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The Influence of Dietary Fat of Varying Unsaturation on the Component Acids of Cow Milk Fats

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In feeding trials in which the basal ration of a group of dairy cows was supplemented by 1 lb./day of various fatty oils, Brown, Dustman & Weakley [1941] observed that the iodine value (i.v.) of the milk fat was altered in different ways by different fats, a feeding period of about 3 weeks being necessary before the extent of the change in i.v. reached its maximum. Coconut oil caused a slight reduction of 4 or 5 units in the i.v. of the milk fat, both crude and refined soya bean oil (i.v. ca. 127) increased it greatly (by over 50 %), and hydrogenated soya bean oil (i.v. 17) increased it slightly (by about 5 or 6 units), as well as having a pronounced laxative action on the cows. These authors ascribed the slight increase in the unsaturation caused by feeding the hydrogenated oil to desaturation of the fat in the ration, an assumption for which there seems to be no evidence.

Similar alterations in the unsaturation of cow milk fats (as indicated by their i.v.'s alone), which result from administration of specific fats in the diet, have been published. Thus, Holland & Buckley [1918; 1923] who fed cows on a basal ration, and on the basal ration supplemented by $\frac{1}{2}$ lb. daily of coconut, groundnut, maize or soya bean oils, observed a slight fall in i.v. with the coconut oil diet, but marked increases (35–45 %) with the three liquid fats. Again, Hill & Palmer [1938] found that the inclusion of maize, cottonseed or linseed oils in the diet increased the i.v.'s, and slightly diminished the Reichert-Meissl values of the corresponding milk fats; tallow slightly increased the milk fat i.v., while butter slightly decreased it, and coconut oil decreased it by 4 or 5 units. Such observations clearly only measure changes in the mean unsaturation of the milk fats, and do not indicate which of

the component acids has significantly altered in amount. Thus, whilst oleic acid is the chief unsaturated acid, at least six others may be present in small proportions in cow milk fat, together with nine saturated acids (of which palmitic acid is the chief, though there are appreciable amounts of butyric, myristic and stearic acids). For a clear picture of milk-fat component acids a detailed analysis of the proportions of each acid is necessary.

Few detailed examinations have been made of the effect of supplementary fats in the cow's diet. Hilditch & Sleightholme [1930] examined milk fats from cows receiving coconut cake or soya bean cake in addition to their normal winter ration; the daily ration of cake (7 lb. coconut, 5 lb. soya bean) could not have contained more (and possibly much less) than 6–7 oz. of fatty oil. The milk fat from cows receiving coconut cake contained less oleic and more lauric and myristic acids than normal, whilst that from animals receiving soya bean cake had somewhat less oleic but the normal amount of octadecadienoic acid, and was otherwise similar to the control milk fats. Hilditch & Thompson [1936] observed similar effects when 4 oz. of linseed, rape or cod-liver oil were added to the daily basal ration of cows. With linseed or rape oils, the component acids differed little, but the proportion of palmitic acid was reduced and that of oleic somewhat increased; with linseed oil, no linolenic acid was present, but the proportion (5.9 % by wt.) of octadecadienoic acids was higher than usual (ca. 3 %), whilst with rape oil the octadecadienoic acids were normal (3.3 %) but there was a similar amount of erucic acid. With cod-liver oil the results were more striking: the milk fat here contained an unusually large amount (5.8 %) of highly unsaturated acids

of the C₂₀ and C₂₂ series, its content of oleic acid was much higher, and the typical lower saturated acids of cow milk fat (notably butyric and hexanoic) were reduced by half. On the hypothesis that milk fat is produced in the mammary gland from blood glycerides by conversion of some of the oleo-glycerides to butyro- and other glycerides by an oxidation-reduction system, the results observed with cod-liver oil might be due to partial suppression of the normal metabolic processes whereby the mammary gland converts blood glycerides into milk glycerides, owing to absorption of some of the highly unsaturated fish oil glycerides.

Smith & Dastur [1938] showed that a similar reduction in the amounts of lower saturated acids (from butyric to myristic) and in tetra- and hexadecenoic acids, with a large increase in the proportion of oleic acid, occurred in milk fat from cows maintained at a very low dietary level, the effect of fasting being apparently to upset the normal metabolic processes of milk fat production.

