6

Vème REUNION DES INSTITUTS DE RECHERCHES SUR LES VIANDES

PARIS - du 7 au 12 SEPTEMBRE 1959 -

Influence of the Basal Diet on the Quality of Pig Fat. II. Feeding a diet low in fat.

by Olle Dahl

Scan's Centrallaboratorium, Malmö, Sweden.

In a great number of feeding experiments the influence of the exogenous fat on the composition of pig's depot fat has been investigated by several workers (for references, cf. Dahl, 1958 a). It has been established repeatedly that unsaturated fatty acids, which cannot be synthesized by the organism, are laid down as glycerides in the fat depots. The difference in this respect between non-ruminants and ruminants has also been stressed (cf. Dahl, 1958 b, and Garton, 1958).

From a practical and also theoretical point of view it is of great interest to know the effect of feeding pigs rations which have a low content of fat. In some districts pigs are sometimes fed a diet almost exclusively consisting of potatoes and skim milk. Such a diet is extremely low in fat and it has been reported that it may cause muscular degeneration and acute heart failure, particularly at low protein and vitamin levels (quoted from Ludvigsen, 1957). It has not been proved, however, that a diet low in fat content will, of itself, occasion these deleterious consequences.

In a feeding experiment Shorland and De la Mare (1945) fed pigs entirely on skim milk, apparently without any harmful complications ; the iodine value of the back fat was low (about 53) and the content of polyethenoid C_{18}-acids was only 0.3 per cent.

Witz and Beeson (1951) reported that obvious signs of fat deficiency such as dermatitis, loss of hair and brown gummy skin exudates were produced in pigs reared on diets containing only 0.06-0.12 per cent fat along with 50 mg α-tocopherol/kg body-weight/day ; several internal organs were also affected.

Hill et. al. (1957) fed miniature pigs and Chester White pigs obtained by hysterectomy 3 to 6 days before expected parturition, on a virtually fat-free diet. The animals were 1 to 20 days old and weighed 0.7 to 2.4 kg at start of the experiment. This very severe regime caused high mortality

.../...

and in most of the surviving animals aortic lesions were observed at or before 98 days on the experiment diet. Garton et al. (1958) fed two groups of weaned pigs on a diet containing 0.73 per cent ether-extractable matter during 12-13 weeks and 29 weeks, respectively, without any overt signs of fat deficiency. This was true whether or not the pigs were given supplementary tocopherol in the form of Rovimix E (Roche Products Ltd). In experiments with rats Longenecker (1939) found about 2 per cent octadecadienoic acid in the depot fat of rats fed on diets very low in fat but high in carbohydrate of protein.

Experiments and Results

Three groups of 8 pigs, each of 4 males and 4 females, were fed on the following diets :

Group I : potato flour, dried beet pulp, dried yeast, solvent-extracted soybean oil meal, and skim-milk (= diet extremely low in fat).

Group II : ground barley and skim milk (= normal diet).

Group III : a mixture of equal parts of ground barley and oats, skim milk (= richer in fat than the preceding diet). In addition, by this experiment earlier investigations (Dahl, 1958 a) were completed.

Minerals and vitamins were provided as indicated in the footnotes to Table 2. In particular it should be mentioned that the pigs in group I were given ample allowances of α-tocopherol.

The piglets originated from four litters of Swedish Large White pigs. The experimental conditions, sampling, and analyzing, were the same as those in earlier feeding trials (Dahl, 1958 a).

The fat content of the feeding-stuffs, as well as the iodine value and content of polyethenoid fatty acids in the dietary fats, are given in Table 1.

The consumption of food, rearing periods, growth, thickness of back fat etc. are summarized in Table 2.

Due to acute volvulus one pig in group I (N° 28) had to be killed at a live weight of 77 kg instead of ca. 86 kg. The statistical calculations were, therefore, performed alternatively, with and without the data of pig n°28. When comparing with the two other groups, the conclusions were, however, not affected by the method of computing.

According to the inspecting veterinarian the volvulus was said not to have been caused by the particular feeding applied.

