CCLXVIII. THE OCCURRENCE AND POSSIBLE SIGNIFICANCE OF SOME OF THE MINOR COMPONENT ACIDS OF COW MILK FAT.

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THE occurrence in butter fatty acids of minute proportions (about 0.2 %) of Δ^9 -decenoic acid, first reported by Smedley [1912], has been definitely established by Grün & Wirth [1922] and by Bosworth & Brown [1933]. Grün & Winkler [1924] mentioned in addition the presence of small quantities of do-, tetra- and hexa-decenoic acids, but Bosworth & Brown, who showed that a tetradecenoic acid forms nearly 1 % of the total butter fatty acids, were unable to detect the presence of hexa- or do-decenoic acids. Riemenschneider & Ellis [1936], however, have recently reported that goat milk fat contains 2.1 % of hexadecenoic acid, as well as smaller amounts of tetradecenoic (0.4 %) and decenoic (0.2 %) acids. No information appears to have been given as to the structure of the tetra- and hexa-decenoic acids of these milk fats. In a recent communication [Hilditch & Thompson, 1936] we described oxidation experiments conducted on certain of the lower fractions obtained from the esters of the "liquid" fatty acids of butter during ester-fractionation analysis, which showed that the above-mentioned lower unsaturated acids were clearly detectable in the ester fractions in question, and which indicated the presence of hexadecenoic acid as definitely as that of tetradecenoic acid.

We have now given this question some further study, primarily in order to ascertain how far the quantitative data for the major component acids, as determined by our ester-fractionation procedure, are affected if (as hitherto) no account is taken of the minor quantities of lower unsaturated acids present. Concurrently, we have endeavoured to ascertain whether any unsaturated acid of lower molecular weight than decenoic acid is present, and also to obtain evidence as to the position of the unsaturated group in the tetra- and hexadecenoic acids, the presence of both of which is indicated by quantitative oxidation of appropriate ester fractions (*v. infra*).

For this purpose we have utilized the ester fractions obtained during the analysis, for Prof. Kay of the National Institute for Research in Dairying, of the component acids of the milk fat of a cow which had been receiving daily injections of 10 mg. of thyroxine. The composition of this milk fat was entirely normal and similar to those which we have previously examined from cows on normal diet; we therefore considered that the treatment of the cow constituted no objection to use of the material from this analysis for the additional experiments. We applied our usual ester-fractionation procedure to the butter fatty acids subject, however, to the following modifications:

(a) After the fatty acids volatile in steam had been fractionally distilled, the i.v., as well as the equivalent, of each fraction was determined.

(b) The esters obtained from the "liquid" acids (resulting from the lead salt-alcohol separation of the acids non-volatile in steam) were divided into two

portions. One portion was distilled in our usual way, a series of small fractions being collected from the refractionation of the first primary fraction; with the other portion, the size of the fractions was modified to some extent, in the hope of collecting larger quantities of those containing methyl tetra- or hexa-decenoate.

(c) In addition to the foregoing analysis, we carried out an ester-fractionation analysis on a specimen of the butter fat which had been completely hydrogenated, the results of which lead to the percentage composition of the mixed, completely saturated, fatty acids and which thus avoid any uncertainty due to the presence of small proportions of unsaturated acids other than those of the C_{18} series.

The cow milk fat studied had the following general characteristics: Reichert-Meissl value 27.3, Polenske value 2.1, Kirschner value 23.2, sap. equiv. 247.8 and i.v. 41.0.

Ester-fractionation analyses of the mixed fatty acids.

The fat (489.5 g.) yielded, after hydrolysis and prolonged distillation in steam of the resulting fatty acids, 435.8 g. of acids non-volatile in steam, while from the aqueous condensates there were ultimately recovered 29.7 g. of steam-volatile fatty acids. The acids non-volatile in steam were submitted to the usual lead salt separation from alcohol with the following result:

	%	Corresponding methyl esters	
		Equiv.	i.v.
"Solid" acids	44.2	274.3	4.7
"Liquid" acids	55.8	272.7	76.0

Fractionation of the fatty acids volatile in steam.

The aqueous condensates from the steam-distillation were extracted exhaustively with ether and the dried recovered acids submitted to direct fractional distillation, with the results given in Table I.