A series of experiments somewhat similar to those of Brown *et al.* [1941] was, therefore, made in order to review the effect of supplementing a basal diet with fats at different levels of unsaturation, and, also, to ascertain whether desaturation of saturated ingested fats occurs as postulated by these workers. Hence, groups of cows were fed on a basal ration either alone or supplemented by refined groundnut oil (i.v. 88), hydrogenated groundnut oil (i.v. 45 and i.v. 17), or palm-kernel oil (i.v. 17). Thus the fatty oil supplements were (1) a natural fatty oil rich in oleic and linoleic acids (about 55 and 20% of the total fatty acids respectively), (2) a hydrogenated oil of a similar degree of mean unsaturation to that of a soft butterfat, (3) a much more saturated hydrogenated groundnut oil; and, for comparison with the latter, (4) a natural vegetable fat (palm-kernel oil) of the same mean unsaturation but entirely different fatty oil composition, consistency and melting-point.

METHODS

The 15 Ayrshire heifers used had calved in Dec. 1941 and Jan. 1942 and belonged to Messrs J. Bibby and Sons, Ltd., Home Farm, Puddington, Wirral, where the experimental feeding, milk collection, and butter-making were carried out in February and March of 1942 under the supervision of Mr A. H. Blissett. The cows, which were at approximately the same stage of lactation, were divided into five groups of three, and were fed as follows:

Group I. Basal diet: 21 lb. medium hay, 14 lb. swedes, 6 lb. oats and 2 lb. groundnut meal per day.

Group II. Basal diet plus 8 oz. refined groundnut oil (i.v. 88) daily.

Group III. Basal diet plus 8 oz. hydrogenated groundnut oil (i.v. 45) daily.

Group IV. Basal diet plus 8 oz. hydrogenated groundnut oil (i.v. 17) daily.

Group V. Basal diet plus 8 oz. refined palm-kernel oil (i.v. 17) daily.

Only half the fat ration used by Brown *et al.* [1941] was given in order if possible to avoid undue laxative action. Very slight laxative action was observed only in group IV; the other groups were normal throughout the experimental period of about 35 days. During the first 3 days the oil supplements were increased gradually till the full daily ration of 8 oz. was being given. The i.v.'s of the milk fats were observed at intervals of a few days: during the first 2-3 weeks the values were variable but thereafter became more constant and, after the 34th day, 2 days' supply of milk was collected and converted into butter for detailed analysis. There was no significant alteration in the milk yields, nor in the proportions of fat and non-fat solids in the milk, in any of the groups during the period of the experiment. The general analytical characteristics of the milk fats from these butters are given in Table 1.

Table 1. *General analytical characteristics of milk fats*

Group ... Fat supplement	I Control	II G.N.O. (i.v. 88)	III H.G.N.O. (i.v. 45)	IV H.G.N.O. (i.v. 17)	V P.K.O. (i.v. 17)
Iodine value	39.2	43.8	43.3	38.8	38.0
Reichert-Meissl value	30.0	23.4	23.6	28.2	25.0
Polenske value	1.5	0.9	1.0	1.5	1.6
Kirschner value	23.5	19.4	19.0	23.1	21.6
Sap. equiv.	248.0	258.8	259.8	251.7	250.5

Alterations in milk fat i.v. following the inclusion of the fatty supplements in the diet were less marked than in some of the earlier investigations, including those of Brown *et al.* [1941]. This may be partly due to the smaller amount of fat given, which was only half of that used by Brown *et al.*, but is probably due to the fact that the i.v. of the milk fat of cows fed on the basal diet alone was much higher than in these other studies. Nevertheless, the i.v.'s of milk fats from cows receiving either refined groundnut oil or hydrogenated groundnut oil (i.v. 45) were definitely higher than that of the control, while the i.v. of milk fat from cows receiving palm-kernel oil was slightly lower than that of the control. There was no significant difference between the i.v. of the milk fat of cows which had received the hydrogenated groundnut oil (i.v. 17) and that of the control.

The component acids in the five milk fats were determined by separation and ester-fractionation as described by Hilditch & Jasperson [1941], the

fatty acids from 400 g. of each specimen being used for analysis (Table 2).

The percentages (wt. and mol.) of the component acids of the five milk fats are arranged for comparison in Table 3 (p. 241).