It was observed that the faeces of the pigs in group I were thinner and more off-smelling than those of the pigs in group II and III. It may be noted that changes in the stools have been observed in infants suffering from linoleic acid deficiency (Hansen et al., 1958).

.../...

29

Veterinary inspection of the carcasses and the organs revealed no notable differences between the groups. All the carcasses and edible organs were approved for human consumption. In particular, the aorta of the pigs in group I was quite normal and without lesions (cf. p. 1).

The back fat and leaf fat from all pigs were extracted and analyzed for iodine value, content of polyethenoid acids, saponification equivalent and resistance to oxidative rancidity ("keepability") at 55° C. In accordance with earlier findings (Dahl, 1958 a) only traces of trienoic and tetraenoic acids could be detected, although the isomerization was performed in a strong (21 per cent) solution of KOH (cf. footnote to Table 1) ; only 0.1 - 0.3 per cent of octadecatrienoic acid was found. The results are summarized in Table 3.

Discussion

From Table 1 it is evident that the pigs in group I (low-fat diet) required a 5-7 days longer rearing period than did the pigs in group II and III. The difference is, however, not statistically significant. It is not possible to decide whether the lower content of plant protein in the ration given to group I may have had any influence on the rearing time.

The dressing-out percentage of the pigs in group I was markedly lower than that of the pigs in group II and III. Furthermore, the back fat of the pigs in group I was thinner than that of the other pigs, although the former received a diet higher in carbohydrates. These differences were statistically significant (cf. Table 4).

No relation was found between length of rearing period on the one hand and "keepability", iodine value, content of linoleic acid, saponification equivalent or sex on the other. A possible correlation exists between iodine value on the one hand and content of linoleic acid and "keepability" on the other, but only within each group and the same kind of depot fat. This is also true for the relation between content of linoleic acid and "keepability".

From Table 3 it is evident that, as would be expected from earlier findings, there is a significant difference with regard to the content of linoleic acid, firstly, between the groups, and secondly, between different kinds of depot fat. The differences between the groups reflect the various contents of linoleic acid in the exogenous fat. In the previous experiments (Dahl, 1958 a) it was found that an almost quantitative deposition of the linoleic acid occurs in the pig's body. From the present data (Table 1 and 2) the following turnover calculation can be made for group I : On an average each pig consumed 180 g dry feed mixture containing 0.31 per cent oil with 35 per cent linoleic acid (as glyceride). Thus 0.10 kg linoleic acid was ingested. Furthermore, 446 kg skim milk, containing on an average 0.12 per cent fat, was consumed. The content of linoleic acid in the skim milk was not determined, but according to Hilditch (1956) the content of linoleic acid in milk fat is 3.5 - 4 per cent. Assuming this value to be valid

.../...

also for the fat in skim milk (cf. below), the skim milk supplied 0.02 kg linoleic acid. The quantity of fat in a carcass from this group might have been about 18 kg (thinner back fat and a lower weight at slaughter than in the earlier experiments). Thus the content of linoleic acid in the depot fat would be about 1.2 per cent provided all the dietary linoleic acid was deposited. This figure is significantly lower than that found by analysis (Table 3). It may be remembered that the back fat constitutes about 90 per cent of the total depot fat in the pig's body. An explanation to the discrepancy between the calculated content of linoleic acid and that found by analysis might be the accumulation of linoleic acid during the suckling period. Furthermore, the content of polyethenoid acids in the fat of skim milk may be considerably higher than that of butter, since the non-separable milk lipids (phospholipids etc.) are likely to have a different fatty acid composition to that of butter. However, in practice it does not seem possible that so low a content of essential fatty acids would be found in the diet that normal rearing would be affected by this factor. Nor does a low content of linoleic acid seem to be related to muscular degeneration or acute heart failure. Most likely, therefore, these diseases originate from a deficiency of protein and/or vitamins in the ration (as is generally assumed), especially with respect to the effect of tocopherol in relation to muscular degeneration. In addition, also selenium deserves attention, since it has recently been shown by Muth et al. (1959) that sodium selenite has a curative effect on white muscle disease in lambs and calves.

