CXI. THE COMPONENT FATTY ACIDS AND GLYCERIDES OF THE MILK-FATS OF INDIAN GOATS AND SHEEP.

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THE milk-fats from goats and sheep are used, although only to a small extent, as substitutes for those of cows and buffaloes in India. The component fatty acids and glycerides of these two fats have been studied by methods recently developed [Hilditch *et al.*, 1929; 1930; 1931] in the case of cow butter-fats, in order to compare their composition with those of the latter and, in certain respects, with beef and mutton tallows [Banks and Hilditch, 1931]. It may be noted, in passing, that "ghee" (the prepared butter-fat used in India on account of the difficulty of keeping ordinary butter fresh in the hot, humid climate) is defined in the Bombay "Adulteration of Ghee" Act as made from the butter-fat of either cows, buffaloes, goats or sheep.

The milk-fats used in the present investigation were specially prepared by churning the fresh milk and at once melting the resulting butter at 100°, the fats being separated by decanting and then filtering through a double layer of filter-paper to remove traces of water and caseinogen. The fats were stored *in vacuo* in sealed amber glass bottles.

The goat milk-fat was from the milk of animals at Lahore (Panjab) taken in January 1932; they had been fed on a winter diet of turnips, grass, zizyphus Jujuba tree leaves and fruits and barley meal. The yield of fat from different samples of the goat milk varied from 3·2 to 3·6 %. The sheep milk-fat was obtained in February 1932 from the milk of Leiah (Multan, Panjab) sheep, which had been fed on a winter ration of grass, zizyphus Jujuba leaves and fruits, turnips, carrots and barley meal; the milk contained from 4·0 to 4·2 % of fat.

The general characteristics of the milk-fats are given in Table I.

Table I.

	Goat milk-fat.	Sheep milk-fat.
Colour	Almost white (cream tinge)	Pale yellow
Sap. equiv.	238·1	232·4
Iodine value	28·8	32·1
Acid value	2·9	2·2
Reichert-Meissl value	31·7	33·9
Polenske value	8·2	8·0
Kirschner value	19·9	22·8
Setting-point (fat)	23·7°	22·2°
Valenta number	21·5°	21·6°
Refractive index $n_D^{40°}$	1·4523	1·4526

Some values recently reported for these fats by other investigators are collected in Table II:

Table II.

	Saponification equivalent	Iodine value	Reichert-Meissl value	Polenske value	Kirschner value
(i) Goat butter-fat:					
Egyptian [Triman, 1913]	—	—	20·8–22·9	4·9–6·5	—
English					
[Knowles and Urquhart, 1924]	—	24·7–36·9	24·5–27·8	4·9–8·7	16·8–19·0
[Bardisian, 1926]	241·3	28·1	—	—	—
Egyptian [Atkinson, 1928]	228–238	32·5–41·2	20–28	4·0–8·7	—
(ii) Sheep butter-fat:					
[Bardisian, 1926]	241·3	32·3	—	—	—
[Faltin and Dedinzky, 1930]	—	—	22·5–39·4	2·2–6·9	15·8–21·0

The Polenske values of these fats are thus decidedly higher than those of cow butter-fats, the Kirschner values are somewhat low in relation to the Reichert-Meissl values as compared with cow butter-fats, and the saponification equivalents also tend to be lower than those of cow butter-fats.

Component fatty acids of goat and sheep milk-fats.

The component fatty acids were quantitatively determined in each case by the method described fully by Hilditch and Jones [1929] and Hilditch and Sleightholme [1930], the mixed acids from 350 g. of fat being employed in each case. The final results for the two fats are summarised in Table IV; but the details of the fractionation data for the goat butter-fatty acids are first quoted in Table III, since comparison of these with the similar details given for cow butter-acids by the workers mentioned [1929, pp. 80–82; 1930, pp. 1102, 1103] helps to indicate the nature of the differences between the respective fats.

