Original Communications

Fatty Acid Contents of Margarines and Other Table Fats

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It is now well established that the prevalence of arteriosclerosis is closely related to the nature and quantity of circulating fats.[1–7] There is also evidence of a possible link between arteriosclerosis and the amount of calories consumed in the form of fat, in particular fat of animal origin.[8–14] When dietary animal fats were replaced by vegetable fats, dramatic decreases in serum cholesterol and other serum lipids have been reported.[15] This effect has been attributed to the replacement of the majority of saturated fatty acids in the diet by unsaturated acids.[16] It has been recommended, therefore, that reasonable substitution of polyunsaturated for saturated dietary fats may be a possible means of preventing atherosclerosis.[17]

There is today considerable consumer interest in the poly- and diunsaturated fatty acid contents of various edible fats, and this persists despite certain authoritative objections against the claims made for beneficial effects of polyunsaturated fats in the diet.

As a result physicians, as well as dieticians and home economists, are being asked increasingly numerous questions about margarines and other edible fats; the study of the fatty acid composition of various table fats reported here may be of help in replying to such inquiries.

METHOD AND MATERIALS

Samples were purchased at local retail stores during a period from October 1961 to March 1962. Duplicate, and in some cases triplicate, analyses were performed. The methyl esters of the fatty acids were prepared as follows: An aliquot of each margarine was saponified with 30 per cent potassium hydroxide in 50 per cent ethanol at 60°c. under prepurified nitrogen. The saponification mixture was acidified and the fatty acids extracted with petroleum ether. The ether was evaporated under vacuum without heating, and the fatty acids were methylated by means of the BF_3-methanol reagent of Metcalfe and Schmitz.[18]

Gas chromatographic analyses were performed in a Wilkens Aerograph A-90-P at 200°c. on an 8-foot column, 1/4-inch in diameter, packed with 20 per cent diethylene glycol succinate on 60/80 chromosorb W. The relative amounts of individual fatty acids were calculated from recorded elution diagrams with the aid of a disc integrator.

RESULTS

The fatty acid composition of margarines is indicated in Table I. The commercial products were classified into three groups, namely, those for which no special claims as to refrigeration or content in polyunsaturates are made (group I), those with labels recommending storage of the product under refrigeration without other specific claims as to composition (group II), and finally those which are advertised as containing large amounts of polyunsaturated acids or corn oil (group III). Corresponding data for shortenings, cooking oils, peanut butters, as well as for butter and lard, are given in Table II.

The last column in both tables shows the ratio of linoleic acid to the sum of all saturated acids (L:S ratio). This term is convenient

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TABLE I

Fatty Acid Composition of Margarines in Per Cent of Total Fatty Acids

Group*	Brand Name	Saturated Fatty Acids					Mono-unsaturated Fatty Acids		Diun-saturated Fatty Acids	Polyun-saturated Fatty Acids‡‡	L:S Ratio§§
		<14†	14‡	16§	18‖	20¶	16:1#	18:1**	18:2††		
I	Blue Bonnet	0.5	0.3	14.1	6.9	...	...	64.1	14.1	...	0.65
	Butler	...	...	11.2	9.9	...	...	52.2	25.0	1.7	1.18
	Clover	...	0.2	11.3	9.0	...	...	64.5	14.5	Trace	0.71
	Good Luck	0.5	0.3	14.6	9.3	...	...	62.7	13.0	...	0.53
	Mother's	0.4	0.1	11.2	7.7	...	...	56.7	22.8	1.0	1.17
	Mrs. Filbert's	0.2	0.2	13.0	7.3	...	...	61.0	18.2	...	0.88
	Parkay	...	0.1	15.6	8.9	...	...	58.2	17.2	...	0.70
	Sun Valley	...	0.2	11.2	9.1	...	...	59.0	20.5	...	1.00
II	Allsweet	...	Trace	12.0	7.6	...	...	66.0	14.4	...	0.73
	Imperial	0.9	0.6	15.3	7.7	...	...	57.2	17.9	Trace	0.73
	Miracle	...	0.1	13.6	7.2	...	...	62.2	16.9	...	0.81
	Nucoa	0.9	0.5	16.0	6.6	...	...	59.0	16.9	...	0.70
	Tri-Nut	42.5	12.2	10.3	4.3	0.2	...	20.1	8.9	Trace	0.13
III	Award	...	0.5	26.3	5.5	...	0.4	32.2	34.9	...	1.08
	Emdee	8.2	2.4	12.8	7.9	Trace	Trace	24.0	43.0	0.8	1.37
	Fleischmann's unsalted	Trace	Trace	13.1	6.5	...	...	64.9	15.5	...	0.79
	Kraft Deluxe	...	...	12.7	6.8	Trace	...	51.1	28.8	Trace	1.48
	Mar-Parv	...	...	12.2	6.9	Trace	...	61.2	19.7	Trace	1.03
	Mazola	...	...	11.4	9.7	...	...	50.7	26.1	1.9	1.23
	Mother's unsalted	0.5	0.2	13.6	6.6	...	...	49.0	30.0	Trace	1.43
	Mrs. Filbert's‖ ‖	Trace	...	11.7	8.6	...	...	48.9	28.8	2.0	1.42
	New Nucoa	...	0.1	12.3	7.3	...	...	50.6	29.7	Trace	1.51
		0.5	0.6	19.1	7.2	...	...	45.9	28.6	...	1.04

