Triglyceride Composition of Coconut Oil

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ABSTRACT

Triglycerides of coconut oil were fractionated by GLC into 13 groups based on their carbon numbers of 28 to 52. These groups represent 99.8% of the total glycerides of coconut oil. With the fatty acid composition of each group, it was possible to calculate the composition of 79 types of triglycerides. These types are defined by the nature of their constitutive fatty acids but the position of the acids on glycerol is unknown. Each group usually has only one major type of triglyceride. For example, group 36 has 52% of trilaurin. Also four types of triglycerides comprise 42.4% of the total glycerides and 24 types comprise 85%. The experimentally found distributions in each group are compared to the random distributions calculated from the fatty acid composition. For groups with carbon numbers 38 and 40, the experimental and random distributions were very similar but for most other groups, the distributions found were much different from the calculated random distributions.

INTRODUCTION

The first studies on the triglyceride composition of coconut oil were made with fractional crystallization (1-3). These last authors succeeded in isolating nine triglyceride fractions of which the fatty acid pattern was determined. From these data, a probable triglyceride composition of this fat was deduced.

From gas liquid chromatographic (GLC) analysis of total triglycerides of coconut oil (4), it was possible to determine the composition of 14 peaks, or groups, of triglycerides identified by their carbon number. A more extensive GLC analysis was made (5) on five fractions previously isolated by molecular distillation. The exact triglyceride composition was not fully established.

The fatty acid composition of each chromatographically isolated group of triglycerides from some natural fats adds to a more accurate knowledge of their triglyceride composition as shown with bovine milk fat (6).

In a previous paper (7) we described a technique of triglyceride fractionation by GLC and its application to coconut oil triglycerides.

This study reports the fatty acid composition of most triglyceride groups of coconut oil fractionated by GLC and the triglyceride type composition of the groups calculated from analytical results.

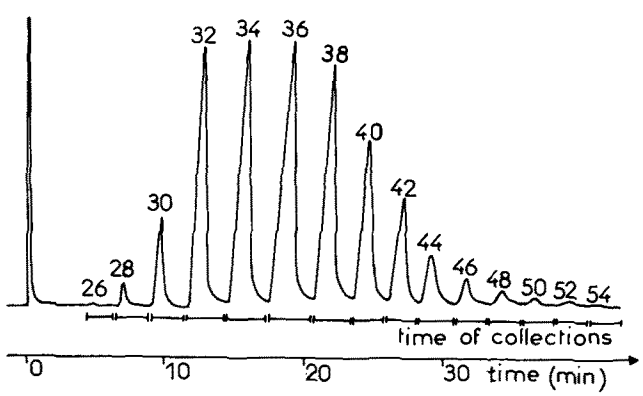

FIG. 1. Chromatogram recorded during fractionation of coconut oil triglycerides and time of peak collections. See operating conditions in the Experiment Section. Triglyceride peaks (or groups) are identified by their carbon number.

EXPERIMENTAL PROCEDURES

Materials

Coconut oil used in this investigation was a refined oil donated by the ASTRA-CALVE Society. The triglyceride fraction of this oil was isolated by silicic acid column chromatography (8) before GLC fractionation.

Methods

Fractionation and Purification of Triglycerides. Triglyceride peaks were obtained using the equipment and the previously described technique (7) using a 6 ft x 3/16 in. stainless steel column packed with 100/120 mesh Gas-Chrom Q and coated with 1% JXR (W/W). A 1609 F & M chromatograph was linearly programmed from 280 to 380 C at a rate of 3 C/min. The final temperature was maintained until the last peak of triglycerides eluted. The nitrogen flow was constant and equal to 185 ml/min; injector temperature: 400 C, collector temperature: 350 C.

Several (from 5 to 10) consecutive separations of 3 mg of the triglyceride mixture per chromatogram were needed to get enough material of the trace components. Between each fractionation, the chromatograph was programmed under the same conditions without sample to elute any triglycerides remaining on the column.