Oxidation of the dilute aqueous solution of the potassium salts of the acids from the penultimate fraction of the "liquid" esters from the sheep milk-fat led to the identification of a dihydroxystearic acid (M.P. 130°) and a tetrahydroxystearic acid (M.P. 174°), thus showing that the ordinary $\Delta^{9:10}$-oleic and $\Delta^{9:10, 12:13}$-linoleic acids were the unsaturated components of the fat. Arachidic acid (M.P. 74·5°) was definitely characterised in the hydrolysed residual fraction of the sheep milk-fat "solid" esters, and its presence was also indicated (although it was not obtained in the pure condition) in the corresponding fraction of the goat milk-fat esters.

An early fractionation analysis of the sheep milk-fat acids by Crowther and Hynd [1917] does not agree with the present data; for example, these authors give the respective percentages (wt.) of butyric, palmitic and oleic acids as 6·5–6·6, 12·8–13·9 and 40·6–40·7. The differences are doubtless accounted for by the facts that they fractionally distilled the esters of the whole of the mixed acids and so did not obtain a sufficient degree of separation, and that they did not allow for the presence of linoleic acid in the unsaturated acids. The limitations involved in Crowther and Hynd's fractionation procedure have already been discussed elsewhere in the case of cow butter-fats [Channon, Drummond and Golding, 1924; Hilditch and Jones, 1929].

The main differences between the component fatty acids of the goat and sheep butters now under discussion and those of cow butter-fats as given by Hilditch *et al.* [1929; 1930; 1931] are the much higher content of caprylic and capric acids (and, to a less extent, of caproic acid), and the lower percentages

Table III. *Fatty acids of goat milk-fat.*

(*a*) *Acids volatile in steam.*

No.	g.	B.P. (° C.)	Pressure	Mean equivalent	Acids: Butyric	Caproic	Caprylic	Capric	Lauric	Oleic	Non Sap.
1	In aqueous solution (5100 cc.)	—	—	—	2·06	—	—	—	—	—	—
2	In recovered ether (2220 cc.)	—	—	—	0·12	—	—	—	—	—	—
3	20·28	35–120	Atmospheric	—	1·97	—	—	—	—	—	—
4	4·35	120–160	,,	—	2·81	—	—	—	—	—	—
5	1·62	160–165	,,	—	1·59	—	—	—	—	—	—
6	2·67	165–178	,,	101·5	1·22	1·45	—	—	—	—	—
7	2·02	120–128	Reduced	113·6	0·14	1·88	—	—	—	—	—
8	1·99	128–132	,,	117·6	—	1·85	0·14	—	—	—	—
9	2·56	135–145	,,	126·0	—	1·53	1·03	—	—	—	—
10	0·92	146–147	,,	130·8	—	0·39	0·53	—	—	—	—
11	2·17	147–153	,,	135·9	—	0·54	1·63	—	—	—	—
12	2·66	190–194	,,	146·9	—	—	2·34	0·32	—	—	—
13	2·41	205–223	(Iodine Value 3·5)	165·9	—	—	0·65	1·67	—	0·09	—
14	2·39	Residue	(Iodine Value 15·2)	208·0	—	—	—	1·22	0·64	0·34	0·19
					9·91	7·64	6·32	3·21	0·64	0·43	0·19

(*b*) *Acids non-volatile in steam, 302 g.*

(Sap. equiv. 247·4; Iodine Value 31·0.)

	Lead salt separation: g.	%	Corresponding esters: S.E.	Iodine Value
"Solid" acids S	94·7	46·3	274·3	5·0
"Liquid" acids L	110·0	53·7	250·3	53·5

(*c*) *Fractionation of methyl esters.*

(i) Esters of "solid" acids S.