A similar calculation for the pigs in group II shows that 1.57 kg linoleic acid (as glyceride) is found in about 21 kg depot fat giving a value of 7.5 per cent linoleic acid, which is in agreement with the content found by analysis. The pigs in group III consumed 2.38 kg linoleic acid (as glyceride), which, when distributed in 22 kg depot fat, gives a content of 10.8 per cent linoleic acid ; this is about 1 per cent higher than that found by analysis. This may depend on too low an estimate of the amount of depot fat. In general, these calculations confirm the results obtained in the previous experiments (Dahl, 1958 a), i. e. an approximately quantitative deposition of dietary linoleic acid takes place.

In the previous investigations a marked relation was found between the iodine value and the content of linoleic acid in the depot fat, but this was not so in the present experiments. Only the iodine value of the leaf fat from the pigs in group III was found to be significantly higher than that of the corresponding fat from the pigs in group II (level of significance : 97 per cent). These results indicate that, under the conditions prevailing, there is a tendency to maintain a relatively constant degree of unsaturation in a certain depot fat. In the absence of linoleic acid this is brought about by some other unsaturated fatty acid, most likely oleic acid. However, the results reported by Shorland and De la Mare (1945) and those obtained in the author's earlier experiments (Dahl, 1958 a) indicate that the ability of the organism to compensate for the unsaturation of the fat is restricted. In this connection the experiments of Bratzler et al.(1950) may be mentioned. These authors reported that supplements of mixed

.../...

tocopherols to a fat-deficient and tocopherol-deficient ration caused an increase in the unsaturation of the pig's depot fat. This was due to the formation of oleic acid at the expense of saturated acids. However, this effect was not observed by Garton et al. (1958).

It may be noted that the thickness of the back fat parallels its content of linoleic acid. The question thus arises whether or not the latter is involved in fat synthesis or deposition.

The results of analysis of variance on the "keepability" data appear in Table 5.

When comparing corresponding fats from the pigs in group II and III, the results are in accord with those obtained in the previous experiments (Dahl, 1958 a), i.e. The "keepability" is inversely related to the content of linoleic acid. The differences between the means of "keepability" for the groups II and III are highly significant. The back fat of the pigs in group I had, however, a very poor "keepability", which is surprising considering the very low content of linoleic acid and the supplementary tocopherol ingested. It has been reported that tocopherols pass into the depot fat and, according to Chipault et al. (1945), the tocopherols are possibly the only natural direct inhibitors of oxidation that occur normally in hog fats. However, Watts et al. (1946) found that the protective effect resulted from feeding tocopherols to pigs was too small to be of any practical significance. Yet it does not seem to be full agreement as to this matter, for later Zaehringer et al. (1959) found that tocopherol supplementation to the pig's ration increased the storage life of frozen pork. This was shown both by the peroxide number and the thiobarbituric acid value. No explanation for the result obtained in our experiments can be offered at present. The "keepability" of the leaf fat was, however, equally high for group I as that for group II and considerably higher than that for group III.

In earlier investigations (Dahl, 1958 c) it was demonstrated that the saponification equivalent of leaf fat is almost the same as that of back fat, although a slight tendency to higher values for the back fat was evident. The present investigations (Table 3) show that the back fat has a significantly higher saponification equivalent, about 1 unit, than the leaf fat ; this is true for all the groups. The difference depends on a slightly lower content of palmitic acid in the back fat than in the leaf fat (Dahl, 1957). The magnitude of the saponification equivalent indicates that the depot fat from the pigs fed a diet low in fat is not richer in hexadeconoic acid than pig fat in general (3 - 5 per cent hexadecenoic acid). This is in contrast to the findings of Longenecker (1939) in feeding experiments with rats. When the rats were fed a diet low in fat but high in carbohydrate or protein the content of hexadecenoic acid in the depot fat increased to 13-16 per cent. If the diet contained 5 per cent fat the content of hexadeconoic acid in the rat depot fat was only about 4 per cent.