Table 2. *Component acids of cow milk fats*

	Steam-volatile acids	Non-steam-volatile		Total	% wt.	% mol.
		'Solid' acids	'Liquid' acids			
Group I. Cows fed on basal diet only						
% of total fat ...	(7.2)	(42.4)	(50.4)			
Butyric	3.94	—	—	3.94	4.0	10.5
Hexanoic	2.27	—	—	2.27	2.3	4.6
Octanoic	0.66	—	0.16	0.82	0.8	1.3
Decanoic	0.18	—	1.76	1.94	1.9	2.7
Lauric	—	0.13	2.06	2.19	2.2	2.6
Myristic	—	4.89	4.43	9.32	9.3	9.6
Palmitic	—	21.77	3.62	25.39	25.5	23.4
Stearic	—	11.76	—	11.76	11.8	9.7
As arachidic	—	0.83	—	0.83	0.8	0.6
Decenoic	—	—	0.19	0.19	0.2	0.3
Dodecenoic	—	—	0.21	0.21	0.2	0.2
Tetradecenoic	—	0.04	0.88	0.92	0.9	1.0
Hexadecenoic	—	0.47	1.81	2.28	2.3	2.1
Oleic	0.15	2.49	31.56	34.20	34.3	28.6
Octadecadienoic	—	—	2.13	2.13	2.1	1.8
Unsatt. C ₂₀₋₂₂	—	—	1.38	1.38	1.4	1.0
Unsaponifiable	—	0.02	0.21	0.23	—	—
Group II. Cows fed on basal diet + 8 oz. of groundnut oil (i.v. 88) daily						
% of total fat ...	(5.3)	(42.4)	(52.3)			
Butyric	2.93	—	—	2.93	2.9	8.2
Hexanoic	1.49	—	—	1.49	1.5	3.2
Octanoic	0.38	—	0.08	0.46	0.5	0.8
Decanoic	0.37	—	0.98	1.35	1.4	1.9
Lauric	—	0.10	1.63	1.73	1.7	2.1
Myristic	—	2.91	4.37	7.28	7.3	7.9
Palmitic	—	21.20	2.47	23.67	23.8	22.8
Stearic	—	12.61	—	12.61	12.7	10.9
As arachidic	—	1.22	—	1.22	1.2	1.0
Decenoic	—	—	0.10	0.10	0.1	0.1
Dodecenoic	—	—	0.15	0.15	0.2	0.2
Tetradecenoic	—	0.03	0.70	0.73	0.7	0.8
Hexadecenoic	—	0.61	1.54	2.15	2.1	2.1
Oleic	0.13	3.66	36.64	40.43	40.6	35.2
Octadecadienoic	—	—	1.82	1.82	1.8	1.6
Unsatt. C ₂₀₋₂₂	—	—	1.53	1.53	1.5	1.2
Unsaponifiable	—	0.06	0.29	0.35	—	—

Group III. Cows fed on basal diet + 8 oz. of hydrogenated groundnut oil (i.v. 45) daily

% of total fat ...	(5.3)	(43.9)	(50.8)			
Butyric	2.72	—	—	2.72	2.7	7.6
Hexanoic	1.54	—	—	1.54	1.5	3.3
Octanoic	0.40	—	0.15	0.55	0.6	0.9
Decanoic	0.51	—	0.97	1.48	1.5	2.1
Lauric	—	0.35	1.61	1.96	2.0	2.4
Myristic	—	2.76	3.38	6.14	6.2	6.7
Palmitic	—	18.89	2.87	21.76	21.8	21.0
Stearic	—	16.53	—	16.53	16.6	14.4
As arachidic	—	1.04	—	1.04	1.0	0.8
Decenoic	—	—	0.09	0.09	0.1	0.1
Dodecenoic	—	0.01	0.17	0.18	0.2	0.2
Tetradecenoic	—	0.03	0.55	0.58	0.6	0.6
Hexadecenoic	—	0.66	1.59	2.25	2.3	2.2
Oleic	0.13	3.60	35.26	38.99	39.0	34.4
Octadecadienoic	—	—	3.28	3.28	3.3	2.9
Unsatt. C ₂₀₋₂₂	—	—	0.59	0.59	0.6	0.4
Unsaponifiable	—	0.03	0.29	0.32	—	—

Table 2 (cont.)