Primary fractions: No.	g.	B.P./1 mm.	Sap. eq.	I.V.
S 1	30·94	122–142°	262·0	2·3
S 2	8·77	144–146	272·3	3·2
S 3	5·80	145–148	275·2	4·7
S 4	4·46	148–151	279·2	5·3
S 5	4·46	151–154	283·2	7·0
S 6	6·86	155–161	291·6	8·6
S 7	6·87	Residue	298·6	13·9

Refractionations: No.	g.	B.P./1 mm.	Sap. eq.	I.V.
S 11	2·53	125–150°	252·4	2·0
S 12	4·55	150–156	257·9	1·5
S 13	4·50	155–159	257·7	1·0
S 14	3·14	156–160	256·3	1·5
S 15	4·67	159–163	266·2	2·1
S 16	3·77	Residue	270·5	3·9

(ii) Esters of "liquid" acids L.

Primary fractions: No.	g.	B.P./1 mm.	Sap. eq.	I.V.
L 1	25·60	70–135°	200·4	9·5
L 2	5·61	136–149	266·3	47·5
L 3	5·46	149–160	279·0	66·3
L 4	7·68	161–162	291·8	83·5
L 5	5·99	163–169	293·4	86·0
L 6	5·91	169–171	295·9	90·7
L 7	6·00	171–175	295·4	89·4
L 8	8·19	Residue	319·3	76·9

Refractionations: No.	g.	B.P./1 mm.	Sap. eq.	I.V.
L 11	2·40	50– 76°	171·2	2·5
L 12	4·47	76– 78	182·0	4·0
L 13	3·05	78– 84	188·0	3·5
L 14	3·05	85–102	202·5	4·3
L 15	3·09	103–115	222·4	7·0
L 16	3·84	Residue	249·6	28·3

Table IV. *Summarised experimental data for fatty acids of goat and sheep milk-fats.*

Acid	Volatile acids	Acids non-volatile in steam: Solid acids S	Acids non-volatile in steam: Liquid acids L	Component fatty acids: Including unsaponifiable % (wt.)	Component fatty acids: Excluding unsaponifiable % (wt.)	Component fatty acids: Excluding unsaponifiable % (mols.)
		Goat milk-fat.				
	8·6 %	42·3 %	49·1 %			
Butyric	3·01	—	—	3·01	3·0	7·6
Caproic	2·33	—	—	2·33	2·3	4·5
Caprylic	1·93	—	2·04	3·97	3·9	6·2
Capric	0·98	—	7·53	8·51	8·6	11·1
Lauric	0·20	—	4·34	4·54	4·6	5·1
Myristic	—	6·24	5·16	11·40	11·5	11·2
Palmitic	—	24·32	0·23	24·55	24·7	21·5
Stearic	—	9·24	—	9·24	9·3	7·3
Arachidic	—	0·14	—	0·14	0·1	0·1
Oleic	0·14	2·36	27·86	30·36	30·5	24·2
Linoleic	—	—	1·51	1·51	1·5	1·2
Unsaponifiable	0·01	—	0·43	0·44	—	—
		Sheep milk-fat.				
	9·14 %	37·61 %	53·25 %			
Butyric	3·32	—	—	3·32	3·3	8·4
Caproic	2·80	—	—	2·80	2·8	5·4
Caprylic	1·55	—	2·21	3·76	3·8	5·8
Capric	1·18	—	6·63	7·81	7·8	10·1
Lauric	0·15	—	5·21	5·36	5·4	6·0
Myristic	—	6·53	5·56	12·09	12·2	11·8
Palmitic	—	19·45	3·97	23·42	23·5	20·4
Stearic	—	6·33	0·55	6·88	6·9	5·4
Arachidic	—	1·85	—	1·85	1·9	1·3
Oleic	0·14	3·45	24·60	28·19	28·3	22·2
Linoleic	—	—	4·07	4·07	4·1	3·2
Unsaponifiable	—	—	0·45	0·45	—	—