.../...

If the iodine values and contents of linoleic acid for the male pigs in group II and III are considered together and the same is done with the corresponding data for the female pigs, analysis of variance discloses that both the iodine value and the content of linoleic acid is significantly higher in the fats from the female pigs with the exception of the iodine value of the leaf fats. This is shown in table 6.

Summary

Growth and quality of depot fat of pigs reared on a diet very low in fat (consisting of potato flour, dried beet pulp, extracted soybean oil meal, dried yeast, and skim milk) were compared with the corresponding features for pigs fed on 1) barley and skim milk and 2) equal parts of barley, oats, and skim milk.

The mixture of the dry ingredients of the diet low in fat contained 0.31 per cent fat, exclusive unsaponifiable matter. The back fat of the pigs reared to bacon weight on the low-fat diet contained on an average 2.0 per cent linoleic acid.

The following results were obtained :

1. the pigs fed on the diet low in fat required a 5-7 days longer rearing period to reach 85 kg live weight at slaughter than the normally-fed pigs. The prolonged rearing time was, however, not statistically significant. Gain of weight per feeding unit was about the same regardless of the diet.

2. The carcasses of the pigs fed on the low fat diet showed a significantly lower dressing-out percentage (about 2 per cent lower) and a thinner back fat (about 6 mm thinner) than the normally-fed pigs.

3. No abnormalities or changes of any kind were visible in any of the carcasses or organs at slaughter.

4. Even the very small quantity of linoleic acid present in the low-fat diet (amounting to about 0.1 per cent in the dry feeding mixture) was laid down in the adipose tissue. Analysis showed a higher content of linoleic acid in the depot fats of the pigs reared on the diet low in fat than could be calculated from the content of linoleic acid in the ration. Possible explanations for this descrepancy are discussed.

5. Although the content of linoleic acid in the depot fats of the pigs fed on the low-fat diet was very low, the iodine values of these fats were as high as those of the fats from the normally-fed pigs. Reasons for this are discussed.

6. The "keepability" (resistance to oxidative rancidity) of the back fat from the pigs fed on the diet low in fat was, in spite of its low content of linoleic acid and the supplements of tocopherol given, very poor and not significantly higher than that of the back fat from the pigs reared on equal parts of barley and oats. The leaf fat of the former pigs, however,

.../...

showed an equally good "keepability" as did the leaf fat of the pigs fed on barley.

7. In depot fats from the female pigs fed on barley and barley plus oats the iodine values and the contents of linoleic acid were found to be significantly higher than those of the corresponding fats from the male pigs.

8. The saponification equivalent of the back fat was throughout significantly higher (about 1 unit) than that of the leaf fat.

Acknowledgement

The author wishes to thank director K. Viwog, head of the Agricultural Institute of Bollerup, whose kind cooperation made it possible to perform these experiments, and agronomist G. Melin for much valuable help with the practical details of rearing.

References

Bratzler, J.W., Loosli, J.K., Krukovsky, V.N., & Maynard, L.A. 1950.J. Nutr. 42, 59.

Chipault, J.R., Lundberg, W.O., & Burr, G.O. 1945. Arch. Biochem. 8, 321.

Dahl, O. 1957. Zeitschr. Lebensm.-Untersuch. u. -Forsch. 106, 81.

Dahl, O. 1958 a. Acta Agric. Scand. 8, 106.

Dahl, O. 1958 b. Svensk Kem. Tidskr. 70, 43.

Dahl, O. 1958 c. Acta Agric. Scand. 8, Supplementum 3.

Garton, G.A. 1958. Mededelingen der Veeartsenijschool van de Rijksuniversiteit Van Gent 2, Nr. 3.

Garton, G.A., Duncan, W.R.H., Madsen, K.A., Shanks, P.L., & Beattie, I.S. 1958. Brit. J. Nutr. 12, 97.

Hansen, A.E., Haggard, M.E., Boelsche, A.N., Adam, D.J.D., & Wiese, H.F. 1958. J. Nutr. 66, 565.