	Steam-volatile acids	Non-steam-volatile		Total	% wt.	% mol.
		'Solid' acids	'Liquid' acids			
Group IV. Cows fed on basal diet + 8 oz. of hydrogenated groundnut oil (i.v. 17) daily						
% of total fat ...	(6.9)	(43.7)	(49.4)			
Butyric	3.60	—	—	3.60	3.6	9.8
Hexanoic	2.08	—	—	2.08	2.1	4.3
Octanoic	1.00	—	0.16	1.16	1.2	1.9
Decanoic	0.04	—	1.48	1.52	1.5	2.1
Lauric	—	0.12	1.78	1.90	1.9	2.3
Myristic	—	4.13	4.04	8.17	8.2	8.5
Palmitic	—	21.15	3.65	24.80	24.9	23.2
Stearic	—	13.79	—	13.79	13.8	11.6
As arachidic	—	1.21	—	1.21	1.2	0.9
Decenoic	—	—	0.13	0.13	0.1	0.2
Dodecenoic	—	—	0.15	0.15	0.2	0.2
Tetradecenoic	—	0.04	0.73	0.77	0.8	0.8
Hexadecenoic	—	0.41	1.09	1.50	1.5	1.4
Oleic	0.18	2.83	32.50	35.51	35.6	30.0
Octadecadienoic	—	—	1.73	1.73	1.7	1.5
Unsatt. C ₂₀₋₂₂	—	—	1.70	1.70	1.7	1.3
Unsaponifiable	—	0.02	0.26	0.28	—	—

Group V. Cows fed on basal diet + 8 oz. of palm-kernel oil (i.v. 17) daily

% of total fat ...	(6.1)	(42.2)	(51.7)			
Butyric	3.19	—	—	3.19	3.2	8.6
Hexanoic	1.67	—	—	1.67	1.7	3.4
Octanoic	1.00	—	0.14	1.14	1.2	1.9
Decanoic	0.08	—	1.24	1.32	1.3	1.8
Lauric	—	0.50	5.47	5.97	6.0	7.1
Myristic	—	6.11	4.76	10.87	10.9	11.3
Palmitic	—	19.26	2.87	22.13	22.2	20.6
Stearic	—	11.97	—	11.97	12.0	10.0
As arachidic	—	1.10	—	1.10	1.1	0.8
Decenoic	—	—	0.13	0.13	0.1	0.2
Dodecenoic	—	0.01	0.43	0.44	0.4	0.5
Tetradecenoic	—	0.04	1.00	1.04	1.0	1.1
Hexadecenoic	—	0.27	2.04	2.31	2.3	2.2
Oleic	0.16	2.86	30.29	33.31	33.5	28.1
Octadecadienoic	—	—	1.15	1.15	1.2	1.0
Unsatt. C ₂₀₋₂₂	—	—	1.83	1.83	1.9	1.4
Unsaponifiable	—	0.08	0.35	0.43	—	—

DISCUSSION

The mean unsaturation of the five milk fats, as indicated by their i.v.'s (Table 1), shows parallelism, but not quantitative agreement, with their contents of oleic acid as determined in the ester-fractionation analyses. Similarly, the almost identical Reichert-Meissl and Kirschner values of milk fats I and IV, and also of milk fats II and III, are reflected in the contents of the lower saturated acids in these two pairs of milk fats as revealed by the detailed analyses. The data (Table 3) show that ingestion of groundnut oil, a fat richer in oleic glycerides than milk fat, is followed by a significant increase in oleic acid in the milk fat (group II), a slight fall in palmitic and a large fall in butyric-decanoic acids. On the other hand, though groundnut oil contains about 20% linoleic acid, the content of octadecadienoic acid is not appreciably altered; nor have the arachidic, behenic or lignoceric acids (about 6% of the groundnut oil), passed into the milk fat.