of palmitic and oleic acids in the former as compared with the latter. This is, of course, in accordance with the characteristic features of the Polenske, Kirschner and Reichert-Meissl values (especially the high Polenske values) of the goat and sheep milk-fats, to which attention has already been directed. The apparently close similarity between the component acids of these two classes of milk-fats, and their differences from the cow milk-fat acids, will be clearly seen from the comparison of the molar percentages of the component acids which follows in Table V. For reasons given by Hilditch and Sleightholme [1930; 1931], the relative number of molecules of each acid present, rather than the relative masses of the acids, forms the best basis for comparison; while additional information may be gained from consideration of the combined amounts of the four groups of acids, butyric-lauric, myristic-palmitic, stearic(-arachidic), and oleic-linoleic, which are found in the various milk-fats.

The combined data in Table V show the marked increase in the butyric-lauric acid group, apparently mainly at the expense of the unsaturated (oleic) acids; but further inspection reveals that the palmitic acid content is also definitely lower than in the majority of cow butter-fats. In each 100 molecules of mixed fatty acids, there are about 11–12 molecules more of caprylic + capric acids in the goat and sheep milk-fats than in those of the cows. Correspondingly, in an English pasture-fed cow butter of normal oleic acid content, there are

Table V. *Comparison of the molar distribution of the component acids of goat, sheep and cow milk-fats.*

Fat	Goat butter	Sheep butter	Cow butters [Hilditch and Sleightholme, 1931] Autumn fed (English)	Early summer pasture (English)	Pasture-fed December (New Zealand)
Butyric	7·6	8·4	8·4	8·9	9·2
Caproic	4·5	5·4	3·5	2·7	3·4
Caprylic	6·2	5·8	2·7	2·0	2·2
Capric	11·1	10·1	2·9	3·0	4·2
Lauric	5·1	6·0	4·1	4·7	4·7
Myristic	11·2	11·8	7·2	10·9	11·5
Palmitic	21·5	20·4	27·1	24·3	25·0
Stearic	7·3	5·4	6·4	5·4	9·5
Arachidic	0·1	1·3	0·7	—	0·5
Oleic	24·2	22·2	33·9	34·6	26·1
Linoleic	1·2	3·2	3·1	3·5	3·7
Butyric-lauric	34·5	35·7	21·6	21·3	23·7
Myristic-palmitic	32·7	32·2	34·3	35·2	36·5
Stearic(-arachidic)	7·4	6·7	7·1	5·4	10·0
Oleic-linoleic	25·4	25·4	37·0	38·1	29·8

about 10–12 mols. % more of this acid than in the Indian goat and sheep butters; while, in a more saturated cow butter-fat (the New Zealand sample in Table V), there are about 7 mols. % more of oleic + stearic acid than in the latter. The chief difference, taking the component acids of the fats as a whole, therefore seems to reside in the varying proportions of the caprylic-capric and oleic(-stearic) acid groups, with a subordinate corresponding variation in the content of palmitic acid. Further information on these differences emerges, however, from the study of the glyceride structure of the goat and sheep milk-fats which is recorded later in this paper.

It may be pointed out here that the two fats under discussion were from goats and sheep which were respectively reared in different localities of the Panjab, about 300 miles apart. The diet of both the goats and the sheep was, however, almost the same, whilst the milk was taken at the same season (January-February, 1932) when the temperature range in each place was almost identical (minimum 35°–maximum 70° F.). In the case of cow butter-fats, Hilditch and Sleightholme were able, to some extent, to correlate a fall in oleic acid content with the change from outdoor (summer) to indoor (winter) conditions or corresponding changes in diet, and with seasonal changes in temperature. The same factors might be considered to be operative in the present instances, but against this may be set the facts that the Indian winter temperature is more equivalent to that of spring or early summer in a temperate climate, and that the notable content of caprylic and capric acids is a feature clearly connected with the species of animal. The small content of these acids in the cow milk-fats has not been observed to increase in consequence of any alteration in temperature or feeding, *etc.*, conditions so far studied.

