## 325. *The Component Acids and Glycerides of an Indian Bear Fat.*

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The mixed acids from the depot fat of a wild bear (*Ursus torquatus*) were separated by the lead salt–alcohol method and their composition was studied by the ester-fractionation procedure. The fat, in general, is similar in composition to fats of other omnivorous land animals. Low-temperature crystallisation was used for the determination of the glyceride structure; neither the rule of " even " nor that of " random " distribution was followed.

The common land-animal fats whose fatty acid compositions are available are from sacred baboon, Ceylon sloth bear, lion and cat,[1] bear,[2] puma,[3,4] tiger,[5] badger,[6] camel, deer,[7] elephant, horse, ox, sheep, and pig,[8] mostly domesticated or in captivity. To these we now add that from Indian bear.

Table 1. *Component acids and glycerides of fats of omnivorous land animals.*

| Acids | Ceylon sloth bear [1] | Sacred baboon [1] | Indian bear [a] |
|---|---|---|---|
| Myristic | 2·6 | 3·2 | 1·8 |
| Palmitic | 28·7 | 18·9 | 25·0 |
| Stearic | 3·4 | 11·9 | 10·7 |
| Tetradecenoic | — | 0·8 | 1·3 |
| Hexadecenoic | 10·6 | 3·8 | 18·0 |
| Oleic | 50·5 | 53·8 | 34·5 |
| Linoleic | 1·0 | 13·2 | 8·7 |
| Linolenic | 1·8 | — | — |
| $C_{20-22}$ unsat. | — | 0·5 | — |
| *Component glyceride groups* | | | |
| Trisat. | 2 | — | — |
| Disaturated-monounsat. | 16 | 10 | 20·8 |
| Monosat.-diunsat. | 68 | 70 | 69·3 |
| Triunsat. | 14 | 20 | 9·9 |

[a] Present work.

[1] Hilditch, Sime, and Maddison, *Biochem. J.*, 1942, **36**, 98.
[2] Steger and Püschel, *Pharmazie*, 1957, **12**, 821.
[3] Giral, *J.*, 1945, 112.
[4] Gunstone, *Biochem. J.*, 1955, **59**, 455.
[5] Pathak and Agarwal, *J. Sci. Food Agric.*, 1952, **3**, 136.
[6] Gupta, Hilditch, and Meara, *J.*, 1950, 3145.
[7] Gunstone and Paton, *Biochem. J.*, 1953, **54**, 617.
[8] Hilditch, " The Chemical Constitution of Natural Fats," Chapman and Hall, London, 1956.

In general, the pattern of both saturated and unsaturated acids is the same as for the fats of other omnivorous land animals (see Table 1). In detail the bear fat is more saturated—other land-animal fats of Indian origin are more saturated than those of animals from colder climates. The present analysis is also in conformity with the findings of earlier workers.[2]

TABLE 2. *Distribution of acyl groups in the glyceride of bear fat.*

| Glycerides | Actual | Computed "Even" [8] | Computed "Random" [10] |
|---|---|---|---|
| Fully saturated | — | — | 5·0 |
| Disat.-monounsat. | 20·8 | 11·0 | 26·0 |
| Monosat.-diunsat. | 69·3 | 89·0 | 44·0 |
| Triunsat. | 9·9 | — | 25·0 |

The glyceride structure was determined and is compared in Table 2 with that calculated on the "even" and the "random" pattern of acyl radicals. The present bear fat does not contain any saturated triglycerides (determined by Hilditch and Lea's method [9]), as suggested by the rule of "even" distribution, but in all other respects the composition is intermediate between the two calculated sets of values.

## EXPERIMENTAL

A dirty green fat was obtained from the thigh region of a freshly killed female bear (*Ursus torquatus*) from the forest of the Cherpunda area (North India). The saponification equivalent of the purified fat was 283·6 and the iodine value was 62·9 with 1·2% of free fatty acids (as oleic).