Herb, S.F. & Riemenschneider, R.W. 1952. J. Am. Oil Chemists'Soc. 29, 456.

Hilditch, T.P. 1956. The Chemical Constitution of Natural Fats. London. Chapman & Hall, Ltd.

Hill, E.G., Warmanen, E.L., Hayes, H., & Holman, R.T. 1957. Proc. Soc. Exptl. Biol. and Med. 95, 274.

.../...

Longenecker, H.E. 1939. J. Biol. Chem. 128, 645.

Ludvigsen, J. 1957. Medlemsblad for Den danske Dyrlaegeforening Nr. 7, 1.

Muth, O.H., Oldfield, J.E., Schubert, J.R., & Remmert, L.F. 1959. Am. J. Vet. Res. 20, 231.

Shorland, F.B. & De la Mare, P.B.D. 1945. J. Agri. Science 35, 33.

Watts, B.M., Cunha, T.J., & Major, R. 1946. Oil & Soap 23, 222.

Witz, W.M. & Beeson, W.M. 1951. J. Anim. Sci. 10, 112.

Zaehringer, M.V., Bring, S.V., Rickard, C.A., & Lehrer Jr, W.P. 1959. Food Techn. 13, 313.

-:-

Table 1. Contents and analyses of oil in barley, oats and dry feeding mixture used for group I (potato flour, dried beet pulp, soybean oil meal, and dried yeast).

	Barley	Oats	Dry feeding mixture for group I
Content of oil (excl. unsaponif. matter), %[1]	1.9	5.0	0.31
Iodine value of oil (" " ")	123.2	114.3	104.1
Linoleic acid [2], as % by weight of total fatty acids in oil	48.9	35.5	35.0
Linolenic " [2] " " "	8.3	8.3	6.3

1) according to the method of Schmid-Bondzynski-Ratzlaff.

2) Method of determination, cf. Dahl (1957). In addition to isomerization in a 7.5 % solution of KOH, isomerization was also performed in a 21 % solution of KOH according to Herb and Riemenschneider (1952) in order to get a more reliable estimate of tetraenoic and higher polyethenoid acids. No appreciable content of such acids was found. The contents of linoleic and linolenic acids were also found to be the same when 21 % or 7.5 % solutions of KOH were used.

Table 4. Significance of difference between means of dressing-out percentage and thickness of back fat for different groups.

	Level of significance of difference between means of	
	Dressing-out percentage	Thickness of back fat
Group I and II [1]	> 95 %, < 98 %	> 98 %, ≤ 99 %
" I " III [1]	98 %	99.9 %
" II " III	no sign.	no sign.

1) No change of significance if pig Nº. 28 in group I is excluded.

.../...

Table 2. Feed consumption, growth, rearing periods, thickness of back fat, etc.

The figures are means, and in some cases, standard deviations (s) are given.
The figures refer to one pig per day, unless otherwise stated.
The dry ingredients were mixed thoroughly before feeding.

	Group I	s	Group II	s	Group III	s
Ground Barley, total consumption per pig, kg	-		169.1		87.7	
Ground Oats, " " " " "	-		-		87.7	
Potato flour, " " " " "	140.2		-		-	
Dried beet pulp, " " " "	26.9		-		-	
Soybean oil meal (solvent extracted) " " " "	3.6		-		-	
Dried yeast " " " " " 1)	5.4		-		-	
Skim milk, total consumption per pig, kg	446.0		425.8		416.0	
Scandinavian feed units, fe (sk), consumed per day	1.692		1.776		1.810	
Digestible true protein consumed, grams per day	141		201		226	
Digestible true protein per fe (sk), grams	83		113		125	
" " milk protein as % of total digest. true protein	70		48		42 ½	
Crude fibre in the dry feeding mixture, %	1,7		4.2		5.8	
Live weight at start of trial, kg	20.0		19.9		20.0	
Age " " " " , days	66.4 3)		69.3		69.3	
Live weight at slaughter, kg	84.8 4)		86.8		86.1	
Dressing-out percentage	74.6 5)	1.0	76.2	1.7	76.4	1.6
Rearing (experimental) period, days	129.5	10.3	124.9	9.3	122.1	10.9
Gain in weight, grams per day	500 6)		536		541	
Fe (sk) required per kg gain of weight	3.38 7)		3.31		3.35	
Thickness of back fat, mm 2)	27.6 8)	3.8	32.6	3.2	34.4	2.7
Grade (class)	expr		expr		expr	