Component glycerides of the goat and sheep milk-fats.

The glyceride structure of the two milk-fats was studied by determining the proportion of fully-saturated glycerides present and the component fatty acids present in the latter, as described by Hilditch and Jones [1929]; information as to the components of the mixed saturated-unsaturated glycerides present was deduced from the combined data for the component acids of the whole fat

and of the fully-saturated glycerides. The details of the fully-saturated glycerides obtained by the oxidation of acetone solutions of goat and sheep milk-fats with potassium permanganate are given in Table VI.

Table VI. *Determination of fully-saturated glyceride (F.S.G.) content.*

(i) Analytical data.

			Purification of crude fully-saturated glycerides							
				"A"		"B"		Acidic products		
Milk-fat	Weight taken g.	Crude F.S.G. g.	Weight taken g.	g.	Acid No.	g.	Acid No.	g.	Acid No.	F.S.G. % (weight)
Goat	300·0	115·4	114·3	103·45	Nil	4·67	22·0	5·18	91·6	36·3
Sheep	300·0	109·5	108·8	97·10	Nil	4·07	27·2	7·03	85·8	33·7

(ii) Summary of observed values.

		Acids in whole fat		Fully-saturated glycerides		"Association ratio" in non-fully-saturated part. Mols. saturated acid per mol. unsaturated acid
Milk-fat	Iodine value	Saturated % (mol.)	Unsaturated % (mol.)	Weight %	Mols. %	
Goat	28·8	74·6	25·4	36·3	39·3	1·40
Sheep	32·1	74·6	25·4	33·7	36·8	1·49

The results of determinations of the component fatty acids in these fully-saturated glycerides are given in Table VII.

Table VII.

Acid	Volatile acids %	Acids non-volatile in steam %	Total %	% (weight) (excluding unsaponifiable matter)	% (mol.) (excluding unsaponifiable matter)
	Fully-saturated glycerides of goat milk-fat.				
	14·4 %	85·6 %			
Butyric	3·94	—	3·94	4·0	9·4
Caproic	4·02	—	4·02	4·1	7·2
Caprylic	3·40	0·62	4·02	4·1	5·8
Capric	3·04	8·60	11·64	11·8	14·2
Lauric	—	7·83	7·83	7·9	8·2
Myristic	—	13·86	13·86	14·0	12·7
Palmitic	—	38·65	38·65	39·1	31·6
Stearic	—	14·63	14·63	14·8	10·7
Arachidic	—	0·27	0·27	0·2	0·2
Unsaponifiable	—	1·14	1·14	—	—
	Fully-saturated glycerides of sheep milk-fat.				
	16·05 %	83·95 %			
Butyric	4·23	—	4·23	4·2	9·8
Caproic	4·68	—	4·68	4·7	8·2
Caprylic	3·80	—	3·80	3·8	5·4
Capric	2·28	6·80	9·08	9·1	10·8
Lauric	1·06	12·72	13·78	13·8	14·1
Myristic	—	17·80	17·80	17·9	15·9
Palmitic	—	33·82	33·82	34·0	26·9
Stearic	—	12·43	12·43	12·5	8·9
Unsaponifiable	—	0·38	0·38	—	—

The molar "association ratios" in the final column of Table VI permit limiting values to be calculated for the possible proportions of either mono-unsaturated di-saturated and di-unsaturated mono-saturated glycerides, or mono-unsaturated di-saturated and tri-unsaturated glycerides which may be present. It is probable that the proportion of triolein in milk-fats is extremely small [*cf.* Amberger, 1918], and that the minimum limits for mono-unsaturated derivatives and the maxima for the di-unsaturated class given in Table VIII are not far removed from the proportions actually present.