The purity of fractionated triglyceride peaks was determined by means of a Girdel analytical apparatus, under the conditions described elsewhere (9). Analyses were carried out on quantities of approximately 2 μg with linear temperature programming from 250 C to 360 C, at a rate of 10 C/min, with a nitrogen flow of 50 ml/min.

The triglyceride peaks which showed a purity less than 95% were purified by another preparative GLC under the same conditions as above.

GLC of Fatty Acids. The fatty acid composition of the collected triglyceride peaks were determined by GLC of butyl esters (9,10) because of the presence of short chain fatty acids in these mixtures.

Two 3 ft x 1/8 in. stainless steel columns packed with 20% DEGS on 80/100 mesh Chromosorb W acid-washed on 75-CD/PT Girdel chromatograph equipped with flame ionization detector were used for the ester analysis. The temperature was programmed from 100 to 200 C at a rate of 5 C/min with a nitrogen flow of 35 ml/min.

Determination of Random Distributions. Random distributions of triglyceride groups or triglyceride types were calculated by the method described by Bailey (11) and as used by Kuksis, et al. (12,13).

RESULTS

Fatty Acid Composition of the Fractionated Groups

Figure 1 shows one of the chromatograms recorded during fractionation of triglycerides into groups by GLC (7). Each peak corresponds to a triglyceride group characterized by its carbon number (number of carbon atoms of the fatty acid moiety in the molecule).

Table I gives the fatty acid composition of 13 groups of coconut oil triglycerides: groups 28 to 52. Also given for each group are the mean molecular weight of the trigly-

TABLE I

Fatty Acid Composition (Mole %) of Triglyceride Groups 28 to 52 of Coconut Oil Triglycerides

	Triglyceride groups[a]													Total triglycerides	
Fatty acids	28	30	32	34	36	38	40	42	44	46	48	50	52	Experimental[b]	Calculated[c]
6:0	9.7	10.2	3.2	1.9	1.1	0.5	0.5	Trace	Trace	---	---	---	---	1.3	1.7
8:0	36.8	19.2	26.5	18.6	8.5	7.2	3.3	2.2	3.0	1.6	0.9	2.5	4.5	12.0	12.3
10:0	12.5	20.1	5.9	12.6	9.7	5.9	6.0	1.8	2.0	3.0	1.9	0.9	2.0	8.0	8.1
12:0	28.7	41.3	54.3	44.4	58.9	51.0	44.2	41.7	22.8	23.5	15.2	5.3	8.4	48.2	47.4
14:0	5.3	2.4	4.4	16.5	11.4	23.0	23.8	17.4	25.5	15.2	14.1	10.8	7.0	14.6	14.8
16:0	3.0	2.9	1.7	3.3	7.8	5.8	13.3	17.3	17.8	27.3	22.6	33,4	28.6	6.9	7.8
16:1	1.3	1.3	0.6	0.6	0.4	0.3	1.0	1.0	2.4	1.4	3.5	8.6	9.8	Trace	0.8
18:0	1.0	0.7	1.1	0.7	0.8	2.6	2.9	7.4	6.9	5.6	7.3	7.8	9.7	2.0	2.1
18:1	1.3	1.4	1.8	1.1	1.0	3.1	4.0	9.7	16.8	19.4	29.1	26.1	22.9	4.5	3.8
18:2	0.1	0.1	0.1	0.1	0.1	0.3	0.5	1.0	1.4	1.9	3.0	2.5	3.1	1.4	0.3
18:3 + 20:0	0.2	0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.8	0.8	1.0	1.2	2.5	0.1	0.2
C>20	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.6	0.5	1.4	0.9	1.5	0.1	0.2
Mole %[b]	0.9	4.2	15.8	19.0	20.3	17.2	9.6	6.4	3.2	1.5	1.0	0.5	0.2		
Experimental molecular weight[d]	560	579	597	617	643	665	690	725	754	765	797	809	800		
Theoretical molecular weight[e]	526	554	582	610	638	666	694	722	750	778	806	834	862		
Difference %[f]	+ 6.6	+ 4.5	+ 2.6	+ 1.1	+ 0.8	- 0.2	- 0.6	+ 0.4	+ 0.5	- 1.7	- 1.1	- 2.8	- 7.2		