Table I. *Fractional distillation of acids volatile in steam.*

Acidity (as butyric acid) in:	g.	Equiv.	i.v.
Ether-extracted aqueous solution	1.14	—	—
Recovered ether	0.36	—	—
Distillate fractions:			
1 (up to 100°)	0.13	—	—
2 (100–160°)	1.53	—	—
3	2.24	90.0	0.0
4	2.70	90.6	0.0
5	2.60	91.7	0.0
6	2.45	92.0	0.0
7	2.78	93.7	0.0
8	2.58	95.9	0.1
9	3.72	103.7	0.1
10	2.71	115.8	0.2
11	3.05	129.3	1.7
Residue	1.68	180.2	17.9

The fairly substantial i.v. of the residues from this particular distillation have been calculated to oleic acid in our previous papers, in consequence of the observation [Hilditch & Sleightholme, 1930] that pure oleic acid is volatile in steam to about the same extent as that indicated by the i.v. in question. Calculated as oleic acid, i.v. 17.9 corresponds to 0.33 g., or 0.07 % oleic acid in the total fatty acids; reckoned as decenoic acid, it amounts to 0.20 g., or 0.043 %

decanoic acid in the total fatty acids. The proportion of unsaturated acid involved in these residues is thus so small that the final composition of the total fatty acids is not affected to more than 0.03% by assuming it to be either decenoic or oleic.

Only the final fraction of distillate had any appreciable i.v. (1.7), representing 0.03 g. as decenoic acid (less than 0.01% of the total fatty acids); the mean equivalent of this fraction lies between those of hexanoic and octanoic acids, and the 1% of unsaturated acid present therein may well be decenoic, although of course it might conceivably be traces of an octenoic acid. Clearly, however, there is no sign of the presence of octenoic or lower unsaturated acids in amounts approaching even the small proportions (0.2%) in which decenoic acid has been recorded in milk fats.

Fractionation of methyl esters of the "solid" and "liquid" acids.

As already mentioned, two separate fractionations of the methyl esters of the "liquid" acids were undertaken, the second being carried out in an

Table II. *Fractional distillation of methyl esters.*

(a) *Methyl esters of "solid" acids.*

Primary fractionation				Refractionation of fraction S1			
No.	g.	Sap. equiv.	i.v.	No.	g.	Sap. equiv.	i.v.
S1	31.52	261.5	1.7	S11	2.43	244.9	1.0
S2	6.24	272.3	2.7	S12	3.09	250.8	1.1
S3	8.21	273.7	3.2	S13	4.05	254.3	1.1
S4	8.11	277.4	4.1	S14	6.17	261.6	1.4
S5	7.75	280.7	5.8	S15	7.22	271.8	2.6
S6	8.26	287.6	8.8	S16	5.01	278.3	6.4
S7	9.22	294.9	10.9				
S8	3.28	304.6	12.9		27.97		
	82.59						

(b) *Methyl esters of "liquid" acids.*

Analysis I.

Primary fractionation				Refractionation of fractions L1			
No.	g.	Sap. equiv.	i.v.	No.	g.	Sap. equiv.	i.v.
1 L1	31.83	232.7	39.4	1 L11	2.30	171.3	5.0
1 L2	19.15	286.1	84.3	1 L12	2.19	187.9	8.8
1 L3	10.53	291.1	90.9	1 L13	2.80	199.5	9.3
1 L4	8.84	291.5	92.9	1 L14	12.79	241.3	29.1
1 L5	8.53	293.9	94.3	1 L15	4.68	279.3	74.5
1 L6	8.38	294.6	95.8	1 L16	3.66	293.4	89.2
1 L7	9.50	294.7	96.2		28.42		
1 L8	5.41	324.3	105.2				
	102.17	300.7*	99.9*				

Analysis II.

No.	g.	Sap. equiv.	i.v.	No.	g.	Sap. equiv.	i.v.
2 L1	68.60	251.3	56.8	2 L11	7.11	180.6	9.1
2 L2	8.77	291.0	84.7	2 L12	7.25	214.7	12.1
2 L3	10.53	293.6	92.7	2 L13	15.15	248.7	36.2
2 L4	9.86	294.4	94.2	2 L14	20.51	281.2	78.3
2 L5	9.14	294.8	94.9	2 L15	14.78	292.7	90.8
2 L6	10.67	296.0	96.8		64.80		
2 L7	4.97	295.9	99.0				
2 L8	4.16	346.0	112.4				
	126.70	297.4*	100.0*				

* Residual esters, freed from unsaponifiable.

attempt to obtain larger quantities of certain of the fractions in view of their subsequent oxidation (to determine the mean equivalent of the saturated esters present). The details of all the fractional distillations are collected in Table II.