Table 3. *Component acids of the five milk fats*

Group	...	I	II	III	IV	V
Dietary fat supplement	...	Nil	G.N.O. (i.v. 88)	H.G.N.O. (i.v. 45)	H.G.N.O. (i.v. 17)	P.K.O. (i.v. 17)
Acid		Weight percentages				
Butyric		4.0	2.9	2.7	3.6	3.2
Hexanoic		2.3	1.5	1.5	2.1	1.7
Octanoic		0.8	0.5	0.6	1.2	1.2
Decanoic		1.9	1.4	1.5	1.5	1.3
Lauric		2.2	1.7	2.0	1.9	6.0
Myristic		9.3	7.3	6.2	8.2	10.9
Palmitic		25.5	23.8	21.8	24.9	22.2
Stearic		11.8	12.7	16.6	13.8	12.0
As arachidic		0.8	1.2	1.0	1.2	1.1
Decenoic		0.2	0.1	0.1	0.1	0.1
Dodecenoic		0.2	0.2	0.2	0.2	0.4
Tetradecenoic		0.9	0.7	0.6	0.8	1.0
Hexadecenoic		2.3	2.1	2.3	1.5	2.3
Oleic		34.3	40.6	39.0	35.6	33.5
Octadecadienoic		2.1	1.8	3.3	1.7	1.2
Unsatd. C ₂₀₋₂₂		1.4	1.5	0.6	1.7	1.9
		Molar percentages				
Butyric		10.5	8.2	7.6	9.8	8.6
Hexanoic		4.6	3.2	3.3	4.3	3.4
Octanoic		1.3	0.8	0.9	1.9	1.9
Decanoic		2.7	1.9	2.1	2.1	1.8
Lauric		2.6	2.1	2.4	2.3	7.1
Myristic		9.6	7.9	6.7	8.5	11.3
Palmitic		23.4	22.8	21.0	23.2	20.6
Stearic		9.7	10.9	14.4	11.6	10.0
As arachidic		0.6	1.0	0.8	0.9	0.8
Decenoic		0.3	0.1	0.1	0.2	0.2
Dodecenoic		0.2	0.2	0.2	0.2	0.5
Tetradecenoic		1.0	0.8	0.6	0.8	1.1
Hexadecenoic		2.1	2.1	2.2	1.4	2.2
Oleic		28.6	35.2	34.4	30.0	28.1
Octadecadienoic		1.8	1.6	2.9	1.5	1.0
Unsatd. C ₂₀₋₂₂		1.0	1.2	0.4	1.3	1.4

It has now been established [Graham, Jones & Kay, 1936; Maynard, McCay, Ellis, Hodson & Davis, 1938; Shaw & Petersen, 1938; Shaw, 1939] that milk glycerides are produced from glycerides in the blood which passes through the mammary gland; this complicates the interpretation of results, since the introduction of fatty acids, or modified fatty acids, from the ingested fats must be considered in terms of the mixed glycerides of the butter and not merely as individual fatty acids. 20–30 % of groundnut oil probably consists of glycerides in which, however, linoleic, arachidic and higher acids are not present [Hilditch & Meara, 1942]; they are palmitodiolein, stearodiolein or triolein. The effect on the milk fat of feeding groundnut oil might be due to admixture of some or all of these glycerides with normal milk fat, and also to interference with the mammary gland, whereby the production of the lower saturated glycerides normal to milk fat is restricted.

In group III the supplementary fat was groundnut oil which had been hydrogenated to give an i.v. of 45.5, i.e. approximately that of butterfat. It contained, however, about 52 % of oleic (and *iso*-oleic) acids and about 33 % of stearic acid; of the glycerides about 10 % were completely saturated, 65 % were monosaturated dioleins (or *iso*-oleins)

and 25 % mono-oleo- (or *iso*-oleo-) disaturated glycerides. The effect on the milk fat of feeding this is broadly similar to that of groundnut oil itself, i.e. increase in oleic acid content, further diminution in palmitic acid and diminution in butyric-decanoic acids. The increase in the stearic acid content is consistent with the larger amount of this acid (as oleo-stearo-glycerides) in the hydrogenated oil.

Both in group II and group III ingestion of fat containing more combined oleic (or *iso*-oleic) acid than normal butterfat increased the oleic acid contents of the resulting milk fats. The similarity in the content of oleic acid in milk fats II and III may perhaps be due to the fact that the oleic (+ *iso*-oleic) acid content of groundnut oil and hydrogenated groundnut oil (i.v. 45) are similar (52–56 %). This selective absorption of oleic (as distinct from linoleic) acid by the mammary gland may explain why [Cranfield, 1916] cows fed with groundnut cake give softer butters than those fed with cottonseed cake, although the i.v. of cottonseed oil is higher than that of groundnut oil, the reason being that the unsaturated acids of groundnut oil consist of 55 % oleic and 20–25 % of linoleic acid, whilst in those of cottonseed oil the proportion is almost reversed (about 30 % of oleic and 45–50 % of linoleic acid).