* According to manufacturer's claims (see text).
† All saturated fatty acids with carbon chains of less than 14, including lauric, capric and caprylic acids.
‡ Myristic acid.
§ Palmitic acid.
‖ Stearic acid.
¶ Arachidic acid.
# Palmitoleic acid.
** Oleic acid and trans isomer.
†† Linoleic acid and other possible positional or stereoisomers of diunsaturated 18-carbon acids.
‡‡ Probably linolenic acid, i.e., 18:3.
§§ Ratio of linoleic to the sum of all saturated fatty acids.
‖ ‖ Mrs. Filbert's corn oil margarine.

as an indication of the quality of edible fats with respect to their content in polyunsaturated acids.[19]

Recorder tracings of typical gas chromatographic experiments of some of the products are shown in Figure 1.

COMMENTS

When the meaning of the prefix "poly," defined by the Webster dictionary as "many, several, diverse, much, multi, pluri, etc." is correctly applied, polyunsaturated fatty acids are those which contain three or more double bonds per molecule. It is evident from the data presented here that none of the edible fats examined contained any significant amounts of other than diunsaturated fatty acids. The use of the term "polyunsaturated fat" in connection with any of these products, therefore, is not justified.

While the unsaturated fatty acids in these edible fats consist, therefore, almost entirely of monounsaturated and linoleic acids, the latter might be considered to be the sole substance of interest in connection with dietary fats and arteriosclerosis. According to a recent statement, however, by the A.M.A. Council on Foods and Nutrition,[19] "The nutritional significance of the increased amount of linoleic acid in the special margarines has

TABLE II
Fatty Acid Composition of Various Edible Fats in Per Cent of Total Fatty Acids

Product	Brand Name	Saturated Fatty Acids						Mono-unsaturated Fatty Acids		Diun-saturated Fatty Acids	Polyun-saturated Fatty Acids	L:S Ratio
		<14	14	16	18	20	22*	16:1	18:1	18:2		
Shortenings	Crisco	3.5	1.2	14.3	13.0	...	...	..	59.0	8.7	...	0.27
	New Crisco	0.2	0.2	14.0	12.0	...	...	..	44.0	27.0	1.8	1.02
	Fluffo	Trace	1.2	25.2	12.5	...	...	2.7	50.7	7.3	Trace	0.19
	Spry	4.7	1.5	18.5	11.5	...	...	..	55.4	8.4	...	0.23
	Staff	1.4	0.6	14.8	9.8	...	...	..	62.0	11.4	...	0.43
	Swiftning	...	2.2	25.1	16.8	...	...	3.2	43.0	9.6	...	0.22
Cooking oils	Kraft	...	1.1	20.4	2.6	Trace	...	1.2	17.6	57.1	...	2.37
	Mazola	...	...	13.3	1.6	...	...	...	28.7	56.2	0.2	3.78
	Staff	0.2	0.5	22.1	2.0	...	...	0.1	17.2	58.0	...	2.34
	Wesson	...	0.7	20.5	2.3	...	...	0.6	18.0	57.8	...	2.46
Olive oils	Elena	...	...	11.2	2.4	...	...	0.7	81.1	4.6	...	0.34
	Pastene	...	...	11.3	1.5	...	...	0.1	82.6	4.5	...	0.35
Peanut butters	Big Top	...	...	11.3	4.6	Trace	0.6	...	57.8	24.6	Trace	1.49
	Jif	...	...	12.0	5.8	Trace	...	...	59.0	23.3	Trace	1.31
	Peter Pan	...	...	10.0	5.8	1.1	1.7	...	56.0	24.7	1.0	1.33
	Planters	...	...	10.8	5.5	1.0	1.7	...	49.1	31.2	0.8	1.64
	Oz	...	...	11.3	5.4	Trace	1.7	...	54.0	26.6	Trace	1.45
	Skippy	...	...	13.2	5.9	Trace	Trace	...	51.2	29.8	Trace	1.56
	Staff	...	...	11.3	4.4	0.4	Trace	...	59.0	24.6	0.4	1.53
Butter	†	8.5	10.7	27.9	13.4	...	...	2.3	30.7	1.2	1.4	0.02
Lard	Armour	0.4	1.6	25.4	15.1	Trace	...	2.5	42.2	10.6	Trace	0.25

