the analysis of leaf fat from pigs fed 0, 20 and 30 percent levels of paring meal and the computed fatty acids as shown in Table 2. All fatty acids detected by GLC in the backfat were also present in the leaf fat samples.

In the control animals, the total level of unsaturated fatty acids in the leaf fat was 50.77% whereas in the backfat it was 48.14%. On the other hand, the backfat was 7.53% higher in unsaturated fatty acids than the leaf fat (Table 3).

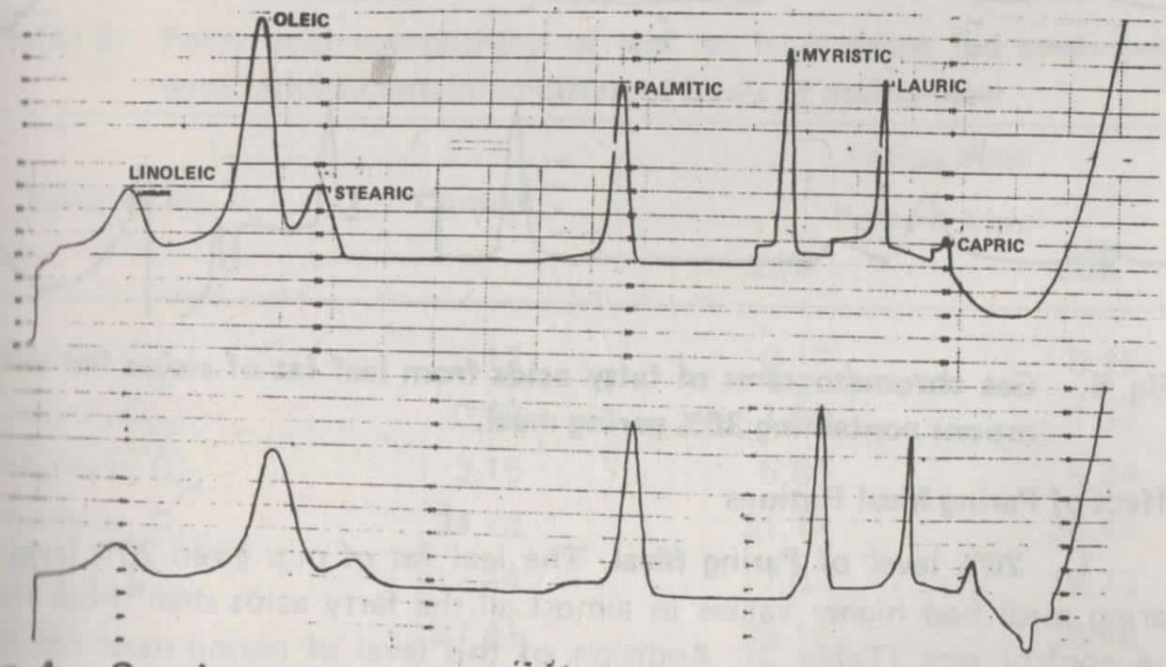


Fig. 4. Gas chromatograms of fatty acids from leaf fat of swine fed with rations without paring meal.