[a]Group: triglycerides with the same carbon number (number of carbon atoms of the fatty acid moiety in the molecule); corresponding to the peaks as they appear on the chromatogram (Fig. 1).

[b]As determined by analytical GLC (9). Traces of groups 26 (0.1) and 54 (0.1 mole %) were found.

[c]Fatty acid composition of coconut oil calculated from the fatty acid composition of groups 28 to 52 and from the group composition of total triglycerides.

[d]Mean molecular weight of the triglyceride groups, calculated from their respective fatty acid composition.

[e]Mean molecular weight of the triglyceride groups, calculated from their respective carbon number, assuming that all fatty acids are saturated (in these conditions error is less than 0.2% for the most unsaturated triglyceride groups, e.g., 48 and 52).

[f]$\text{Difference } \% = 100 \times \frac{\text{Experimental M.W.} - \text{Theoretical M.W.}}{\text{Theoretical M.W.}}$

TABLE II

Example of Determination of Triglyceride Type[a] Composition of Group 38[a] of Coconut Oil Triglycerides

Fatty acid composition of group 38, mole %			Determination of triglyceride type composition of group 38			
Fatty acids	Experimental	Calculated[b]	Triglyceride types	Moles %	Equation system[c]	Solution
6:0	Trace	---				
8:0	7.2	7.3	8,12,18	a	a + b = 7.2 x 3	a = 15
10:0	5.9	5.7	8,14,16	b	2c +d +e = 5.9 x 3	b = 7
12:0	51.0	51.0	10,10,18	c	a +d +2f = 51.0 x 3	c = 3
14:0	23.0	24.3	10,12,16	d	b +2e +f = 23.0 x 3	d = 10
C_{16}[d]	6.1	5.7	10,14,14	e	b + d = 6.1 x 3	e = 1
C_{18}[d]	6.1	6.0	12,12,14	f	a + c = 6.1 x 3	f = 64
C_{20}[d]	Trace	---				
	99.3	100.0				a + . . .+f =100

[a]Group: triglycerides with the same carbon number. Type: triglycerides defined by the nature of their constituent fatty acids without considering their degree of unsaturation. The position of the acids on glycerol is unknown.

[b]Calculated from the triglyceride type composition determined in the four last columns.

[c]These equations mean that the fatty acid composition of group 38, whose triglyceride type composition is: a,b,c,d,e,f must be identical to the experimentally determined fatty acid composition (Experimental). Number 3 means that 100 moles of triglycerides include 300 moles of fatty acids.

[d]Fatty acids with the same number of carbon atoms.

cerides of this group calculated from their fatty acid composition (experimental molecular weight) and the mean molecular weight calculated from the carbon number of the group (theoretical molecular weight) assuming that all the fatty acids are saturated. The difference between these experimental and theoretical values are expressed in per cent. The Table also shows the fatty acid composition of total triglycerides as previously determined (9) and the one calculated from the fatty acid composition of groups 28 to 52 and from the group composition of the total triglycerides (9).

The fatty acid composition of the triglyceride groups 26 and 54 was not determined because it was impossible to get enough material with a sufficient degree of purity to run a precise analysis. But we must point out that these triglycerides are found in the mixture in trace amounts, since the triglycerides of groups 28 to 52 represent by themselves 99.8% of the total triglycerides.

If we compare the molecular weights, experimental and theoretical, of the triglycerides of each group, there is generally a good correlation between the two values since the difference does not exceed 5% except for the extreme peaks 28 and 52.