Scandinavian feed units, fe (sk), per kg of barley ——— 1.009
" " " " " " " " oats ——— 0.940
" " " " " " " " food mixture (except minerals) for group I — 0.940

Digestible true protein of barley ——— 7.7 %
" " " " oats ——— 10.1 %
" " " " food mixture (except minerals) for group I - 3.1 %
" " " " skim milk ——— 2.85 %

In addition to the ingredients listed in Table 1, each pig in group I got an average daily dose of 20.8 g dicalcium phosphate ($CaHPO_4$) containing 0.5 % $FeSO_4 \cdot 5H_2O$, 0.2 % $CaSO_4 \cdot 5H_2O$, 0.5 % $MnSO_4 \cdot 5H_2O$, and 0.5 % $ZnCO_3$; 6.9 g iodized salt ; 17400 I.U. vitamin A, 3500 I.U. vitamin D_3, and 10.5 mgs dl-α- tocopherolacetate. Similarly, each pig in group II got 12.5 g ground limestone, 13000 I.U. vitamin A, and 2600 I.U. vitamin D_3. Each pig in group III got 15.0 g ground limestone and the same doses of vitamin A and D_3 as the pigs in group II. The minerals were mixed in the other dry ingredients. The vitamins were given once a week as liquid preparations, the fat content of which was low and could be neglected.

Table 2 - continued

1) Consisting of equal parts of brewers' yeast and sulphite yeast (obtained by fermentation of waste sulphite liquor from paper pulp manufacture) ; it contained 75 γ thiamine, 40 γ riboflavin, and 350 γ niacin per gram. In addition, 70 mgs thiamine, 500 mgs niacin, and 10 mgs choline chloride were mixed in each kg of yeast.

2) Several measurements on each carcass ; see Dahl (1958 a).

3) If pig N°. 28 is excluded (see the text), the mean is 85.9 kg.

4) " " " " " " " " " " " " " not influenced.

5) " " " " " " " " " " " " " 130.1 days.

6) " " " " " " " " " " " " " 510 grams.

7) " " " " " " " " " " " " " 3.32 fe (sk)

8) " " " " " " " " " " " " " not influenced.

Table 5. Significance of difference between means of keepability for different groups.

Depot	Means of keepability compared	Level of significance of difference
Back fat	Group I and II " I " III " II " III	99 % no sign. > 99.9 %
Leaf fat	Group I and II " I " III " II " III	no sign [1] 99.9 % > 99.9 %

1) No change of significance if pig N°. 28 in group I is excluded.

Table 3. Analyses of back fat and leaf fat.