* Behenic acid.
† Averages of three brands; variations between these brands were small.

not been well established. On the basis of the average per capita consumption of margarine, the extra amount of linoleic acid made available by the use of special margarine is not very great."

Notwithstanding the answer to the question of whether dietary linoleate in quantities consumed with margarines or in any other amounts has beneficial effects, it is generally assumed that only the excess of linoleic acid over the sum of all saturated fatty acids is apt to define the relative merit of a food in this connection, as expressed by the L:S ratio.

This ratio, shown for each product in the last column of Tables I and II, is lowest for butter, followed by lard, most shortenings and olive oils, and is highest in the cooking oils. Margarine and peanut butter assume intermediate positions.

The L:S ratio is substantially increased only in a few special margarines as compared with the regular ones. Certain claims made for some margarines, namely, that they contain large amounts of corn oil, are in fact not always true. One manufacturer even achieves softness by the addition of short chain saturated fatty acids of low melting point, instead of adding triglycerides containing large quantities of linoleic acid.

In general, those interested in substituting unsaturated fats for saturated ones in their diets must remember that most margarines, regular and special alike, contain substantial amounts of saturated fats in order to retain a workable consistency. Certain exceptional margarines, however, do have an L:S ratio exceeded only by cooking oils. In order to enable physicians and consumers to identify such products, more detailed labeling (including L:S ratio) should be required. The composition of complex products such as these may

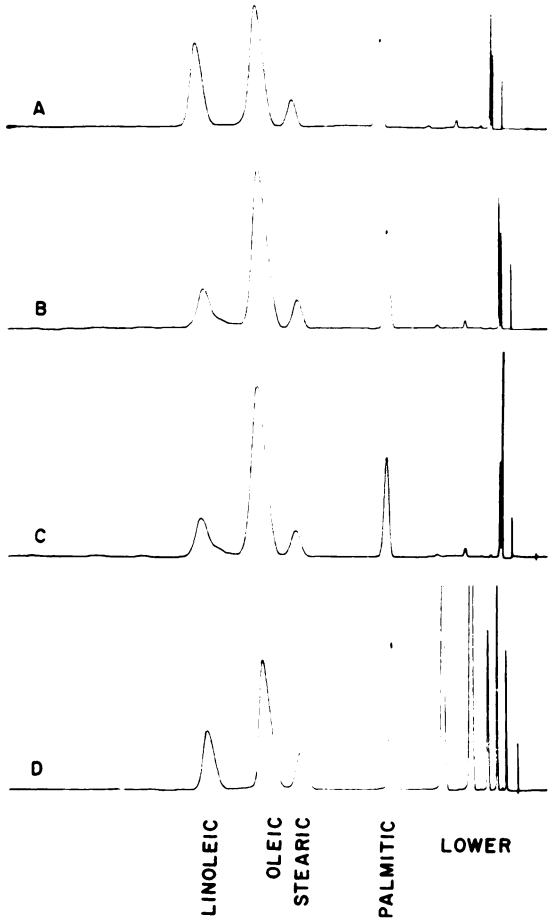

FIG. 1. Gas chromatograms of fatty acids from various margarines. *Tracing A* is a chromatogram of "Mazola." Note the relatively high proportion of linoleic acid. *Tracing B* is of a regular margarine, "Blue Bonnet." *Tracing C* is of Fleischmann's margarine labeled as containing "liquid corn oil." Actually it appears to be identical with the same manufacturer's "Blue Bonnet" (Tracing B). *D* is a tracing of Tri-Nut margarine which has been softened by the addition of short chain saturated fatty acids.

be subject to variation depending on sample and time. Also, manufacturers occasionally may radically change the composition of their product without any or with only minor changes in the label. The data herein discussed apply only to the products named during the period stated.

SUMMARY

The fatty acid composition of forty-three margarines and other edible fats was determined by gas chromatography. Considerable variations were found in the contents of saturated and unsaturated fatty acids. The claims made for certain "improved" products are not always borne out. It is suggested that consumers' needs for information would be better served by a statement on the label of the L:S (linoleic acid:total saturated fatty acids) ratio.

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