In order to obtain data for the calculation of mixtures of two unsaturated esters (e.g. tetra- and hexa-, or hexa- and octa-decenoates) along with saturated esters in the "liquid" ester fractions, some of the latter were oxidized in acetone solution with powdered KMnO_4 ; the saturated esters were thereby isolated and their equivalent determined. (It is difficult to ensure quantitative recovery of the purified saturated esters and it is therefore preferred to employ only their equivalent in the calculation. The equivalent and i.v. of the original ester fraction, with the mean equivalent of the saturated components therein, afford the data necessary for the calculation of the weights of two saturated and two unsaturated components.) The results of these oxidation analyses are given in Table III.

Table III. *Saturated esters present in certain "L" fractions (Table II).*

No.	Ester fraction			Saturated ester Sap. equiv.
	g.	Sap. equiv.	i.v.	
1 L 14	12.79	241.3	29.1	237.5
1 L 2	19.15	286.1	84.3	265.4
2 L 12	7.25	214.7	12.1	221.4
2 L 13	15.15	248.7	36.2	243.2
2 L 14	20.51	281.2	78.3	264.0

Loss of some of the more volatile saturated esters prevented the determination of the mean equivalent of the saturated components in fraction 2 L 11, and it is possible that the value 221.4 found for those in fraction 2 L 12 is somewhat higher than the true figure for the same reason. In the case of 2 L 13, sufficient saturated esters (6.92 g. from 12.51 g. oxidized) were recovered to permit their further resolution into three fractions by distillation (2.06, 2.16, 2.02 g. with equivalents respectively 234.5, 244.5 and 251.0). The composition of the saturated methyl esters in 2 L 13 was thus laurate 8.0 %, myristate 77.4 % and palmitate 14.6 %.

We have calculated the composition of the total fatty acids of the milk fat in three ways: (a) calculating all unsaturation as due to C_{18} unsaturated acids in the manner hitherto adopted and (b) allowing for decenoic, tetra- and hexa-decenoic acids as indicated by the oxidation data in Table III for each of the fractionations of "liquid" methyl esters numbered I and II in Table II. As pointed out in a previous paper [Hilditch & Thompson, 1936], a slight error is necessarily introduced in the latter case, because a little methyl oleate distills over in all the fractions, and the fractionation procedure is unable to yield a precise estimate of the amounts of the minor unsaturated acids present. Nevertheless the results obtained for decenoic and tetradecenoic acids are of the order given by Bosworth & Brown as a result of their study of several kg. of butter fatty acids and are further of interest when compared with the figures for the hydrogenated butter fatty acids which are given later in this paper. For the purposes of calculation the fractions in the analyses I and II have been computed as follows.

1 L11, 1 L12, 1 L13	...	...	Saturated esters + methyl decenoate
1 L14	...	...	Saturated esters (equiv. 237.5) + methyl tetra- and hexadecenoates
1 L15, 1 L2...	...	...	Saturated esters (equiv. 265.4) + methyl hexadecenoate and C ₁₈ unsaturated esters
1 L16, 1 L3, 1 L4, 1 L5, 1 L6, 1 L7			Methyl palmitate + hexadecenoate + C ₁₈ unsaturated esters
2 L11, 2 L12	...	...	Saturated esters + methyl decenoate
2 L13	...	...	Saturated esters (equiv. 243.2) + methyl tetra- and hexadecenoate
2 L14	...	...	Saturated esters (equiv. 264.0) + methyl hexadecenoate and C ₁₈ unsaturated esters
2 L15, L2, L3, L4, L5	...	...	Methyl palmitate + hexadecenoate + C ₁₈ unsaturated esters

The final results (weight and molar percentages) for the three alternative calculations are given in Table IV.

Table IV. *Component acids of cow milk fat.*

(a) Without allowance for unsaturated acids below C₁₈.

I Utilizing oxidation data (as above) from analysis I (Tables II and III).

II Utilizing oxidation data (as above) from analysis II (Tables II and III).