Table VIII. *Limiting values for the molar percentages of the four types of mixed glycerides in the goat and sheep milk-fats.*

Milk-fat	Iodine value	"Association ratio"	Glycerides (mols. %) Fully-saturated	Mono-unsaturated di-saturated	Di-unsaturated mono-saturated	Tri-unsaturated
Goat	28·8	1·40	39·3	45·5–53·1	15·2–0	0–7·6
Sheep	32·1	1·49	36·8	50·2–56·7	13·0–0	0–6·5

As in cow butter-fats, the proportion of fully-saturated components of goat and sheep milk-fats is clearly a function of the relative amounts of saturated and unsaturated acids in the whole fats; also, the content of fully-saturated glycerides approaches to some extent that of the latter (i) in synthetic glycerides of the same degree of unsaturation [Bhattacharya and Hilditch, 1930] and (ii) calculated on the assumption that the amount of fully-saturated glycerides is proportional to the cube of the content of the saturated acids in the whole fats. At the same time, as Table IX illustrates, the amount of fully-saturated

Table IX.

	Iodine value	Total saturated acids % (mols.)	Fully-saturated glycerides % (mols.) Observed	Calculated $y \propto x^3$	From synthetic glycerides curve	Association ratio
Goat butter	28·8	74·6	39·3	41·7	37·5	1·40
Sheep butter	32·1	74·6	36·8	41·7	37·5	1·49
*Cow butter II	31·6	72·4	41·3	38·0	34·0	1·11
*Cow butter V	34·5	70·2	39·6	34·5	30·5	1·07

* [Hilditch and Sleightholme, 1930.]

glycerides in each of the present cases is somewhat less, for a given ratio of saturated to unsaturated acids in the whole fat, than that characteristic of cow milk-fats (of which two specimens of somewhat similar iodine value are quoted. It will be noticed, also, that in the goat and sheep fats there is a considerably higher ratio of saturated to unsaturated acids in the mixed saturated-unsaturated glycerides than in the cow butter-fats.

Closer examination of the component fatty acids present in the fully-saturated and non-fully-saturated parts of the fats reveals some interesting features. For example, Hilditch and Sleightholme [1931] observed remarkable constancy in the component acids of fully-saturated glycerides from six pasture-fed cow butter-fats which differed widely in iodine value and fully-saturated glyceride content, but the corresponding components of the goat and sheep butter-fats are by no means the same (*cf.* Table VII). In particular the fatty acids of the

fully-saturated components of the goat and sheep fats include respectively molar contents of 31·6 and 26·9 % of palmitic acid, in contrast to the values 39·3–43·1 % obtained by the former authors for cow butters; whilst the stearic acid values (10·7 and 8·9 %) contrast equally with the almost constant figure (14·2–15·8 %) for the six cow butter-fats. The main differences between the two classes of milk-fat fully-saturated glycerides are thus the much higher proportion of the butyric-lauric acid group, and the correspondingly lower proportions of palmitic and stearic acids in the cases of the goat or sheep as compared with that of the cow.

These differences are illustrated in Table X, which gives a comparison of the proportions of the butyric-lauric acid group, and of myristic, palmitic,

Table X. *Molar distribution of fatty acids in goat, sheep and cow butter-fats.*

				Cow butters [Hilditch and Sleightholme, 1931]		
Section	Acids	Goat butter	Sheep butter	Autumn fed (English)	Early summer pasture (English)	Pasture-fed December (New Zealand)
Whole fat	Butyric-lauric	34·5	35·7	21·6	21·3	23·7
	Myristic	11·2	11·8	7·2	10·9	11·5
	Palmitic	21·5	20·4	27·1	24·3	25·0
	Stearic(-arachidic)	7·4	6·7	7·1	5·4	10·0
	Oleic-linoleic	25·4	25·4	37·0	38·1	29·8
Fully-saturated	Butyric-lauric	44·8	48·3	28·6	30·5	29·6
	Myristic	12·7	15·9	13·2	15·1	14·9
	Palmitic	31·6	26·9	43·1	39·5	39·9
	Stearic(-arachidic)	10·9	8·9	15·1	14·9	15·6
Saturated-unsaturated	Butyric-lauric	27·7	28·4	19·0	18·3	19·8
	Myristic	10·4	9·4	5·0	9·4	9·2
	Palmitic	15·1	16·5	20·9	18·7	15·0
	Stearic(-arachidic)	5·1	5·5	4·1	2·2	6·6
	Oleic-linoleic	41·7	40·2	51·0	51·4	49·4