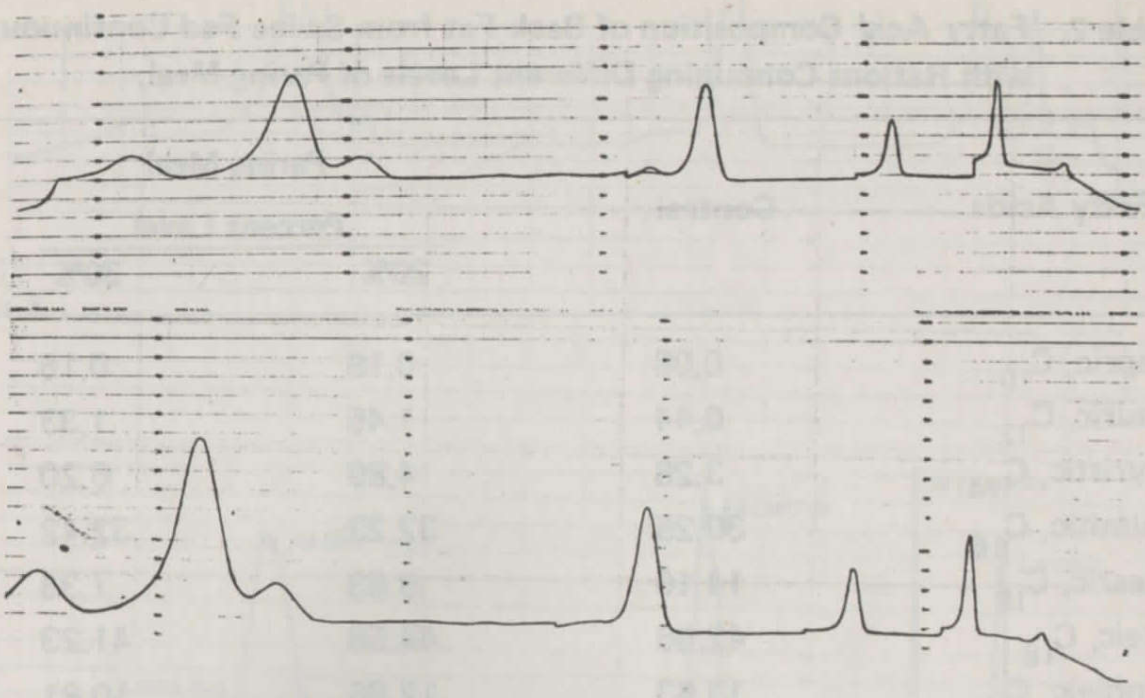

**Fig. 5. Gas chromatograms of fatty from leaf of fat swine fed with rations containing 20% paring meal.**

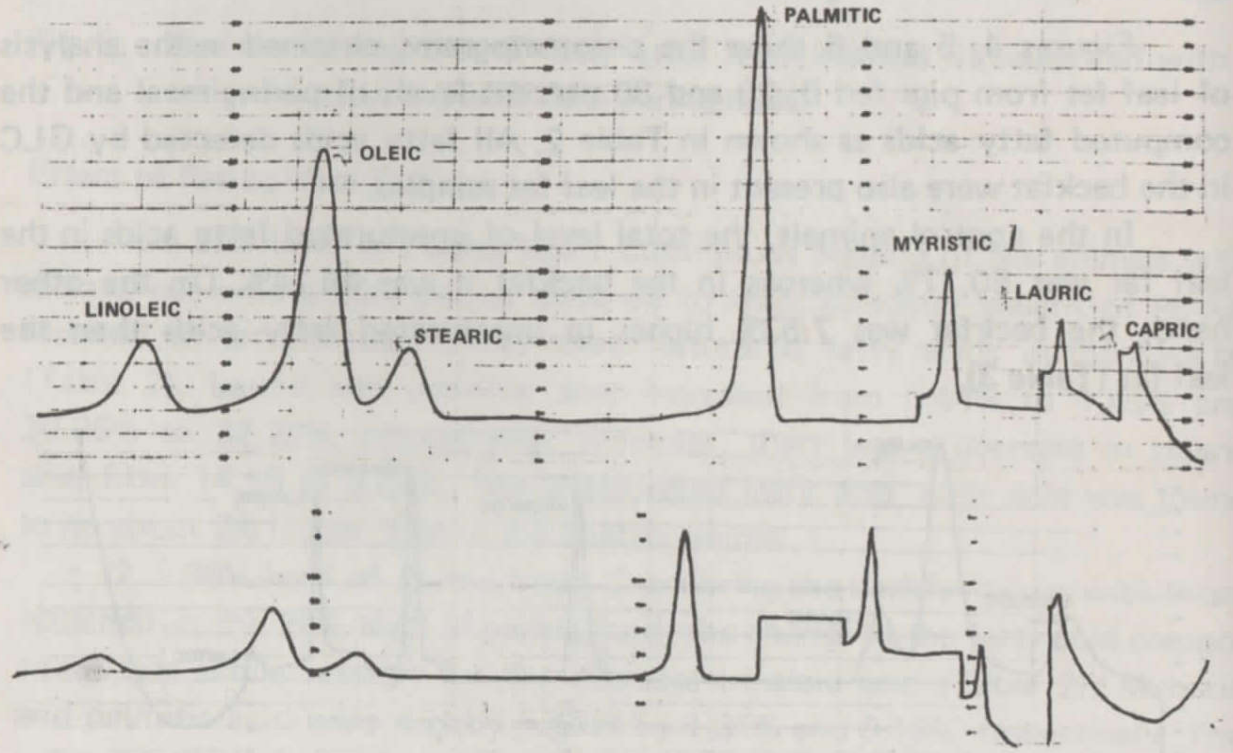


**Fig. 6. Gas chromatograms of fatty acids from leaf fat of swine fed with rations containing 30% paring meal.**

### Effect of Paring Meal Rations

1. **20% level of Paring Meal.** The leaf fat of pigs given 20% level of paring meal had higher values in almost all the fatty acids than those from the control pigs (Table 3). Addition of this level of paring meal resulted to higher values for lauric, myristic and stearic acid in the leaf fat than in the backfat.

2. **30% level of Paring Meal.** The 30% paring meal fed pigs had less linoleic acid in the leaf fat than in the control (Table 3). As the level of paring meal was increased in the feed rations, palmitic, stearic and lauric acid increased in the leaf fat.

The other fatty acids in the leaf fat with exception of myristic and oleic acids were slightly higher if not the same as in the backfat samples at level of paring meal. A marked increase of stearic acid in the leaf fat was brought about by the addition of more paring meal in the diet of the animals. Stearic acid which was 7.38% in the backfat was 18.73% in the leaf fat at this level of paring meal.

The changes in oleic and linoleic acid in leaf fat brought about by the addition of paring meal was found to be statistically insignificant.

It seems apparent from the data obtained in this study that although the levels of lauric and myristic acids increased in pork fat when paring meal was fed, these fatty acids constituted only a small proportion of the total fatty acids in the backfat and leaf fat of pigs considering the fact that 10-45 gm. oil per kilo of feed (coconut oil + paring meal) in the starter rations was fed to the animals and that lauric and myristic acid constituted more than 50% of the fatty acid of coconut oil or paring oil (Pascual and Cunanan, 1966). This