Acid	Weight percentages			Molar percentages		
	(a)	I	II	(a)	I	II
Butyric	3.7	3.7	3.7	9.8	9.8	9.7
n-Hexanoic	2.0	2.0	2.0	4.1	4.1	4.2
n-Octanoic	1.3	1.0	0.9	2.1	1.6	1.5
n-Decanoic	2.7	2.6	2.6	3.7	3.5	3.5
Lauric	4.0	1.7	2.7	4.8	2.0	3.2
Myristic	7.9	9.3	8.6	8.2	9.6	8.9
Palmitic	23.8	25.4	26.2	21.9	23.4	24.0
Stearic	10.7	10.7	10.7	8.9	8.9	8.8
As arachidic	0.5	0.4	0.5	0.3	0.3	0.3
As decenoic	—	0.2	0.5	—	0.3	0.6
As tetradecenoic	—	1.2	0.7	—	1.3	0.8
As hexadecenoic	—	5.0	4.9	—	4.6	4.5
As oleic	38.3	32.4	31.9	31.9	27.0	26.5
As octadecadienoic	4.7	4.0	3.9	4.0	3.3	3.3
As C ₂₀₋₂₂ unsaturated	0.4	0.4	0.2	0.3	0.3	0.2

The results of these alternative calculations are very similar to those for two other cow milk fats studied similarly by Hilditch & Thompson [1936]. They point to the presence of decenoic and tetradecenoic acids in proportions closely similar to those suggested by Bosworth & Brown, but they also indicate the presence of more hexadecenoic acid than of either of the former. The effect of allowance for these minor proportions of lower unsaturated acids upon the major component acid figures is to reduce the oleic acid percentage by about 5% (mol.) and to increase the palmitic acid by about 2% (mol.); the rest of the acids are not significantly affected.

Ester-analysis of the completely hydrogenated butter fat.

Further evidence in regard to the proportions of total C₁₄, C₁₆ and C₁₈ acids present in the cow milk fat has been obtained by carrying out a fractionation analysis on the acids from the fat after it had been completely hydrogenated.

The butter fat (400 g.), without any previous refining treatment, absorbed hydrogen in presence of nickel on kieselguhr at 180° with great ease, yielding a white solid fat of i.v. 0.1. The hydrogenated fat (301.9 g.) yielded 16.1 g. of acids volatile in steam and 270.6 g. of acids non-volatile in steam. The details of the fractionation analyses for each group of acids are given in Tables V and VI.

Table V. *Fractional distillation of acids volatile in steam (hydrogenated butter fat).*

Acidity (as butyric acid) in:	g.	Equiv.
Ether-extracted aqueous solution	1.03	—
Recovered ether	0.12	—
Distillate fractions:		
1 (up to 100°)	1.46	—
2 (100–160°)	2.83	—
3	2.57	93.0
4	2.06	94.3
5	2.06	100.1
6	1.94	115.6
7	0.99	129.5
8	1.06	170.5

Table VI. *Fractional distillation of methyl esters of acids non-volatile in steam (hydrogenated butter fat).*

Primary fractionation			Refractionations		
No.	g.	Sap. equiv.	No.	g.	Sap. equiv.
1	28.98	235.7	11	1.70	174.6
			12	2.30	193.4
			13	2.65	214.4
			14	3.24	232.5
			15	3.49	245.0
			16	3.98	253.4
			17	4.66	265.2
			18	3.96	281.6
				25.98	
2	41.16	276.4	21	4.06	265.0
			22	4.05	267.6
			23	4.58	270.8
			24	4.17	273.5
			25	4.12	275.5
			26	3.87	280.2
			27	4.03	286.0
			28	2.70	290.3
			29	3.84	295.2
				35.42	
3	6.25	285.2			
4	7.34	288.5			
5	7.34	291.8			
6	6.26	293.8			
7	6.87	295.9			
8	6.71	296.5			
9	5.43	298.7			
10	2.90	299.2			
11	4.92	321.7			
	124.16				

(Residual esters, freed from unsaponifiable, sap. equiv. 303.5)

These figures lead to the following composition for the total acids in the hydrogenated butter fat:¹

Acid	% (wt.)	% (mol.)
Butyric	3.5	9.4
<i>n</i> -Hexanoic	1.6	3.2
<i>n</i> -Octanoic	0.7	1.2
<i>n</i> -Decanoic	2.6	3.6
Lauric	3.6	4.3
Myristic	7.9	8.2
Palmitic	34.0	31.6
Stearic	45.2	37.9
As C ₂₀₋₂₂ saturated	0.9	0.6