Palm-kernel oil which was fed to group V contains about 45 % of combined lauric and 15–20 % combined myristic acids, with smaller amounts of other saturated acids and a comparatively small amount of oleic acid (about 15 %); of a complex mixture of mixed glycerides, dilauromyristin and laurodimyristin are the most prominent. The chief effects on the milk fat of feeding palm-kernel oil are a slight fall in oleic, butyric and palmitic acids, a threefold increase of lauric acid and a 20 % increase of myristic acid. This suggests that milk fat of the normal type preponderates but is modified by admixture with a small amount of certain of the palm-kernel oil glycerides, mainly lauromyristins. Hilditch & Sleightholme [1930] observed a similar effect as the result of feeding cows with coconut cake. This is interesting chiefly because it shows that two fats of the same i.v. (palm-kernel oil and hydrogenated groundnut oil, i.v. 17) may lead to milk fats in which the detailed fatty acid compositions reveal quite different mechanisms of production.

The milk fats from cows of group IV, in which the hydrogenated groundnut oil of i.v. 17 supplemented the basal diet, have a fatty acid composition which more closely resembles that of the control milk fat than any of the preceding groups; the oleic acid is slightly increased (as in the work of Brown *et al.* [1941], when twice our amount of the highly hydrogenated fat was fed); the palmitic acid and the lower saturated acids are almost unchanged

(within the range of experimental error), and there is a definite increase in stearic acid. We can explain this as follows. About 50 % of the glycerides of hydrogenated groundnut oil (i.v. 17) are completely saturated (tristearin, palmito-, arachido-, etc., distearins), the remaining 50 % being mono-oleo-disaturated glycerides (oleodistearin, oleopalmitostearin, oleostearoarachidin, etc.). The fully saturated triglycerides, m.p. 65–70° and above, will not occur in the liquid phase in the cow's digestive tract unless held in solution by the mono-oleo-glycerides which are liquid at the body temperature of the cow. Arnshlick [1889] and Bloor [1914] showed that 90 % of tristearin, if fed to animals, is excreted unchanged, whilst Langworthy [1923] observed that assimilation of hydrogenated groundnut oils falls off rapidly when their melting-point exceeds 50°. With our hydrogenated groundnut oil, m.p. 58°, the bulk of the completely saturated glycerides would therefore not pass into the blood stream, and what did do so would be mono-oleo-disaturated glycerides of which oleodistearin would be a main component. Any alteration in milk fat due to this fat supplement would therefore be smaller than those associated with the softer groundnut oils fed to groups II and III. Also, since the dioleo-glycerides (and triolein) of the softer groundnut oils are absent from the hydrogenated oil (i.v. 17), which contains instead mono-oleo- (and *iso*-oleo-) glycerides (rich in oleodistearin), the slight increases in oleic acid and stearic acid (see Table 3) in the milk fats of group IV are consistent with absorption from the blood of minor quantities of glycerides such as oleodistearin.

Variation in the component acids of milk fats following ingestion of supplementary dietary fats of different degrees of unsaturation can be interpreted by taking into consideration (i) the limits of assimilation of high melting (fully saturated) components, (ii) the proportions of dioleo- and of mono-oleo-glycerides in the supplementary fat, (iii) the relatively small conversion of linoleo-glycerides and certain other acylglycerides into cow milk fats, and (iv) the experimentally justified postulate that milk glycerides are derived from blood glycerides in the mammary gland. It is unnecessary to presuppose that a desaturation of stearic to oleic glycerides is responsible for these changes.

The general trend of the present results is perhaps still more clearly discerned from the molar percentages of component acids included in Table 3. In the control fat I the molar content of palmitic acid is 23.4 % and of oleic acid 28.6 %. Groundnut oil (fed to group II) contains palmito-diolein which has 66.7 % (mol.) of oleic acid among its component acids, and in the milk fat of group II the oleic acid has increased by 6.6 % (mol.) as compared with group I though there is no significant alteration in

the molar content of palmitic acid. The hydrogenated groundnut oil of i.v. 45, used in group III, consists of about 65 % of dioleo-glycerides (with 66.7 % (mol.) oleic acid) and about 25 % of mono-oleo- (and *iso*-oleo-) glycerides (with 33.3 % (mol.) oleic acid); the dioleo-glycerides include stearo- as well as palmito-diolein, and possibly some oleodistearin as well as oleopalmitostearin, owing to hydrogenation. The milk fat of group III shows, correspondingly, a smaller increase than group II in oleic acid (5.8 % mol.) as compared with the control, while the molar content of palmitic acid is decreased by 2.4 % (mol.) and that of stearic acid is increased by 4.7 % (mol.). The unsaturated glycerides in the more completely hydrogenated groundnut oil (i.v. 17) used in group IV are wholly of the mono-oleo- (or *iso*-oleo-) type and there is a correspondingly smaller increase (1.4 % mol.) in the milk-fat oleic acid as compared with the control, and a similar slight increase (1.9 % mol.) in that of stearic acid. Finally, in group V, with palm-kernel oil, the predominating lauro-myristins of the dietary fat have been transferred to some extent to the milk fat, leading to a slight reduction in the oleic acid and a definite reduction (2.8 % mol.) in the palmitic acid content.