These differences are all positive for the first peaks and all negative for the last peaks. For the first peaks of low molecular weight, the difference may be explained by a loss of short chain fatty acids (6:0 and 8:0) in spite of the use of butyl esters because of the very small amount of material available.

The difference noticed for the last peaks may be explained by the contamination due to the tailing of the preceding peaks of lower molecular weight.

The good correlation of the experimental and theoretical molecular weights proves the good purity of the triglyceride groups as determined by rechromatography. The good purity explains the similarity of the fatty acid composition of the total triglycerides experimentally determined and the one calculated from the fatty acid composition of the different groups (last two columns in Table I).

One may thus consider the fatty acid composition of the triglycerides of each group as very close to the real values except for the extreme peaks 28 and 52.

The short chain fatty acids (6:0, 8:0 and 10:0) are found mainly in the fractions of low molecular weight (groups 28 to 34), whereas the long chain acids are in the triglycerides of higher molecular weight (groups 40 to 52); the medium chain fatty acids (12:0 and 14:0) can be found in all groups of triglycerides, in appreciable amount, but especially in group 36 for lauric acid (close to 60%) and in group 38 and 40 for myristic acid (about 23%).

In general the difference of the proportion of a given fatty acid in one group and the next one is rather regular. However it must be noted that there are two, sometimes three groups, in which the proportion of one of the fatty acids is low compared to those of the preceding and following groups, namely 8:0 (groups 30 and 36), 10:0 (groups 32 and 38), 12:0 (groups 34, 40 and 44), 14:0 (groups 36, 42 and 46), 16:0 (groups 38, 44 and 48) and 18:0 (groups 40 and 46).

Triglyceride Type Composition

A triglyceride type is defined by its three constitutive fatty acids (without considering their degree of unsaturation) but the distribution of these acids on the three glyceryl positions is unknown.

The distribution of the triglyceride types in each group was calculated from the fatty acid composition of the group as follows: three fatty acids out of those found in each triglyceride group in which the sum of the carbon atoms corresponds to the carbon number of the group were combined in every possible way. A series of equations was then derived to calculate the triglyceride type composition. These equations mean that the fatty acid composition of the group, calculated from the triglyceride type composition, must be identical to the experimentally determined fatty acid composition.

Table II gives an example of such equations and of the results thus obtained for group 38.

Usually the number of triglyceride types exceeds the number of equations that may be derived from the fatty acid present. We must resort to approximations, for example, leave out the fatty acids present in trace amounts (the shortest or longest chain fatty acids). Usually it is then possible to calculate a fatty acid composition which is compared to the experimental composition; from this comparison the computed values can be empirically adjusted to consider triglycerides having fatty acids present in only trace amounts.

Table III shows values that were determined for each group (28 through 52). These data are compared with random values. Traces of groups 26 (0.1) and 54 (0.1 mole per cent) were found.

TABLE III

Experimental and Random Distribution of Triglyceride Groups and Triglyceride Types in Coconut Oil Triglycerides