The molar percentages of each group of acids (C₁₀, C₁₄, C₁₆, C₁₈) from the analyses of the original butter fatty acids given in Table IV, (a) without and (I and II) with allowance for lower unsaturated acids, may now be compared with the above results from the hydrogenated butter fat (Table VII):

Table VII. *Molar percentages of the different fatty acid groups.*

From analysis of ...	Original butter fat			Hydrogenated butter fat
Acids	(a)	I	II	
C ₄	9.8	9.8	9.7	9.4
C ₆	4.1	4.1	4.2	3.2
C ₈	2.1	1.6	1.5	1.2
C ₁₀	3.7	3.8	4.1	3.6
C ₁₂	4.8	2.0	3.2	4.3
C ₁₄	8.2	10.9	9.7	8.2
C ₁₆	21.9	28.0	28.5	31.6
C ₁₈	44.8	39.2	38.6	37.9
C ₂₀₋₂₂	0.6	0.6	0.5	0.6

It is evident that columns I and II (i.e. with allowance for the lower unsaturated acids) are in much better agreement with the data for the hydrogenated butter fat than column (a). The C₁₆ acid content of the hydrogenated butter fat is indeed higher than that as calculated under I and II, which would point to the presence of even more hexadecenoic acid than our figures suggest. We are aware however that the separation of methyl myristate from a mixture containing large proportions of methyl stearate as well as methyl palmitate is difficult and it is possible that, in spite of the refractionation of fraction 2 (in Table VI), this separation has not been quite complete. It is therefore possible that the values in the final column for C₁₄ and C₁₈ acids may be slightly below, and that for C₁₆ acid correspondingly above, the true figures.

The values for the component acids of the hydrogenated fat, at all events, definitely confirm the presence of hexadecenoic acid and, on the whole, support the modified calculations I and II which we have employed in order to allow for the presence of this and the other two lower unsaturated acids (C₁₀ and C₁₄) in the original milk fat.

¹ We have satisfactorily verified the identity of myristic and palmitic acids in some of the fractions given in Table VI, but we have not succeeded in definitely establishing the presence of lauric acid. The acids from fraction 13, for example, which might have been rich in methyl laurate, failed to yield an individual specimen of lauric acid on repeated recrystallization; crystallization of the anilides prepared from the acids of this fraction also failed to reveal the presence of laur-anilide. We are consequently doubtful whether lauric acid is actually present in milk fats, even in the small proportions suggested.

Structure of tetra- and hexa-decenoic acids of butter fat.

Although the position of the double bond in the 0.2 % of decenoic acid present in butter fat has been given ($\Delta^{9:10}$) by Grün and by Bosworth & Brown, the structures of the tetra- and hexa-decenoic acids have not been stated. We have attempted to obtain evidence on this point by examining the mono- and dicarboxylic acids produced in the course of KMnO_4 -acetone oxidation of fraction 2 L13 (Table II), in which methyl tetra- and hexa-decenoate were both present. The esters (12.8 g.), after oxidation in acetone with powdered KMnO_4 , removal of the acetone and decoloration of the manganese oxides, were extracted with ether from the aqueous salt solution. The ether extract was washed repeatedly with aqueous K_2CO_3 and the united aqueous extracts were heated with aqueous KOH in order to hydrolyse the monomethyl esters of dicarboxylic acids produced during the oxidation. The solution was finally concentrated to a small bulk, made acid and distilled for some hours in steam in order to separate the mono- from the di-carboxylic acids.

The residual liquor from the steam-distillation was repeatedly extracted with ether and yielded 2.87 g. of solid acids. These were refluxed with petroleum (B.P. 40–60°) to remove any remaining monobasic acids. The undissolved acids were recrystallized from water; they melted at 98–100° and had an equivalent of 96.5; on further crystallization from chloroform the melting-point was raised to 105° (unchanged when mixed with azelaic acid), the equivalent then being 93.7 (azelaic acid, 94.0). The mother-liquors from the various crystallizations were examined for other dicarboxylic acids, but without result. The yield of crude azelaic acid (2.87 g.) from the 4.7 g. of unsaturated methyl esters present in the specimen oxidized corresponds to 61 % of the weight of the unsaturated esters and suggests that in all the latter the unsaturation was in the $\Delta^{9:10}$ -position. (The theoretical yields of azelaic acid from methyl $\Delta^{9:10}$ -tetradecenoate, $\Delta^{9:10}$ -hexadecenoate and $\Delta^{9:10}$ -octadecenoate are respectively 78, 70 and 63 %; the yield of azelaic acid actually isolated from a $\Delta^{9:10}$ -unsaturated ester by the KMnO_4 -acetone method is about 85–90 % of theory [Armstrong & Hilditch, 1925].)