is in consonance with the reports of Cresswell and Brooks (1971) that while the levels of lauric and myristic acids increased in pork fat when coconut oil was fed, they constituted only a small proportion of the total fatty acids in the backfat of pigs fed with 10% level of oil. Likewise, less than 1% of capric acid was found in the pork fat of pigs receiving the oil. This agrees with the findings of Christen (1963) and Chung and Lin (1965) who reported that these acids were not readily utilized in the formation of fat tissues.

**Table 3. Fatty acid composition of leaf fat from swine fed continuously with rations containing different levels of paring meal.**

| Fatty Acids | Control | Paring Meal Percent Level | |
|---|---|---|---|
| | | 20% | 30% |
| Capric, $C_{10}$ | 0.12 | 0.17 | 0.15 |
| Lauric, $C_{12}$ | 0.48 | 1.99 | 1.37 |
| Myristic, $C_{14}$ | 3.15 | 5.86 | 4.34 |
| Palmitic, $C_{16}$ | 34.78 | 31.11 | 36.48 |
| Stearic, $C_{18}$ | 12.24 | 17.03 | 18.73 |
| Oleic, $C_{18}$ | 37.41 | 39.16 | 38.48 |
| Linoleic, $C_{18}$ | 11.65 | 9.05 | 11.34 |

**Effect of Shifting Diets on the Fatty Acid Composition of Backfat Paring Meal-Free Rations**

Linoleic acid was the only fatty acid that increased in level in the backfat samples obtained from the 20% paring meal fed pigs. Capric and stearic acid showed similar changes in the 30% paring meal fed pigs after the animals were shifted to paring meal-free diets. It is interesting to note that a marked decrease in palmitic acid in the backfat samples resulted after the change in diet (Table 4).

The resulting change in the fatty acid composition in the backfat that is, the lowering of levels for lauric, myristic and palmitic acids after the pigs were shifted to the control ration was found to be statistically significant ($P < .05$). It is interesting to recall the findings of Ostwald et al. (1962) in which changes in adipose tissues of rats were also observed to occur after a week of change in the dietary fat.