*Component Acids.*—A portion (160 g.) of the fat was saponified and the mixed fatty acids (142·7 g.; I.V. 66·9) were recovered. 98·6 g. of the mixed acids were resolved by the modified

TABLE 3. *Separation of the acids of bear fat by the lead salt–ethanol method.*

| Group | Sol. of Pb salt in EtOH at 15° | Weight (g.) | Weight (%) | I val. |
|---|---|---|---|---|
| X | Insoluble | 29·1 | 29·5 | 2·8 |
| Y | Soluble | 69·5 | 70·5 | 91·4 |

TABLE 4. *Component acids in groups* X *and* Y *from the whole fat of the bear.*

(Figures in parentheses indicate unsaturation, *e.g.*, —2·0 H means monoethenoid).

| Acids | Component acids * of groups (%) X | Component acids * of groups (%) Y | Total (%) | Fatty acids in the whole fat excl. non-sap. % (w/w) | Fatty acids in the whole fat excl. non-sap. % (mol.) |
|---|---|---|---|---|---|
| Saturated | | | | | |
| Myristic | 0·9 | 1·0 | 1·9 | 1·8 | 2·2 |
| Palmitic | 20·5 | 4·4 | 24·9 | 25·0 | 26·2 |
| Stearic | 6·8 | 3·8 | 10·6 | 10·7 | 10·0 |
| Unsaturated | | | | | |
| $C_{14}$ | — | 1·3 (—2·0 H) | 1·3 (—2·0 H) | 1·3 | 1·5 |
| $C_{16}$ | 0·5 (—2·0 H) | 17·5 (—2·0 H) | 18·0 (—2·0 H) | 18·0 | 19·0 |
| $C_{18}$ | 0·7 (—2·0 H) | 42·5 (—2·4 H) | 43·2 (—2·4 H) | 43·2 | 41·1 |
| Unsap. | 0·05 | 0·06 | 0·1 | — | — |

* The figures are derived from quantities of fractions actually obtained on fractionation. Loss was small and ignored. Hence the figures total 100.

Twitchell lead salt method [8] into two groups X and Y (Table 3), which were separately converted into the methyl esters and fractionated in an efficient electrically heated column [11] at about 0·1 mm. The saponification equivalent and iodine value of each fraction were determined. The composition of the fat, calculated by Hilditch's method,[8] is recorded in Table 4.

*Component Glycerides.*—Neutral fat was crystallised from acetone and ether at various

[9] Hilditch and Lea, *J.*, 1927, 3106.
[10] Longenecker, *Chem. Rev.*, 1941, **29**, 201.
[11] Longenecker, *J. Soc. Chem. Ind.*, 1937, **56**, 199T.

temperatures as shown in the chart. Fractions of nearly similar iodine values were combined, giving the fractions A, B, and C.

The mixed acids recovered from each fraction A, B, and C were resolved into solid and liquid groups by the usual lead salt–alcohol method.[8] The resolved fractions are designated AA, AB, BA, BB, CA, and CB in Table 5. Each fraction was converted into its methyl ester and then fractionated for the determination of component acids above through the same column. The compositions of the fractions thus obtained were calculated and therefrom those of the major fractions A, B, and C, and finally of the whole fat were obtained (see Table 6).

TABLE 5. *Separation of the mixed acids of glyceride fractions* A, B, *and* C.

| | | Weight | | |
|---|---|---|---|---|
| Fraction A | Sol. of Pb salt in EtOH at 15° | (g.) | (%) | I val. |
| AA | Insoluble | 22·0 | 50·7 | 1·6 |
| AB | Soluble | 21·4 | 49·3 | 66·6 |
| Fraction B | | | | |
| BA | Insoluble | 21·4 | 31·2 | 5·2 |
| BB | Soluble | 47·1 | 68·8 | 75·7 |
| Fraction C | | | | |
| CA | Insoluble | 33·5 | 23·0 | 9·6 |
| CB | Soluble | 112·0 | 77·0 | 84·5 |

TABLE 6. *Component acids of glyceride fractions,* A, B, *and* C (mol. %).