The aqueous condensates from the steam-distillation were extracted with ether and worked up as in the case of the steam-volatile acids from a butter analysis. The ether-extracted aqueous washings still contained water-soluble acids equivalent to 24.1 ml. of $N/10$ alkali, the nature of which was not determined. The acids extracted by ether gave, on distillation, a fraction of equivalent 127.8 and a subsequent smaller fraction with equivalent 141, pointing to the presence of *n*-heptanoic acid (equivalent 130) accompanied by small quantities of acids of lower and higher mol. wt.

Evidence was thus afforded of the presence of *n*-heptanoic and azelaic acids (corresponding with the oxidation products of $\Delta^{9:10}$ -hexadecenoic acid), while in addition no other dicarboxylic acid was detected and the total yield of azelaic acid was of the order which would be encountered if in all the unsaturated acids present the double bond was in the $\Delta^{9:10}$ -position. It therefore seems that the position of the ethenoid bond, in the three lower unsaturated acids which form minor components of the butter glycerides, is the same with respect to the carboxylic group as in oleic acid:

The relatively high proportions of fully-saturated glycerides in animal milk and depot fats have been pointed out in former communications from this laboratory and it has been suggested that stearo-glycerides in depot fats may result by saturation of pre-formed oleo-glycerides [Banks & Hilditch, 1931; 1932], and that the lower saturated acids combined as glycerides in milk fats may also result from transformation of an oleo-glyceride into, for example, a butyro- or a myristo-, etc. glyceride [Hilditch & Sleightholme, 1931]. The latter view, involving chemical change commencing from the end of the alkyl fatty acid chain instead of from the carboxylic group, is perhaps now not so unconventional as when it was first put forward, owing to the recent observations of Jowett & Quastel [1935] on "multiple alternate oxidation" as opposed to the simple theory of β -oxidation, and of Verkade & van der Lee [1934] on ω -oxidation of fats. The identity of the position of the double bond in the minor lower unsaturated acids of butter fat with that in oleic acid, with the apparent absence of any unsaturated acid below $\Delta^{9:10}$ -decenoic acid, is also in harmony with this conception of milk fat formation, for the acids in question may represent fragments, so to speak, of transformed oleo-glycerides which have escaped final saturation to lower saturated glycerides.

SUMMARY.

Detailed analyses have been made of the component acids of a typical cow milk fat, and the results calculated (a) on the assumption that no unsaturated acids of lower molecular weight than oleic were present and (b) allowing for the presence of decenoic, tetra- and hexa-decenoic acids on the basis of special analyses to determine the saturated ester contents of certain of the ester fractions obtained in the course of the fractional distillations of "liquid" methyl esters. Comparison of these results with those for the similar analysis of the component acids of the completely hydrogenated butter shows that the total proportions of C_{16} and C_{18} acids present are in agreement only when allowance has been made, as in (b), for the presence of lower unsaturated acids.

In addition to the traces of decenoic acid and somewhat over 1% of tetradecenoic acid reported by Bosworth & Brown, there must be about 4–5% of hexadecenoic acid also present. As regards the chief component acids, palmitic and oleic, the result of the correction for the lower unsaturated acids is to increase the palmitic acid figure by about 2%, while the oleic acid figure is reduced by about 5%.

There is no detectable amount of any unsaturated acid of lower molecular weight than $\Delta^{9:10}$ -decenoic acid in butter fat, and the positions of the double bond, relative to the carboxyl group, are the same in the decenoic, tetra-, hexa- and octa-decenoic acids of butter fat. It is suggested that these observations are in harmony with the hypothesis put forward in earlier communications, namely, that the lower saturated glycerides of milk fats have been produced from pre-formed oleo-glycerides, and that these minor, lower unsaturated components may represent degradation products of oleo-glycerides which have escaped complete saturation to lower saturated groups.

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