Group	Pig N°	Sex	Back fat: Iodine value	Back fat: Linoleic acid, %	Back fat: Keepability, days at 55° C	Back fat: Saponification equivalent	Leaf fat: Iodine value	Leaf fat: Linoleic acid, %	Leaf fat: Keepability, days at 55° C	Leaf fat: Saponification equivalent
I (fed potato flour)	8	M	58.8	1.9	5.0	284.5	47.9	1.2	20.8	283.1
	9	M	55.8	1.9	10.9	283.7	46.5	1.2	33.2	283.2
	23	M	59.2	1.5	7.1	284.9	49.8	1.2	21.7	283.9
	27	M	58.8	2.3	2.7	285.6	49.6	1.5	29.1	283.8
	28	F	59.2	2.3	10.0	284.2	53.4	1.8	13.2	283.1
	29	F	57.9	2.1	7.0	284.5	50.2	1.6	16.1	283.5
	44	F	56.3	2.0	18.0	284.6	48.9	1.6	21.0	283.2
	50	F	55.5	1.7	12.8	285.8	44.4	1.1	37.2	284.3
Mean			57.7	2.0	9.2	284.7	48.8	1.4	24.0	283.5
Standard deviation			1.6	0.3	4.8	0.7	2.7	0.3	8.4	0.4
Confidence interval of mean, 95 % level [1]			± 1.1	± 0.2	± 3.2	± 0.5	± 1.8	± 0.2	± 5.6	± 0.3
II (fed barley)	10	M	54.7	6.5	20.8	284.0	44.4	5.5	21.5	282.5
	11	M	54.1	5.9	24.4	284.2	44.9	4.8	33.0	282.9
	20	M	56.2	7.2	16.1	284.2	46.4	6.1	21.9	283.0
	21	M	60.5	7.9	11.3	285.2	50.1	6.4	22.5	284.1
	4	F	59.7	8.4	12.1	284.5	48.1	7.4	18.3	283.5
	14	F	56.6	7.8	17.3	283.7	46.3	6.1	28.0	282.5
	32	F	61.3	8.9	14.5	284.5	50.2	7.6	28.6	283.7
	33	F	56.6	7.3	12.2	284.6	46.0	6.1	22.4	283.6
Mean			57.5	7.5	16.1	284.4	47.1	6.3	24.5	283.2
Standard deviation			2.7	1.0	4.6	0.5	2.2	0.9	4.8	0.6
Confidence interval of mean 95 % level [1]			± 1.8	± 0.7	± 3.1	± 0.3	± 1.5	± 0.6	± 3.2	± 0.4
III (fed barley + oats)	6	M	56.8	9.5	5.9	284.3	49.7	8.3	10.0	283.7
	7	M	55.2	8.9	9.2	283.9	48.7	7.6	12.2	283.6
	13	M	54.9	9.1	2.0	283.5	47.8	8.1	10.6	283.2
	22	M	57.3	9.3	5.9	285.3	49.0	8.4	11.3	284.3
	5	F	58.4	9.5	6.0	285.5	48.8	8.6	11.0	283.5
	25	F	60.7	10.8	8.5	284.0	49.7	9.6	13.0	283.6
	31	F	61.4	11.9	7.2	285.6	51.3	10.5	12.1	284.0
	34	F	57.2	9.6	9.3	284.8	48.2	8.9	11.4	283.7
Mean			57.7	9.8	6.8	284.6	49.2	8.8	11.5	283.7
Standard deviation			2.3	1.0	2.4	0.8	1.1	0.9	1.0	0.3
Confidence interval of mean 95 % level [1]			± 1.6	± 0.7	± 1.6	± 0.5	± 0.7	± 0.6	± 0.6	± 0.2

[1] The means have been ommited.

Table 6. Differences due to sex. Significance of difference between means of iodine value and content of linoleic acid.

Males from groups II + III compared with females from these groups [1]

Statistic	Iodine value		Content of linoleic acid	
	Males	Females	Males	Females
Back fat :				
Mean	56.2	59.0	6.9	8.1
Standard deviation	2.0	2.1	0.6	0.9
Confidence interval of the mean, 95 % level [2]	± 1.4	± 1.4	± 0.4	± 0.6
Level of significance of difference between means	> 98 %		> 99 %	
Leaf fat :				
Mean	46.6	47.5	5.7	6.9
Standard deviation	1.8	1.6	0.5	0.8
Confidence interval of the mean, 95 % level [2]	± 1.2	± 1.0	± 0.4	± 0.5
Level of significance of difference between means	no sign.		> 99 %	

1) When calculating the statistics the iodine values for leaf fat in group III have been reduced by 2.1, the contents of linoleic acid for back fat in group III have been reduced by 2.3 % and those for leaf fat in group III by 2.5 %, thus accounting for the enhancing influence of oats upon the iodine value and the content of linoleic acid as compared with feeding barley alone. The means in Table 5 are, therefore, those which should have been expected if both the groups II and III had been fed only barley.

2) The means have been omitted.

-:-:-:-:-:-:-:-:-:-