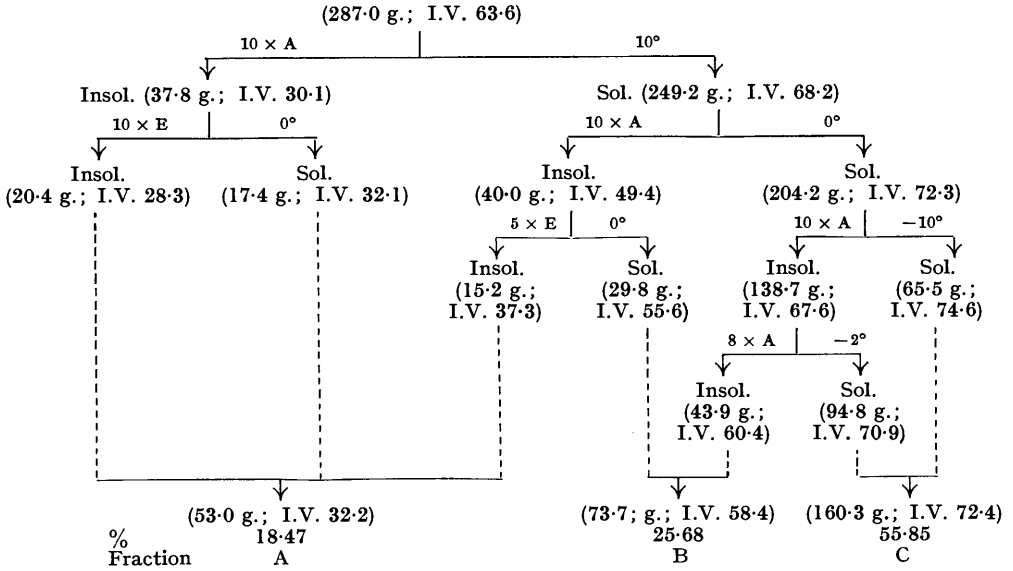
| Acids | A | B | C | Total |
|---|---|---|---|---|
| Myristic | 0·2 | 0·5 | 1·0 | 1·7 |
| Palmitic | 8·0 | 7·4 | 9·3 | 24·7 |
| Stearic | 3·1 | 2·5 | 5·0 | 10·6 |
| Tetradecenoic | 0·2 | 0·3 | 1·1 | 1·6 |
| Hexadecenoic | 1·5 | 2·9 | 12·2 | 16·6 |
| Oleic | 5·6 | 10·3 | 23·2 | 39·1 |
| Linoleic | — | 1·7 | 4·0 | 5·7 |

TABLE 7. *Component glycerides (mol. %) of bear fat.*

(Calc. according to the suggestions of Hilditch and Meara, *J. Soc. Chem. Ind.*, 1942, **61**, 117.)

| | A | B | C | Whole fat |
|---|---|---|---|---|
| Component acid groups | | | | |
| Myristic and " palmitic " | 8·2 | 7·9 | 10·3 | 26 |
| Stearic | 3·1 | 2·5 | 5·0 | 11 |
| Tetra- and hexa-decenoic | 1·7 | 3·2 | 13·3 | 18 |
| " Oleic " and linoleic | 5·6 | 12·0 | 27·2 | 45 |
| Component glyceride groups (mol. %) | | | | |
| Disat.-monounsat. | 15·2 | 5·6 | — | 21 |
| Monosat.-diunsat. | 3·4 | 20·0 | 45·9 | 69 |
| Triunsat. | — | — | 9·9 | 10 |
| " Dipalmito " monoethers | 6·0 | — | — | 6 |
| " Monopalmito " diethers | 12·6 | 23·8 | 30·9 | 67 |
| Triethers | — | 1·8 | 24·9 | 27 |
| " Dioleo " monoethers | 3·4 | 10·4 | 25·7 | 40 |
| " Mono-oleo " diethers | 10·1 | 15·2 | 30·1 | 55 |
| Triethers | 5·1 | — | — | 5 |
| Possible component glycerides (mol. %) | | | | |
| Disaturated monounsaturated (20·8%) | | | | |
| " Dipalmito-olein " | 6·0 | — | — | 6 |
| " Palmito-stearo-olein " | 4·1 | 5·6 | — | 10 |
| " Palmito "-stearo-hexadecenin | 5·1 | — | — | 5 |
| Monosaturated diunsaturated (69·3%) | | | | |
| " Palmito-diolein " | 3·4 | 10·4 | 15·9 | 29 |
| " Palmito "-hexadeceno-" olein " | — | 7·8 | 15·0 | 23 |
| Stearo-hexadeceno-" olein " | — | 1·8 | 15·0 | 17 |
| Triunsaturated (9·9%) | | | | |
| Hexadeceno-" diolein " | — | — | 9·9 | 10 |

*Crystallisation of the bear fat, with iodine values of the fractions and sub-fractions* (A = *acetone*, E = *ether*, *ml. of solvent/g. of fat*).




The possible component glycerides were calculated from the composition of the individual groups of acids by Hilditch's computational method [8] and are given in Table 7.

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