Triglyceride groups[a]	Moles % into the total triglycerides		Triglyceride types[d]	Moles % into the groups		Moles % into the total triglycerides	
	Experimental[b]	Random[c]		Experimental[e]	Random[c]	Experimental[f]	Random[c]
			6,6,16	8	0.1	0.1	Trace
			6,8,14	10	4.7	0.1	0.15
			6,10,12	30	9.7	0.3	0.30
28	0.9	3.11	8,8,12	50	77.5	0.4	2.41
			8,10,10	2	8.0	Trace	0.25
				100	100.0	0.9	3.11
			6,6,18	3	0.9	0.1	Trace
			6,8,16	8	1.4	0.3	0.07
			6,10,14	3	1.9	0.1	0.09
			6,12,12	37	18.7	1.6	0.91
30	4,2	4.84	8,8,14	2	15.1	0.1	0.73
			8,10,12	43	60.9	1.8	2.99
			10,10,10	4	1.1	0.2	0.05
				100	100.0	4.2	4.84
			6,6,20	---	Trace	---	Trace
			6,8,18	6	0.7	1.0	0.08
			6,10,16	2	0.4	0.3	0.04
			6,12,14	7	0.4	1.1	0.04
			8,8,16	2	3.0	0.3	0.35
32	15.8	11.41	8,10,14	4	8.0	0.6	0.92
			8,12,12	75	79.3	11.9	9.04
			10,10,12	4	8.2	0.6	0.94
				100	100.0	15.8	11.41
			6,8,20	---	Trace	---	Trace
			6,10,18	2	0.4	0.4	0.05
			6,12,16	7	2.1	1.3	0.26
			6,14,14	2	0.7	0.4	0.08
			8,8,18	4	3.2	0.8	0.40
			8,10,16	5	3.4	0.9	0.43
34	19.0	12.60	8,12,14	48	43.5	9.1	5.48
			10,10,14	2	2.2	0.4	0.28
			10,12,12	30	44.5	5.7	5.62
				100	100.0	19.0	12.60
			6,10,20	---	Trace	---	Trace
			6,12,18	2	1.6	0.4	0.30
			6,14,16	2	0.4	0.4	0.08
			8,8,20	---	Trace	---	Trace
			8,10,18	3	2.6	0.6	0.50
36	20.3	19.11	8,12,16	12	13.6	2.4	2.58
			8,14,14	12	4.3	2.4	0.83
			10,10,16	10	0.7	2.0	0.13
			10,12,14	7	17.8	1.5	3.39
			12,12,12	52	59.0	10.6	11.30
				100	100.0	20.3	19.11
			6,12,20	---	Trace	---	Trace
			6,14,18	---	0.6	---	0.09
			6,16,16	---	0.1	---	0.02
			8,10,20	---	Trace	---	Trace
			8,12,18	15	18.3	2.6	3.00
38	17.2	16.39	8,14,16	7	4.8	1.2	0.78
			10,10,18	3	0.9	0.5	0.15
			10,12,16	10	9.8	1.7	1.63
			10,14,14	1	3.1	0.4	0.51
			12,12,14	64	62.4	10.8	10.21
				100	100.0	17.2	16.39
			6,14,20	---	Trace	---	Trace
			6,16,18	---	0.4	---	0.04
			8,12,20	---	0.3	---	0.04
			8,14,18	8	7.9	0.8	0.91
			8,16,16	2	1.6	0.2	0.18
40	9.6	11.48	10,10,20	---	Trace	---	Trace
			10,12,18	14	16.2	1.3	1.86
			10,14,16	4	4.2	0.4	0.48
			12,12,16	40	42.2	3.8	4.84
			12,14,14	32	27.2	3.1	3.13
				100	100.0	9.6	11.48
			6,16,20	---	Trace	---	Trace
			6,18,18	---	0.3	---	0.03
			8,14,20	---	0.1	---	0.01
42	6.4	10.04	8,16,18	6	4.3	0.4	0.44

(Continued on page 138)

TABLE III (Continued from page 137)

Experimental and Random Distribution of Triglyceride Groups and Triglyceride Types in Coconut Oil Triglycerides