SUMMARY

1. Cows have been fed on a basal diet and on a basal diet supplemented by (a) groundnut oil, (b) groundnut oil hydrogenated to about the same i.v. as a soft butterfat, (c) groundnut oil hydrogenated to i.v. 17, and (d) palm-kernel oil, also of i.v. 17. The milk fats from the five groups have been analysed by ester-fractionation and the proportions of their component acids determined.

2. Ingestion of groundnut oil and of hydrogenated groundnut oil of i.v. 45, both of which contained considerably more oleic acid than the control milk fat, led to increased amounts of oleo-glycerides in the resultant milk fats and some diminution of the butyric-decanoic glycerides. In the case of the hydrogenated groundnut oil there was also an increase in the stearo-glycerides. Ingestion of palm-kernel oil increased the proportions of lauro- and myristo-glycerides, and slightly diminished both the palmito-glycerides and the oleo-glycerides of the resulting milk fat.

3. Ingestion of the more completely hydrogenated groundnut oil of i.v. 17 gave a milk fat almost identical with the control milk fat except for slightly increased proportions of oleic and stearic acids. This is consistent with the likelihood that this fat, about 50 % of which was completely saturated tristearin or acyl-distearins melting at 65–70° or above, would be relatively unassimilable, and that those glycerides which passed into the

blood stream would be exclusively mono-oleo- (or *iso*-oleo-) glycerides, amongst which oleo- (or *iso*-oleo-) distearin would be prominent. There is no evidence in this work that any desaturation of stearo-glycerides occurs during the transformation of hydrogenated groundnut oil to glycerides in the milk of the cow.

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Sclerotiose—a Polysaccharide Metabolic Product of *Penicillium Sclerotiorum* van Beyma

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During work on the metabolism of *Penicillium sclerotiorum*, disappearance of the carbohydrate constituent of the acid Czapek-Dox and other media employed was observed [Curtin & Reilly, 1940; Reilly & Curtin, 1943]. This, it was suggested, was probably the most important factor in the metabolic process. Had the disappearance of the carbohydrate been accompanied by a rapid and permanent decrease in the pH, the production of an acid in the substrate would have been indicated. It was invariably found, however, in batches grown on a number of different media, that though a drop in pH occurred initially, the pH of the fully grown substrate reverted towards neutrality. That there was no connexion between these variations in pH and (a) the initial pH of the medium or (b) the production of sclerotiorine by the mould, was proved by the fact that similar series of pH readings were obtained when the mould was incubated (1) on acid Czapek-Dox medium (pH 4.2) with the production of sclerotiorine, and (2) on Raulin-Dierckx medium (pH 7.0) (when sclerotiorine is not produced). The filtered substrate of the mould after a full period

of growth on acid Czapek-Dox medium contained no reducing carbohydrate. This, coupled with the fact that elimination of glucose caused no permanent drop in the pH value, suggested production by the mould of an insoluble glucose complex.

The mycelium was therefore extracted with boiling water and the flocculent precipitate which appeared on cooling was found to be a polyglucose, of specific rotation $\alpha_D = +244$ to $+284$, and for which we suggest the name 'sclerotiose'. In properties, it proved to be similar to other polysaccharides isolated from the lower fungi, being soluble only in hot water, giving no colour with iodine, and dissolving only to a slight extent in dilute NaOH, thus resembling mycodextran from *P. expansum* [Dox & Niedig, 1914], the polysaccharides from *P. digitatum* and *Fumago vagans* [Birkinshaw, Charles & Raistrick, 1931], and the polysaccharide from *P. javanicum* [Ward, Lockwood, May & Herrick, 1935] for which the specific rotations range from $\alpha_D = +217$ to $+299$. An examination has been made of sclerotiose and of some of its derivatives.