**Table 4. Effect of shifting diets of 20% and 30% paring meal fed swine to paring meal free rations on the fatty acid of back fat.**

| Fatty Acids | Control % | 20% Paring Meal | | 30% Paring Meal | |
|---|---|---|---|---|---|
| | | Shifted[a] % | Unshifted[b] % | Shifted[a] % | Unshifted[b] % |
| Capric, $C_{10}$ | 0.07 | 0.12 | 0.18 | 0.17 | 0.15 |
| Lauric, $C_{12}$ | 0.44 | 0.78 | 1.45 | 1.60 | 2.33 |
| Myristic, $C_{14}$ | 3.28 | 4.13 | 4.89 | 5.39 | 6.20 |
| Palmitic, $C_{16}$ | 30.25 | 21.64 | 32.23 | 22.80 | 32.42 |
| Stearic, $C_{18}$ | 14.10 | 8.48 | 9.83 | 10.74 | 7.38 |
| Oleic, $C_{18}$ | 42.96 | 40.65 | 44.58 | 35.04 | 41.23 |
| Linoleic, $C_{18}$ | 13.63 | 13.87 | 12.86 | 11.12 | 10.81 |

[a] *Paring meal free ration was fed to pigs upon reaching 75 kg up to their slaughter weight of 85 kg.*

[b] *Fed continuously up to slaughter weight of 85 kg with paring meal.*

**Effect of Shifting Diets on Fatty Acid Composition of Leaf Fat Paring Meal Free Rations**

Palmitic acid was the only fatty acid that showed a very slight increase in percentage in the leaf fat of 20% paring meal fed pigs after the shifting of diet (Table 5). However, this fatty acid together with all other fatty acid components gave significantly lower values in the leaf fat obtained from the 30% paring meal fed animals.

The combined saturated and unsaturated fatty acids for the leaf fat and backfat samples in all treatments are shown in Table 6. The difference in fatty acid composition between the two areas of deposition was the presence of a higher level of saturated fatty acids and a lower level of unsaturated fatty acids in the leaf fat than in backfat. This is in agreement with the findings of Del Mundo (1971) and Zamora (1972) that leaf fat has lower iodine number than backfat.

Results of this investigation show that the amount of oil in the starter ration are at a low level and that apparently, the effect on the fatty acid composition of pork fat was not pronounced. Eckey (1954) reported that the effect on fatty acid composition is expected to be greater when the oil content in the ration is high.

**Table 5. Effect of shifting diets of 20% and 30% paring meal fed swine to paring meal free rations on the fatty acid of leaf fat.**

| Fatty Acids | Control % | 20% Paring Meal | | 30% Paring Meal | |
|---|---|---|---|---|---|
| | | Shifted[a] % | Unshifted[b] % | Shifted[a] % | Unshifted[b] % |
| Capric, $C_{10}$ | 0.12 | 0.08 | 0.17 | 0.10 | 0.15 |
| Lauric, $C_{12}$ | 0.48 | 2.74 | 2.99 | 1.21 | 1.37 |
| Myristic, $C_{14}$ | 3.15 | 4.47 | 5.86 | 3.65 | 1.34 |
| Palmitic, $C_{16}$ | 34.78 | 32.92 | 32.82 | 35.03 | 36.48 |
| Stearic, $C_{18}$ | 12.24 | 15.50 | 17.03 | 13.85 | 18.73 |
| Oleic, $C_{18}$ | 37.41 | 38.29 | 39.16 | 37.12 | 38.48 |
| Linoleic, $C_{18}$ | 11.65 | 8.04 | 9.05 | 8.46 | 11.34 |

[a] *Paring meal free ration was fed to pigs upon reaching 75 kg up to their slaughter weight of 85 kg.*

[b] *Fed continuously up to slaughter weight of 85 kg with paring meal.*

**Table 6. Percentage of total saturated and total unsaturated fatty acids of fat from swine fed continuously with rations containing different levels of paring meal.**

| Deposition Area | Fatty Acids | Control | Paring Meal | |
|---|---|---|---|---|
| | | | 20% | 30% |
| a. Back fat | Saturated | 48.14 | 48.58 | 47.78 |
| | Unsaturated | 56.59 | 57.44 | 52.04 |
| b. Leaf fat | Saturated | 50.77 | 57.78 | 61.07 |
| | Saturated | 49.66 | 47.21 | 49.82 |

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