Triglyceride groups[a]	Moles % into the total triglycerides		Triglyceride types[d]	Moles % into the groups		Moles % into the total triglycerides	
	Experimental[b]	Random[c]		Experimental[e]	Random[c]	Experimental[f]	Random[c]
			10,12,20	---	0.2	---	0.02
			10,14,18	3	5.6	0.2	0.56
42	6.4	10.04	10,16,16	2	1.2	0.1	0.12
			12,12,18	44	56.0	2.8	5.63
			12,14,16	43	29.2	2.7	2.92
			14,14,14	2	3.1	0.2	0.31
				100	100.0	6.4	10.04
			6,18,20	---	Trace	---	Trace
			8,16,20	---	0.1	---	0.01
			8,18,18	10	4.9	0.3	0.25
			10,14,20	---	0.1	----	0.01
			10,16,18	7	5.2	0.2	0.27
44	3.2	5.10	12,12,20	---	1.4	---	0.07
			12,14,18	51	66.2	1.6	3.38
			12,16,16	20	13.5	0.7	0.69
			14,14,16	2	8.6	0.4	0.42
			14,14,16	100	100.0	3.2	5.10
			6,20,20	---	Trace	---	Trace
			8,18,20	2	0.2	Trace	0.01
			10,16,20	---	0.1	---	Trace
			10,18,18	8	6.1	0.1	0.15
			12,14,20	---	1.7	---	0.04
46	1.5	2.52	12,16,18	60	63.3	1.0	1.60
			14,14,18	15	8.3	0.2	0.21
			14,16,16	15	20.3	0.2	0.51
				100	100.0	1.5	2.52
			8,20,20	2	Trace	Trace	Trace
			10,18,20	2	Trace	Trace	Trace
			12,16,20	2	1.4	Trace	0.02
			12,18,18	40	63.0	0.4	0.93
48	1.0	1.47	14,14,20	2	0.4	Trace	0.01
			14,16,18	40	33.0	0.4	0.48
			16,16,16	12	2.2	0.2	0.03
				100	100.0	1.0	1.47
			10,20,20	2	Trace	Trace	Trace
			12,18,20	10	5.5	0.05	0.02
50	0.5	0.42	14,16,20	10	1.4	0.05	0.01
			14,18,18	20	66.2	0.1	0.28
			16,16,18	58	26.9	0.3	0.11
				100	100.0	0.5	0.42
			12,20,20	2	Trace	Trace	Trace
			14,18,20	8	5.0	Trace	0.01
52	0.2	0.14	16,16,20	30	1.0	0.1	Trace
			16,18,18	60	94.0	0.1	0.13
				100	100.0	0.2	0.14

[a]Group: triglycerides with the same carbon number (number of carbon atoms of the fatty acid moiety in the molecule) corresponding to the peaks as they appear on the chromatogram (Fig. 1).

[b]As determined by analytical GLC (9). Traces of groups 26 (0.1) and 54 (0.1 mole %) were found.

[c]As calculated from the fatty acid composition of total triglycerides according to Bailey (11).

[d]Type: triglycerides defined by their three constituent fatty acids considering only their chain length but not their unsaturation; fatty acid position in the molecule is unknown.

[e]As determined according to the method reported in Table II. All groups required simplifying assumptions to complete the calculations.

[f]As calculated from the triglyceride type composition of the group and from the triglyceride group composition of total triglycerides.

DISCUSSION

A study of these different data calls for the following comments.

In 13 of the triglyceride groups, we always find one or two triglyceride types that predominate in the mixture, e.g., 8 groups of the 13 analyzed include 50% or more of a triglyceride type. These triglyceride types contain usually lauric acid (for 6 of the 8 types considered).

Simple triglycerides, when present, exist in trace amounts except for trilaurin which accounts for 52% of group 36. For triglyceride types containing C_{16} and C_{18} fatty acids, especially groups from 40 and 42, C_{16} is represented mainly by palmitic acid (16:0) and C_{18} by oleic acid (18:1).

If we compare these experimental data to those calculated for assuming a random distribution, we may observe that there are rather marked differences.

The same triglyceride types exist in large amounts in a given group, but the values are generally quite different; for some groups the experimental distribution is very close to a random distribution; this is true for group 38, group 40 and to a smaller extent group 36. The differences are particularly significant in extreme groups, that is to say, in those whose fatty acid composition, and consequently whose triglyceride composition is known with less accuracy (Table I). The inaccuracy of experimental values is not the only

reason because for groups 34 and 42, for example, whose fatty acid composition is accurately known (Table I), marked differences appear between the two distributions in the triglyceride types.