stearic (with arachidic) and oleic (with linoleic) acids in the whole fats, and their fully-saturated and non-fully-saturated components. As in Table V, the data given by Hilditch and Sleightholme for three pasture-fed cow butter-fats are added for comparison with the goat and sheep butter-fats.

Especial interest attaches to the figures deduced for the component acids of the mixed saturated-unsaturated glycerides, for here the contents of myristic, palmitic and stearic acids are very similar in all three types of milk-fat—cow, sheep and goat; the concordance is, indeed, almost exact between the cow fat in the final column (which was of the same order of total unsaturation (iodine value) as the goat and sheep fats) and the latter. In these mixed component glycerides, therefore, in all three fats, the only essential difference is that, in 100 molecules of fatty acids, there are about 10 molecules less of unsaturated C_{18} acids, and about 10 molecules more of the butyric-lauric group, in the goat and sheep fats as compared with cow butter-fats. Moreover, the relative increase in the butyric-lauric group of acids is most marked in that of capric and caprylic acids. These features seem to offer considerable support to Hilditch and Sleightholme's suggestion that the lower fatty acids in milk-fats are formed at the expense of C_{18} acids, *i.e.* a precursor of stearic or oleic acid in a tallow may, in the course of milk-fat metabolism, appear instead as a lower fatty acid, with the proviso that only one molecule of any of the lower acids is produced in

milk-fat for each molecule of stearic (oleic) acid which otherwise would have resulted in a body-fat.

Finally, it may be pointed out that the relationships between sheep milk-fat and sheep tallows appear to be quite parallel with those disclosed between cow butter-fats and beef tallows [Banks and Hilditch, 1931]; the contents of myristic and palmitic acids in the whole fats and in their non-fully-saturated components, are closely similar, although (as in the analogous comparison between sheep and cow milk-fats) this accordance is lacking in the fully-saturated portions of sheep, butter and mutton tallow.

SUMMARY.

The component fatty acids of Indian goat and sheep milk-fats, and of their fully-saturated glycerides, have been determined in detail, and from these data the general structure of the glycerides has been deduced. The results have been compared with those previously obtained by other workers for cow butters and animal body fats.

The fatty acids of the milk-fats of goats and sheep, from two different places in the Panjab, but fed upon almost similar rations in the same winter season, are closely similar in composition, but differ from those of cow or buffalo butters in the higher content of the lower fatty acids (capric, caprylic and caproic) and the lower content of C_{18} unsaturated acids in the former than in the latter. The two sets of fats can be readily distinguished from each other by the Polenske value.

The content of fully-saturated glycerides in the two fats seems to be a function of the mean unsaturation, as in cow milk-fats. The component fatty acids of the fully-saturated glycerides are not so closely alike as in those of cow butter-fats, and also differ from the latter. In the mixed saturated-unsaturated glycerides, however, the molar contents of myristic, palmitic and stearic acids are very similar to those of the corresponding portions of cow butter-fats, and the only difference is that, in the goat and sheep milk-fats, there is about 10 % (mols.) less of C_{18} unsaturated acids and 10 % (mols.) more of the butyric-lauric acid group (the increase being mainly in capric and caprylic acids). The excess of capric and caprylic acids, as compared with cow butter-fats, therefore appears to be almost wholly at the expense of oleic acid.

The general properties and component glycerides of these two milk-fats are not far removed from those of the cow or buffalo, and there is, from this point of view, no reason why they should not be used as substitutes for the latter.

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