If we examine the proportion of the different triglyceride types in the oil we may notice that four triglyceride types appear in a proportion close to 10%, each belonging to one of the four principal groups of the mixture: 32, 34, 36 and 38. This is true for trilaurin which represents 10.6% of the coconut oil triglycerides. The other triglycerides, and there are many of them, exist generally in trace amounts practically between 0% and 2%. Thus, four triglyceride types represent 42.4% of the coconut oil triglycerides and only 24 types (proportion equal or superior to 1%) of the 79 possible types, represent 85.0% of the total triglycerides.

The difference between these values and the values which would be obtained in a random distribution correspond to the differences observed on the triglyceride types within the groups and on the triglyceride groups.

These differences do not compensate each other and the proportion of the different triglyceride types in coconut oil often deviate in a significant way from a proportion in a random distribution.

If we compare our data with those obtained by others (1-3), the most striking difference is that we find a rather large amount of trilaurin (more than 10%) in coconut oil. This simple triglyceride could not be obtained, particularly by Dale and Meara (3) using fractional crystallization, while it was isolated from other fats (14). Trilaurin seems to be a major component of group 36 since lauric acid represents nearly 60% of total fatty acids in this group.

As for the other triglyceride types, our results agree quite well with those of Dale and Meara. We also found rather large amounts of caprodilaurin (about 20%), caprolauromyristin (about 12%) and dilauromyristin (about 11%). We obtained smaller quantities of lauromyristopalmitin (less than 3%) and caprolauro-olein (4 to 5%) than did these authors (13% and 9% respectively).

As already mentioned by Bomer and Baumann (1), but not by Dale and Meara, we also found laurodimyristin (3.1%) and dimyristopalmitin (0.5%).

Thus by means of GLC fractionation of triglyceride groups and analysis of their fatty acids, it has been possible to determine the composition of 79 types of triglycerides in coconut oil. Only 14 (13) or 15 (9) or 17 (5) groups of triglycerides identified through GLC by their carbon number had been reported previously.

It was possible to establish for each isolated group equations mathematically solvable by means of only slight approximations. This is not true for most other natural fats with a smaller number of individual fatty acids for which other separation techniques have to be previously applied.

REFERENCES

1. Bomer, A., and J. Baumann, Z. Unters. Nahr. Genussm. 40:97 (1920).
2. Collin, G., and T.P. Hilditch, J. Soc. Chem. Ind. London 47:261 T (1928).
3. Dale, A., and M. Meara, J. Sci. Food Agric. 6:162 (1955).
4. Kuksis, A., and M.J. McCarthy, Can. J. Biochem. Physiol. 40:679 (1962).
5. Augustin, P., Oleagineux 22:99 (1967).
6. Breckenridge, W.C., and A. Kuksis, Lipids 3:291 (1968).
7. Bugaut, M., and J. Bezard, J. Chromatogr. Sci. 8:380 (1970).
8. Fillerup, D.L., and J.F. Mead, Proc. Soc. Exp. Biol. Med. 83:574 (1953).
9. Bezard, J., and M. Bugaut, J. Chromatogr. Sci. 7:639 (1969).
10. Clement, G., and J. Bezard, C.R. Acad. Sci., Paris 253:564 (1961).
11. Bailey, A.E., "Industrial Oil and Fat Products," 2nd Ed., Interscience, New York, 1951, 834 p.
12. Kuksis, A., M.J. McCarthy and J.M.R. Beveridge, JAOCS 40:530 (1963).
13. Kuksis, A., M.J. McCarthy and J.M.R. Beveridge, Ibid. 41:201 (1964).
14. Bomer, A., and K. Ebach, Z. Unters. Lebensm. 55:501 (1928).

[Received January 5, 1970]